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# Design and Development of Hybrid Charging Topology

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## ABSTRACT

Implementation of this system is to ensure continuous output current to load utilizing both Photovoltaic (PV) energy and AC Grid. Utility interfacing PWM converter designed here to operate by both solar energy and storage batteries that highly satisfies the necessity in rural areas where National Grids are hardly available and power cut problem reduces the effectiveness of system. Solar energy gets priority here to charge storage battery rather than AC source that may save hundreds of megawatts power every day. To extend the battery lifetime and keep system components hazard-free, it includes exact battery-level sensing, charging-current controlling by microcontroller unit (MCU) charge to congregate maximum PV energy from AC Solar Modules. Investigation on improvement of power- interfacing control and optimization of overall system operation assent to intend usage recommendation in this exposition.

**Keywords :** Solar Energy, Hybrid Charging Topology, Battery, Electric Vehicle.

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## I. INTRODUCTION

Most of the recent commercial MPS system is the composition of PWM (Pulse Width Modulation) type converter, storage battery & converter-cum-charger transformer regardless of the concern for overload, overcharging or low battery cut problems. Exact voltage level sensing and battery-charge controlling are also unavailable. These phenomena result in degradation of battery lifetime and in the same time huge wastage of power and extends electricity bill. So, intelligent modification is needed in the existing MPS system. The proposed system utilizes a MCU (microcontroller unit) to successfully overcome these tribulations. Moreover, due to limited sunshine hours and non-ideal conditions, it is not only desired to accumulate maximum PV energy from panels but also to ensure maximum utilization. The designed system has been rigorously tested in extremely harsh

environments to ensure reliable, trouble-free operation regardless of any change in climate. Hence, new research directions are explored for the utilization of solar energy, electrical engineering development and power electronics technology.

## II. PROPOSED SYSTEM

The proposed system basically consists of three tiers:

- a) Input power system,
- b) Intelligent processing system and
- c) Output power system.

The core part of this system is the intelligent switching circuit which is composed of PIC 18F25K22 based MCU unit which ensure uninterrupted output power based on the available input. This pre-programmed section intelligently not only maintains maximum AC output power with greater efficiency but also DC

supply to small DC load that may reduce pressure of AC output. The following sub-sections give the details of entire system.

### Input Power and Switching System

Input power section allows three different sources of energy like grid line, storage battery and Photovoltaic energy. To minimize the burden on the grid line, the system is designed as follows: when Grid supply is present, switching circuitry gets informed about its availability from AC main sensing section and passes AC main's signal to converter output socket. In absence of AC grid supply, switching circuitry takes DC input from storage battery and turns on converter circuit i.e. composition of oscillator, MOS driver, output amplifier and transformer section and AC low-pass filter. Oscillator section generates 50 Hz MOS driver signal that gets amplified, sent to converter transformer using MOSFET switching and transforms into AC and injects AC energy to the AC-side output connection. Such periodical switching ON/OFF of MOSFET starts an alternating current with 50Hz frequency at primary winding of step-up transformer that results in 220V AC supply at the secondary winding. All these functionalities are done here by implementing PIC 18F25K22 MCU unit that resembles the change-over section of commercial MPS section implementing by analog circuitry.

### Intelligent Processing and Battery Charging System

In absence of solar energy, it is mandatory to use AC mains to charge storage battery. But, in daytime, it prefers solar energy to AC grid in battery charging for power saving purposes. To ensure maximum possible PV energy, some intelligence is applied in this proposed system. With a regular charge controller, if the batteries are low at say 12 volts, then a 40 watt solar panel rated at 2.20 amps at 18.20 volts (2.20 amps times 18.20 volts = 40 watts) will only charge at 2.0 amps times 12.4 volts or just 25 watts, losing 35% of panel's capacity. In this case the system compensates for the lower battery voltage by delivering closer to 3 amps into the 12.4 volt battery maintaining the full power of the 40 watt solar panel. The intelligent charging section involves three level of charging like absorption level charging, bulk level charging and float charging.

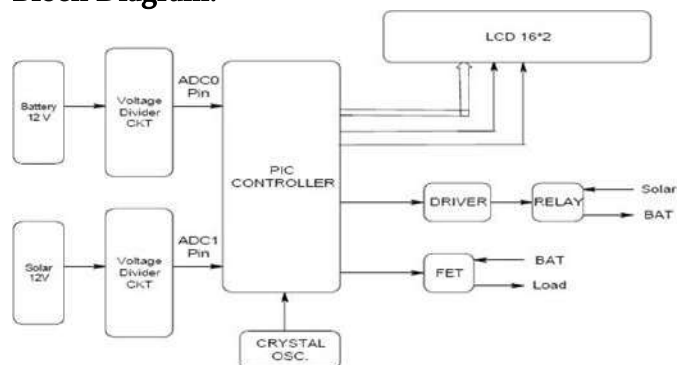
A bulk level charging is maintained for initializing charging process for a discharged battery. When Battery voltage exceeds a critical level, charge controller maintains adsorption level charging. A full charged battery gets only float level charging that maintains trickling current (i.e. one tenth of full charge current) causes available solar energy being unused.

### Output Power system

Implementing such configuration described in previous section, maximum utilization of photovoltaic energy is not yet confirmed practically. In semi-urban areas, where load-shedding are not much frequent, almost 80% of available solar energy are being left unused. To utilize such power, this system contains an output pin that supplies additional DC power to small loads like in mobile charging application, DC fan, DC light, DC iron, electric filters etc.

## III. SYSTEM DEVELOPED

### Block Diagram:



Block Diagram of solar charger Controller circuit  
HARDWARE:



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Fig 1 shows complete hardware for the charging system Which LCD display is connected to show battery voltage as well as grid and panel voltage .In our system two inputs and one output we were provided. In which inputs are provided for grid and panel respectively, output is provided for the connection of load.

Fig 2 shows Lead-acid batteries are available in several different configurations like small sealed cells with capacity of 1 Ah to large cells with capacity of 12,000 Ah. Lower and higher cut-off voltages can be changed with the help of modes. In this project, we are using battery of 12V, 18 Ah capacity.

In Fig 3. Shows Solar cells produce energy by performing two basic tasks: (1) absorption of light energy to create free charge carriers within a material and (2) the separation of the negative and positive charge carriers in order to produce electric current that flows in one direction across terminals that have a voltage difference. In this project, we are using solar panel of 12V.

#### IV. RESULT

Charging by raw without load

Time (in minutes)	Raw Voltage (V)	Battery Voltage (V)
0 (Start)	11.9	11.3
20	12.4	11.7
32	12.2	11.8
40	12.4	11.9

Charging by PV without load

Time (in minutes)	Panel Voltage (V)	Battery Voltage (V)
0 (Start)	12.2	11.3
15	12.2	11.7
30	12.3	11.8
50	12.0	11.9



## V. FUTURE WORK

Here we can also implement a fine adjuster of output DC voltage level to power large possible and even tiny loads. A voltmeter can also integrate for this purpose at the output section to make this as user-friendly as possible.

## VI. CONCLUSION

This project presenting topology of hybrid charging system for sort of electric vehicle, which is generally used to reduce use of non-renewable source of energy, which is fairly significant. This study develops a system that provide a circuit by which we can charge EV's using solar as well as grid power, to mostly reduce pollutants emission from power generation and transportation sector in a suitable way.

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# IoT Based Overloaded Power Monitoring and Controlling System

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## ABSTRACT

One of the buzzwords in the Information Technology is Internet of Things (IoT). The future is Internet of Things, which will transform the real world objects into intelligent virtual objects. The IoT aims to unify everything in our world under a common infrastructure, giving us not only control of things around us, but also keeping us informed of the state of the things. The proposed system enhances electrical safety by fast disconnection of the power supply in case of fault events like leakage current, electrical arc, overcurrent or overvoltage and has been designed with the goal to be integrated in smart environments like smart homes or smart cities for protecting the electrical equipment. The system also enables real-time monitoring and notification events through an advanced communication interface using a data concentrator architecture. This paper provides an extended description of the proposed system's design and implementation, as well as the experimental validation results.

**Keywords :** IOT, overload control, smart control, smart monitoring.

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## I. INTRODUCTION

As the population is increasing the electricity demand is also increasing. Power generating plants are been installed to meet the growing demand. Due to depletion in natural resources the gap between the supply and the demand is continuously increasing. For the betterment of power distribution and generation this overload power detection and controlling technique is used.

The security and reliability of the electrical energy infrastructure is of vital importance today more than ever, given the degree to which electric-powered technology has become embedded in all human

activities. Protecting the electrical power supply system against interruptions due to various faults is thus a main research concern. One of the components involved in power-system protection is the circuit breaker, which is responsible for closing the system when a fault or anomaly occurs in order to protect the electrical equipment.

In today's world, the technological trend of implementing "smart" technologies, fostered by the emergence of Cloud Computing and the Internet of Things (IoT), led to a transfiguration of ordinary devices and environments to "smart" entities. In this context, traditional electrical protection devices also tend to transcend and become "smart", and

consequently offer improved fault-detection and protection, remote monitoring and event notification. By becoming smart, a home is embedded with ubiquitous computing equipment that connects all the household devices to one another and the Internet. A smart city also embeds in the urban landscape computers, sensors, cameras and other sensitive equipment operating in the background. In these circumstances, protecting the power supply grid against faults becomes even more important, given the increasing number of sensitive devices connected in the emerging Smart world.

The revolution has been brought within the modern world by Internet of Things based technology after its discovery in the field of computer and internet. Thus we can practice the concept of IOT technology in the power system. Today the world is moving fast towards the more operative and well-organized smart grid technology by switching the existing timeworn technology with the new smart grid technology. Hence we can make use the technologies in order to make the existing power system more operational and well organized. The motive of this project is to improve the sharing out of power in India where problems like load shedding a common situation.

## II. Literature Survey

Literature review plays an important role in deciding the objectives of the study. It helps in the successful completion of the work to arrive at the desired results. Many improvements in communication and hardware technology have been developed - a promising one is the IoT technology, from home automation to industrial IoT. The IoT is an emerging technology, and it has been a great interesting topic for the past few years. Much literature is available on monitoring, controlling, and protecting the transformer, and enormous work has been done in this area. A system based on the microcontroller to monitor and save the substation transformer from current rise due to

overload is proposed [1]. A PLC-based automatic control system [2, 3] to monitor and detect the transformer's internal faults and external faults were proposed. In [4], a protective system using a temperature sensor, microcontroller, LCD, GSM, and Xbee was proposed to send the message to the electricity board. A conventional fault detecting method [5] have been employed for transformer protection. Nowadays, transformer fault monitoring based on vibration analysis drawing the attention of researchers because of added advantages. This method shows satisfactory results, but it can still be improved using computer algorithms to analyze the data and predict the fault. This work presents, development of an IoT based system for real-time monitoring and control of transformer parameters. This system is placed close to the transformer, and considered parameters are diagnosed and are transmitted to a centralized web server. Thus, the data is utilized to know the transformer's condition on a real-time basis and are stored within a server database for future analysis. system enables the two-way communication between the transformer and the operator by sending SMS alerts [5,6]. Misovic et al performed a detailed mathematical analysis on thermal imaging of power transformer to estimate its hot spot temperature. Data from remote terminal unit (RTU) is collected for monitoring and analysis purpose using GPRS technology [7]. Behera et al and Pai et al have discussed about an implementation of PLC based self-intelligent cooling and monitoring system for key operating parameters of DT [8,9]. Kumar et al work on the compact design of remote monitoring system for a 3-phase transformer. Remote monitoring of operating point of 3-phase transformer is achieved using Arduino microcontroller and ZigBee based wireless device [10]. Nelson et al and Cheng et al focused on the design of RTU for fault analysis in DT using GSM message technology [11,12]. Vishwanath et al has proposed the design of multiple incipient faults detection system for 3-phase distribution transformer using PIC microcontroller, LCD display GSM board and Xbee

technology. The designed system monitors the current, temperature and voltage parameters by sending messages at electricity board by GSM modem [13].

### Analysis of Literature Survey

It is essential to monitor regularly the operational status of the loaded distribution transformer. Monitoring is the observation of transformer conditions and is of two types: offline and online. The difference between the two is that in off-line, the transformer is in the off state, and online, the transformer is in on state to measure the data. The transformer is to be protected from both internal and external faults. Among these temperature variations, oil level fall and load change require regular monitoring to safeguard the transformer [1, 7]. If transformers operate under healthy conditions, they have a long life; otherwise, their lives are significantly reduced. The main causes of failure in the transformer are overloading and ineffective cooling. Overloading of power transformers beyond the nameplate rating causes rise in temperature of both oil and windings. If the temperature rise of winding crosses the specified value, the insulation may get damaged [1, 3, 9]. Continuous heating weakens the insulation and causes an accelerated reduction in transformer life.

### III. Proposed Work

In this technique to detect overloading power, a current sensor is used. This current sensor provides the current status of power value from the ac source. This value is then comparing with the reference value which is already being set in IOT device. The comparison is done in controller. If there is any overloading, it will be controlled by the relay which is directly connected to the load. The IOT mobile application used is Blynk app to feed reference value and to control the overloading from remote distance. "Blynk" app is free mobile application software that connects the robot with the internet and helps the user to control the device from a remote location. It has a

live monitoring feature that enables the user to control the overloading power anywhere by using the "Blynk" app on his mobile phone. To provide internet of things (IoT) access, NodeMCU which is a microcontroller integrated with the Wi-Fi module on a single board is used.

NodeMCU is used to control the operation of motors connected. Controller read the data given by the IOT based application and then according to the commands given or the programming it will give command signals to the relays which will control the loads connected accordingly. NodeMCU is a Wi-Fi based module that provides an internet service to the microcontroller to execute the given command from the user.

Current sensor is used ACS712 which is 5ampere current sensor detecting the overload current from the AC source. A voltage sensor in the form of transformer is also used to detect voltage range but in normally voltage doesn't change its value so we are focusing over current. For display the output LCD display is used which is connected to the controller. Two relays are used to connect the respective load with controller. These relays will help to control overloading situation and prevent load from the damage.

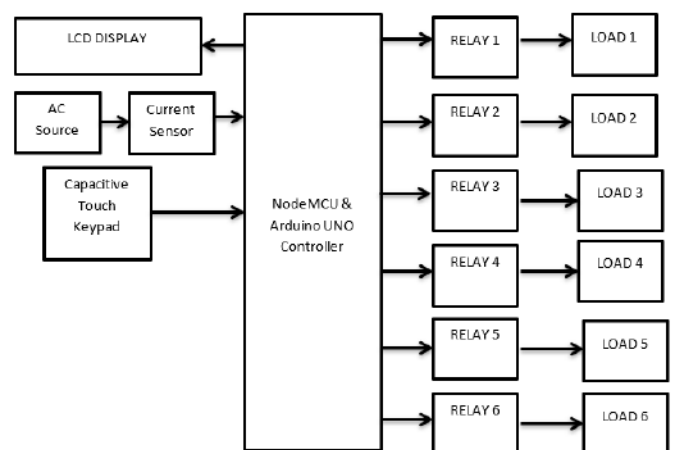


Fig.1 Block diagram

### IV. METHODOLOGY

In Existing system, the load current is increasing in nature so it will directly influence to the consumers

equipment and utility side customers. The equipment connected in consumer side will be ruin due to over current flows in the circuit. No specific controller is installed in a power lines for the tenacity of fault recognition. The existing system was not able to detect the faults like short circuit of feeders, feeder overloading and earth faults because of probabilities of collapsing the equipment due to extra-large over load current.

In order to overcome the circumstances like overloading or short circuit, we have planned a simple prototype model of overload monitoring and controlling using IOT. This project is designed in such a way that it shows normal load for one light bulb and overload status when another bulb is connected or the load is increased. Current sensor is used ACS712 which is 5ampere current sensor detecting the overload current from the AC source. A voltage sensor in the form of transformer is also used to detect voltage range but in normally voltage doesn't change its value so we are focusing over current. For display the output LCD display is used which is connected to the controller. Two relays are used to connect the respective load with controller. These relays will help to control overloading situation and prevent load from the damage. In the system, current sensors are used to measure the incoming and outgoing current flowing through energy meter. When the outgoing current is greater than incoming then overloading occurs. For controlling through IOT device we have used BLYNK application. Two loads can be controlled by Blynk application from the remote distance. A notification will appear in case of overloading and user can turn off or turn on load by this application.

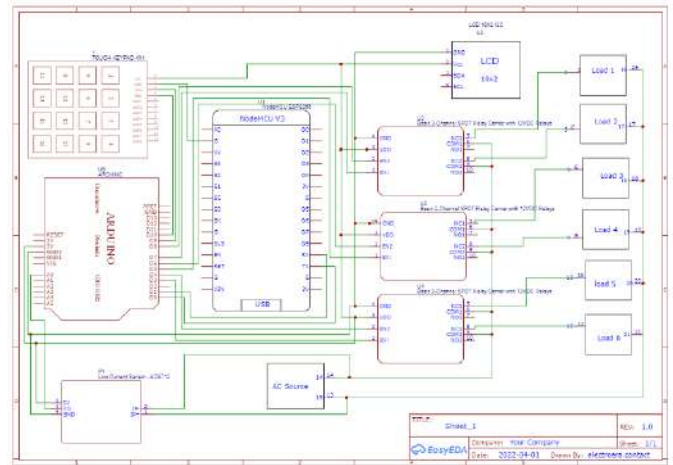


Fig.2 Circuit Diagram

### Circuit description:

We have used NodeMCU as controller which has inbuilt Wi-Fi along with two relays and two loads. For displaying output 16X2 LCD display panel is used with I2C module to interface with NodeMCU controller. For current detection in the circuit a current sensor ACS712 is used.

Current sensor is connected between AC source and controller. This sensor will detect current from AC source and gives output to the controller. This current sensor module has 3 pins named as Vcc pin, ground pin and output pin Vout. The supply pin is connected to the Vin pin of the controller and ground pin is connected to the ground pin. Output the the current sensor is given to the controller at A0 pin which is analog pin. The current is varying in nature hence we used analog pin to detect changing current.

Relays are connected to the controller at pin number D3 and D4. The purpose of relays is to provide path for the current to reach the load. These relays will be ON or OFF by the IOT application when the overload occurs. One end of relays is connected to the controller and other end is connected to the load. When controller allows relay turn ON then only current reaches to the load.

Power value will be indicating on LCD display which is connected to the controller via I2C module which converts serial data from controller to parallel data for LCD display. I2C module has 4pins which are connected to the digital pins of controller. SCL and SDA pins of module are connected at D1 and D2 pins respectively. Rest 2 pins are ground and supply pins which are connected to ground and supply pins of controller.

## V. Conclusion

This paper described the design, implementation and functional validation of an advanced power-system protection device with IoT-based support for integration in smart environments like Smart Homes or Smart Cities. In this work, the development and implementation of real-time monitoring and control systems for transformer protection and recording have been presented. This system is designed to protect the distribution transformer from overloading, overheating, and other abnormalities. An IOT system is employed to monitor and control the operational parameters of the transformer. The IOT system is located close to the transformer base, and the above parameters are sensed and then transmitted to the centralized web server. Thus, the data is utilized to know the transformer condition on a real-time basis and are stored within a server-based database for future analysis and immediate protective precautions.

## VI. Future Scope

Today the world is moving fast towards the more operative and well-organized smart grid technology by switching the current time worn technologies by the smart grid technology. Thus we can make use of both the expertise in order to make the present power system more operative and well organized. Smart grid

and IOT will be a perfect amalgam of two know-hows which results in improvement of the current power structure of India. In addition to that there are many such benefits of using technology. Many current problems that are present in the existing power grid structure can be solved out. The motive of the paper is to enhance the sharing out of power in India where hitches like load shedding a common situation.

## VII. Results

This system is implemented on embedded microcontroller systems included with self-contained programs within the hardware. It is based upon online monitoring of overload power in the load and controlling has defined in this work. Code is written for NodeMCU controller to monitor the considered operational parameters and the ESP8266 Wi-Fi module to maintain connectivity with a BLYNK application which is IOT dashboard. When any one of the operating parameters varies beyond the predefined/set value, this device can alert the condition of power overload and help the utilities control operational parameters regularly and send a notification to the user on Blynk application. Then the operator reads the message, and immediate remedial action is initiated to protect the load.

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## Automated Smart Cabin

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### ABSTRACT

With the rising demand for security and energy conservation, framework with high reliability and fast reaction frameworks are real need for industries. Radio frequency is the suitable technology for short distance wireless communication. In this project, a wireless transmitter and receiver system using RF modules (RF Transmitter and RF Receiver) is implemented. RF Transmitter and Receivers is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. The Transmitter sends a signal which is to be received by the Receiver to which further mechanism of security and energy conservation is connected.

Keywords— Rf transmitter and receiver, Relay, Servo motor, Door access control, Battery

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## I. INTRODUCTION

Security systems play an important role to prevent unauthorized personnel entry into a secured environment, which may include physical and intellectual property. Communication over Radio Frequency has many advantages as it doesn't require a line of sight connection between the transmitter and receiver as in case of infrared communication[1]. Conventional locks can be easily hacked by unwanted people thereby allowing unauthorized personnel into secured premises. Access Control System recognizes authenticates and authorizes entry of a person to enter into the premise thereby giving complete protection ensuring security with the system. Many access control systems use network for communication purpose and information is communicated through these networks[1]. On account of these perils, it is basic to have a type of individual recognizable proof (ID) to get to one's own specific data. Security get to framework is

exceptionally helpful to use at home, office and business structures. Every one of these years, different frameworks are acquainted with track the individual's development. Energy conservation has become a global phenomenon these days and you will know the significance it has acquired because we as a nation have a separate day dedicated to remind everyone how important it is to save energy. The basic idea behind energy conservation is to reduce the consumption of energy. So, even if you cannot reduce the usage of energy run appliances completely, shift to those which are more energy efficient. We are implementing smart relay which cuts the supply when the user is not around.

## II. Objective

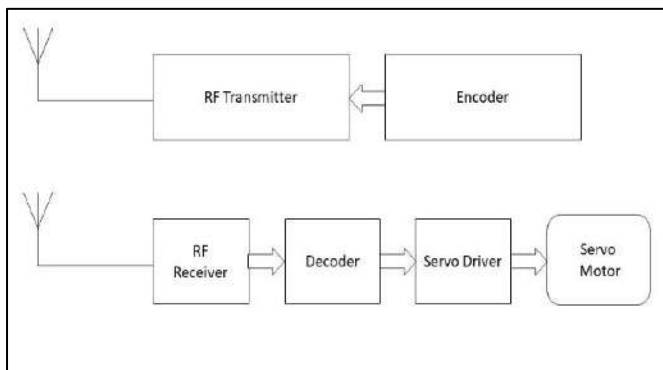
Providing automation to doors and electric appliances using RF technology to achieve preferable security and for conservation of electrical energy.



### III. Methodology

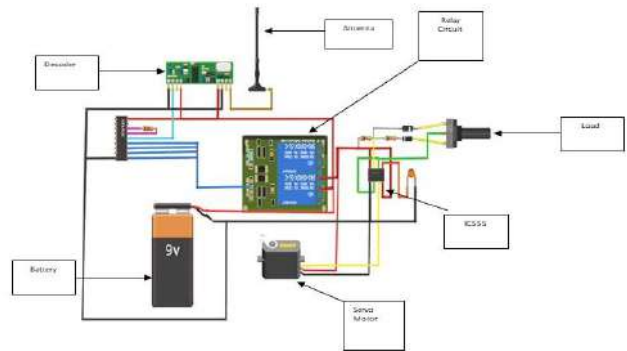
As we now know the importance of security and energy conservation let's discuss the working and technology we are using in our framework. RF transmitter and receiver is the backbone of our framework[1]. RF stands for 'Radio Frequency' as the name suggests this is a wireless communication technology which uses radio frequency as a medium to transfer data in a particular range which depends on different modules. The Transmitter sends signal to the receiver when the receiver is in the range it receives the signal and send it to the microcontroller which then sends signal to the Servo motor and relay. We're using servomotor to unlock the Door of the cabin and relay to open and close the circuit.

#### Block Diagram

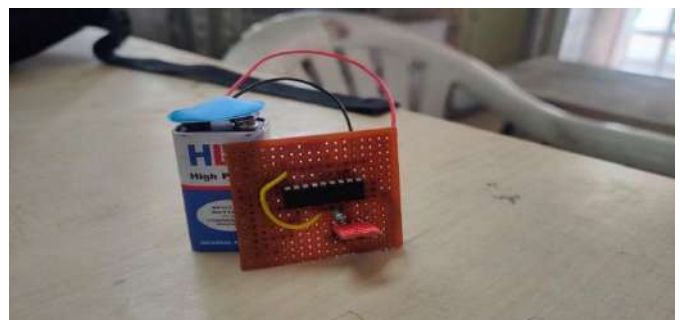


The Transmitter sends signal to the receiver when the transmitter is in the range, receiver receives the signal and send it to the microcontroller which then sends signal to the Servo motor and relay. A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. We're using servomotor to unlock the Door of the cabin and relay to open and close the circuit.

#### Circuit Diagram



#### Hardware



#### 1. RF Transmitter and encoder

The RF transmitter receives serial data and transmits it wirelessly through its RF antenna. RF receiver receives the transmitted data and it is operating at the same frequency as that of the transmitter.

The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus consume significantly low power in battery operation. When logic one is sent carrier is fully on to about 4.5mA with a 3volts power supply. The data is sent serially from the transmitter which is received by

the tuned receiver. Transmitter and the receiver are duly interfaced to two microcontrollers for data transfer.

RF signals travel in the transmitter and receiver even when there is an obstruction. It operates at a specific frequency of 433MHz.

An RF module (short for radio-frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio-frequency (RF) communication. For many applications, the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver. They are of various types and ranges. Some can transmit up to 500 feet. RF modules are typically fabricated using RF CMOS technology.

## 2. RF Receiver and Decoder

HT12D is a **2 12 series decoder**, most commonly used in remote control applications. By using the HT12E encoder and HT12D decoder, we can transmit 12 bits of parallel data serially. HT12D converts serial data to its input to 12 bit parallel data. These 12 bit parallel data is divided in to 8 address bits and 4 data bits.

## 3. Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on

another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

## 4. Servo Motor

A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

### Component Ratings

Components	Ratings
RF Transmitter and receiver	Launch distance: 20-200 meters, Operating Voltage:3.5V-12V
Servo Motor	Operating Voltage: 3.0V-7.2V
DC Battery	9V
Resistor	12ohm
Capacitor	50V
555 Timer IC	4.5V-14V
Encoder(Tx) and Decoder(RX)	1.8V-5.5V
Relay x 2	12V

### Advantages

- Very less power is required for the circuit.
- Significantly reliable Framework.
- Less maintenance.
- Energy Conservation.

### Disadvantages

- The Transmitter end requires a portable battery.
- Battery needs to be changed.

### Applications

- It can be used in bank cabins and office cabins where high security is required.
- Garage door and Car door controllers.

### IV. Conclusion

In this paper, The automated door lock system is implemented using RF transmitter and receiver. This framework is less expensive compared to other wireless technologies and easy to implement so that even smallscale offices can get high security as well as help in conserving less Electricity. The model is feasible to implement in real world scenarios. The application of this system are they can be used in offices, cabins and banks, etc.

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# Bluetooth Based Home Automation Using Arduino

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## ABSTRACT

The world is moving fastly towards automation. People have less time to handle any work so automation is simple way to handle any device or machine will work to our desire. This paper aim is to develop and design a Home automation using Arduino with Bluetooth module. Home automation system gives a simple and reliable technology with Android application. Home appliances like fan, Bulb, AC, automatic door lock are controlled by Home automation system using Arduino Uno with Bluetooth module. The paper mainly focuses on the monitor and control of smart home by Andorid phone and provide a security based smart home, when the people does not present at home. This paper motive is controlled home appliances in smart home with user friendly, design at low cost, simple installation.

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**Keywords :** Home automation, Arduino UNO, Bluetooth, smart phone, Security

## I. INTRODUCTION

Wireless technologies are becoming more popular around the world and the consumers appreciate this wireless lifestyle which gives them relive of the well-known “cable chaos” that tends to grow under their desk. Now with the embedded Bluetooth technology, digital devices form a network in which the appliances and devices can communicate with each other. Today, home automation is one of the major applications of Bluetooth technology. Operating over unlicensed, globally available frequency of 2.4GHz, it can link digital devices within a range of 10m to 15m at the speed of up to 3Mbps depending on the Bluetooth device class. With this capability of Bluetooth; we

propose a home automation system based on Bluetooth technology.

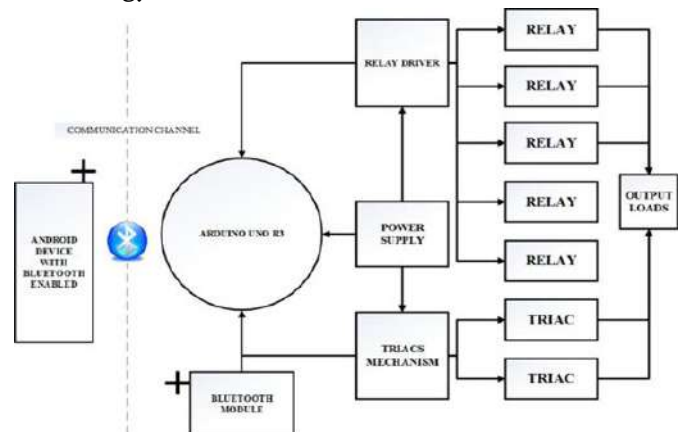


Fig 1. Block diagram for Bluetooth based home automation

Smartphones are the new craze and they have made life easier than ever. They are portable and always in the pockets. This portability of smartphones has led the marketers and the designers to develop services and solutions around the mobile domain. There are apps to shop online, do banking, trade stocks and uncountable day to day tasks. Then how can home automation systems remain isolated from the mobile technology.

## II. IMPORTANCE

Managing all of your home devices from one place being able to keep all of the technology in your home connected through one interface is a massive step forward for technology and home management. Flexibility for new devices and appliances. Smart home systems tend to be wonderfully flexible when it comes to the accommodation of new devices and appliances and other technology. No matter how state-of-the-art your appliances seem today, there will be newer, more impressive models developed as time goes on.

Maximizing home security. When you incorporate security and surveillance features in your smart home network, your home security can skyrocket. There are tons of options here -- only a few dozen of which are currently being explored. Remote control of home functions. Don't underestimate the power of being able to control your home's functions from a distance. On an exceptionally hot day, you can order your house to become cooler in just enough time before you get home from work. Remote control of home functions. Don't underestimate the power of being able to control your home's functions from a distance. On an exceptionally hot day, you can order your house to become cooler in just enough time before you get home from work. Improved appliance functionality. Smart homes can also help you run your appliances better. A smart TV will help you find better apps and channels to locate your favourite programming. Ultimately, connecting your appliances.

## III. ARCHITECTURE

This venture centres around the robotization of machines with the assistance of an android application. In this day and age, enhancement is the primary thought process. Any framework created goes for streamlining the human endeavours to a negligible and our control many appliances of smart home. framework goes for doing likewise. The architecture of this device as shown in figure 2. The user will communicate to Android application through the Arduino Uno via Bluetooth module. This model is very resilient and gauge able, maximum efficiency, safety and securely added smart home appliances with least amount of human effort. The Bluetooth signal having most efficient energy to connect any signal without loss of information with least harmonics. Home automation system main part consists of Arduino with microcontroller. The people must have mobile application with proper connection. It should be used as multi appliances works as together. The Arduino board is configured for each home appliances using coding in microcontroller. By the help of Microcontroller, we can control the electromagnetic relay which works as a switch to receive a signal from the Arduino through Bluetooth module HC-05. When the signal transmits from transmitter as datasheet to relay then the relay works as switch.

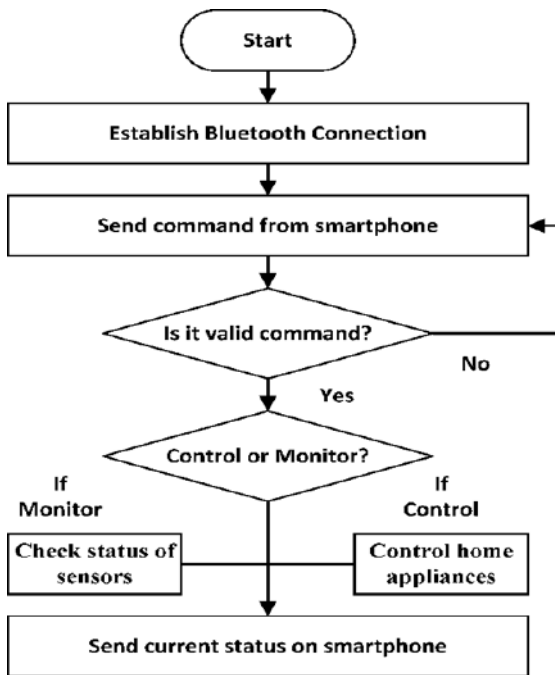


Fig 2. Flow chart

**IV. SIMULATION**

Simulation is the process of using a model to study the performance of a system. It is the operation of a model in terms of time or space, which helps to analyse the performance of an existing or a proposed system. It is a technique that involves modelling a situation and performing experiments on that model. The software selected in this project to execute the simulation is Proteus software.

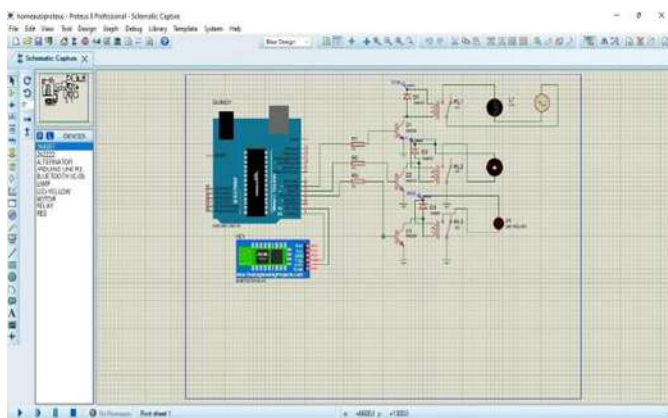


Fig 3 circuit before execution

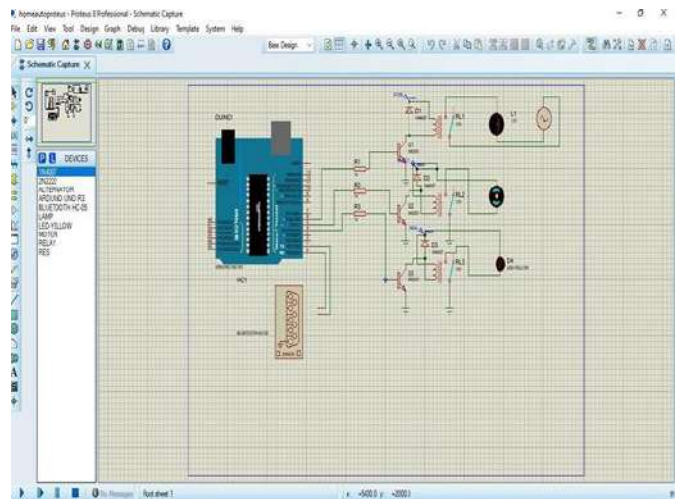


Fig 4 circuit after execution

**V. HARDWARE DESCRIPTION**

Arduino Uno: -

Arduino Uno is a microcontroller chip reliant on the Atmega328(datasheet) with 14 modernized I/o pins, in which 6 pins can be used as yields, 6 pins are used as straightforward data sources. It has 16 MHz earth resonator, a USB affiliation, a force jack and a reset button. The microcontroller has 32kB of ISP streak memory, 2kB RAM and 1kB EEPROM. The board gives sequential correspondence capacity through UART, SPI and 12C. Because of well plan the Arduino is straightforward. In Arduino we utilize significant level of programming language like C language, C++ language etc. It is straightforward and easy to use language. It has a lot of favorable position like performing multiple tasks, robotization, time area and so on.



Fig 5 Arduino UNO

## Bluetooth Module

HC-05 Bluetooth module is utilized to associate the microcontroller with android application. Bluetooth get the data from client and send to the microcontroller (Arduino Uno). It is easy to utilize Bluetooth Serial Port Protocol (SSP), planned as remote sequential association setup. The Bluetooth of sequential port module is Advanced Bluetooth v2.0+Enhanced information Rate at 3Mbps regulation with 2.4 GHz radio recipient with BB (base band). The Bluetooth of Rx and Tx pins are associated with the Arduino pins of Tx and Rx individually. HC-05 module is an easy-to-use Bluetooth SPP (Serial Port Protocol) module, planned for direct distant consecutive affiliation.



Fig 6 Bluetooth module

## Relay Drivers

Relay is an electromagnetic switch which is used to defer two circuits electrically and connect magnetically. When Arduino transmit the signal then relay driver receive signal and start its work. They are frequently used to interface an electronic circuit (working at low voltage) to an electrical circuit which works at extremely high voltage. For instance, a hand-off can make a 5V DC battery circuit to switch 230V AC mains circuit. In this way a little sensor circuit can drive, say, a fan or an electric knob. A transfer switch can be separated into two sections: information and

yield. The info area has a loop which creates attractive field when a little voltage from an electronic circuit is connected to it. This voltage is known as the working voltage. Generally utilized transfers are accessible in various arrangement of working voltages like 6V, 9V, 12v, 24V and so on. In a basic hand-off there are three contactors: ordinarily shut (NC), regularly open (NO) and normal (COM). At no info express, the COM is associated with NC. At the point when the working voltage is connected the transfer curl gets charged and the COM changes contact to NO. Diverse transfer setups are accessible like SPDT and DPDT which have distinctive number of changeover contacts. By utilizing legitimate blend of contactors, the electrical circuit can be turned on and off.

## VI. CONCLUSION

An Arduino based home automation system using Bluetooth and an android application with voice command has been designed and implemented. The Home automation system used an Android application and a Bluetooth technology in the design; this is because they are easy to use, fast, readily available, and reliable in communications between the remote user and devices. A low cost and highly reliable home automation system that can assist handicapped/old aged people, as well as a user-friendly device was developed. Other features can be added in the future such as biometrics so that un authorized persons can not have access to the appliances and an also timing schedule can developed for each appliances connected this will effectively conserve energy.



## VII. CONCLUSION

An Arduino based home automation system using Bluetooth and an android application with voice command has been designed and implemented. The Home automation system used an Android application and a Bluetooth technology in the design; this is because they are easy to use, fast, readily available, and reliable in communications between the remote user and devices. A low cost and highly reliable home automation system that can assist handicapped/old aged people, as well as a user-friendly device was developed. Other features can be added in the future such as biometrics so that un authorized persons can not have access to the appliances and an also timing schedule can developed for each appliances connected this will effectively conserve energy

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# Water Leakage Detection and Monitoring System Using IOT

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## ABSTRACT

The water supply shortage has increased in recent years due to overpopulation, climate change and obsolete water facilities, where deteriorated pipes cause most of the water leaks. The problem is not the size of the leak, but the time it takes to detect it. This paper presents the implementation of a system installed in the hydraulic facilities of a residence, to detect water leaks. The system consists of a water sensor installed by a water reservoir of interest, a microprocessor to interpret the data and evaluate. The design of a water level sensor device that can detect and control the level of water in a certain water tank, the system firstly senses the amount of water available in the tank by the level detector part and then adjusts the state of the water pump in accordance to the water level information. There has been wastage of water daily through the pipeline leakages due to its full water were never arrived to the taps. The aims of our proposed work are to develop a real-time prototype pipeline leakage alert system whether it is a water leak or not, an alert message send to IoT Application to avoid leakage.

**Keywords :** AutoML, Machine Learning, Artificial Intelligence

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## I. INTRODUCTION

With the growth of the world population, the demand of fresh water has increased causing serious problems in the field of water supply. Therefore, control of water has become a considerable issue today. With the growth of the world population, the demand of fresh water has increased causing serious problems in the field of water supply. Therefore, control of water has become a considerable issue today. Scientists, technicians, politicians, and generally, many other inhabitants of the planet become increasingly

educated on the subject. The threat of pollution hovers over and limits water supplies. The shortage of this vital liquid requires great attention. The proportion of fresh water found in rivers, lakes, and underground sources comprise only 3% of the total amount of water on earth. In addition, the water found needs treatment for human consumption, to eliminate particles and organism harmful to health, and ultimately must distribute through pipes to homes safety.

This work focuses on the issue of distribution, more specifically, on the issue of “water leaks” in residential

areas. In a developing country like India, loss of water in domestic sector on account of leakage is approximately 30 to 40% of the total flow in the distribution. This leads to high risks in public health, money invested and on the valuable natural resource. India had an irrigation efficiency of ~36 percent in 1993-1994 and projected that efficiency would have to increase to 60 percent by 2050 to bring a balance in the demand and supply of water. Even those slow leaks that only because mold damage require expenses to repair. The more water spilled (or splashed) the more money the repairs cost to residents. For this reason, it's crucial to have some system installed in residences to detect water leaks. Current digital water leak detection systems can locate multiple water leaks to within 1-meter resolution over a complex network of cables running several kilo meters.

## II. Methodology

The water leakage detection system can be deployed in the already existing plumbing with flow rate sensors attached in the path of the water flow. The sensor does not obstruct the water flow but just collects the data of flow rate. Actuators like solenoid valve is needed to control the water flow in the event of a leak.

The proposed system uses a microcontroller which constantly reads the data from multiple flow rate sensors thereby constantly monitoring the water flow. It compares the flow rate by calculating the difference in data from subsequent sensors and takes the necessary action. If the difference is greater than the Set threshold, microcontroller sends alert information to the user. This minimizes the water wastage. On the other hand, if the difference is less than the threshold, it sends the sensor data to the cloud for data logging and the process continues as shown in Fig. 1. Online data logging allows the user to keep track of the water usage and take necessary decisions to conserve the water.

The Microcontroller constantly monitors the flow rate when the system is in On State. The Leak detection algorithm works in such a way that, whenever the Flow rate difference between two consecutive sensors is greater than a calibrated threshold value, a leakage is detected by the microcontroller. Fig. 7 shows the leakage scenario in the system. The Flow rate difference is also logged into the Cloud through GPRS module as in Fig. 8. Whenever a Leakage is detected an alert or notification is triggered and message is sent to the concerned authorities.

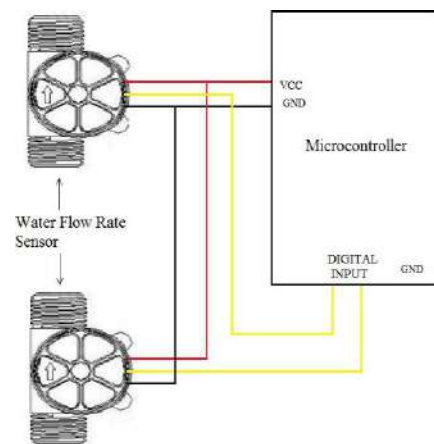


Fig. Microcontroller Connected to flow Sensor

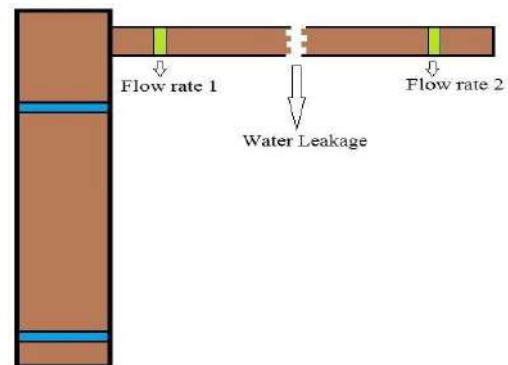
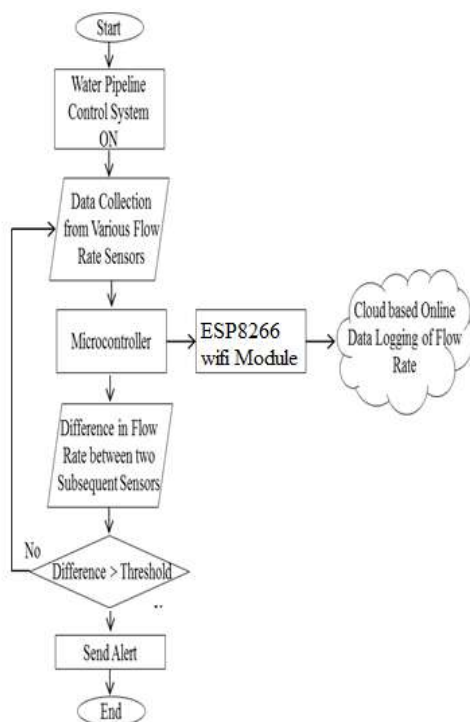


Fig. Leakage Scenario

The automatic water cut-off system is very useful to stop the leakage of water at various points if a leakage is detected. The Monitoring system detects the leakage of water and sends an alert signal.



All the flow rate measurement sensors pertaining to a particular area are connected to microcontroller for as show in Fig. 6. Couple of microcontrollers is connected to the Network such that we can monitor and control water supply for the whole region. Each Flow rate sensor sends the amount of water passing through it to microcontroller. The microcontroller collects the data from flow sensors and sends the values to the Cloud using GPRS [7] connected to the internet. The flow rate measurements are logged into a sensor cloud which can be utilized for later use. This method is commonly known as data logging.



### Hardware Component

#### 1. NodeMCU Microcontroller

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. NodeMCU board as shown in fig 1. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs. NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.



Fig1. NodeMCU Controller

#### 2. Water Flow Rate Sensor

Water flow sensor consists of a copper body, a water rotor, and a **hall-effect sensor**. When water flows through the rotor, rotor rolls, its speed changes with different rate of flow. ... This one is suitable to detect flow in water dispenser or coffee machine.

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse Signal. The water flow sensor as shown in fig 2.



Fig 2. Water Flow Rate Sensor

### 3. Buzzer

A buzzer or *beeper* is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of *buzzers* shown in fig 3 and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

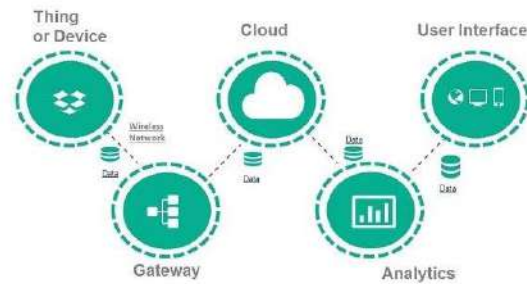


### 4. Internet of Things

The Internet of Things (IoT) describes the network of physical objects “things” that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments.

### Major Components of IoT



### III. RESULTS AND DISCUSSION

A prototype was developed with help of three flow rate sensors in series in the water pipeline. The prototype is tested at various conditions of waterflow. Positive results were obtained using the prototype built.

Water Flow controller is turned ON initially such that water flows through the water pipelines. The Flow rate data of both the sensors is obtained by the microcontroller periodically. The Microcontroller also uses water leakage detection algorithm to calculate the flow rate difference between three consecutive sensors. The difference is also logged into the Cloud for triggering the leakage detection. Once the leak is detected notification is sent to authorities for fixing of damaged pipelines. In addition to Water flow is stopped when leak is detected.

### IV. CONCLUSION

Water for domestic purposes is always very essential and it is mandatory to prevent it from getting wasted due to any pipeline leaks. Hence the designed prototype is an effective solution for monitoring the flow of water as well as detecting for leaks in the pipelines. The smart water leakage detection system can help in water distribution process by remote activation of solenoid valves. Usage of cloud logging technique enables the data acquisition and analysis in

any point of the pipeline. This makes the system cost efficient and simple.

The system is capable of detecting leaks between any sensor nodes rather than the exact location of the leak. The sensors require lengthy wiring for power supply and data transmission. This reduces the area under observation. The sensors and actuators can be powered by batteries or solar panel. Wireless transceivers can be fitted to acquire the data from the sensor and send command signals to actuator. This sensor network based system may increase the system cost, but it adds the advantage of monitoring a huge area with minimal human power.

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# Spatial Panel Data Model of West Java's Regional Revenue

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## ABSTRACT

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The spatial panel data model is the construction of a regression model that is used to explain the spatial dependence on panel data. Space dependence may apply between adjacent areas, as in the economic field. This should not be ignored because if the freedom between regions is not fulfilled. The spatial panel data model may be in the form of a SAR, SEM or GSM model. In this study, the spatial panel data model is used to model regional income in districts/cities in West Java, the results of the analysis obtained are that the SEM model with random effect is the best model because value of  $R^2 - adj$  is 97.64%.

**Keywords:** Panel Data, Spatial Autocorrelation, Spatial Autoregression.

## I. INTRODUCTION

Modeling in statistics was run to determine the relationship between the variables of interest to the investigator. It is not uncommon for data obtained from observations in several different locations at one time to be referred to as data across locations. In addition, if the reviewer creates observations for some time and then combines them with cross-site data, the existing data is referred to as panel data. If based on assumptions on component errors, panel data may have a fixed or random effect. If there is a constant impression, the error component of the existing regression model is a fixed parameter (location and time are determined by the investigator), whereas in a model with a random effect, the error component is a location and time impression determined randomly from the population. The problem that may arise from panel data is that there is a relationship between the location of the perception which is known as spatial dependence. This should not be ignored because if the

independence between observations cannot be met, then spatial panel data modeling is required. The spatial panel data model is divided into two, namely the spatial lag model (spatial autoregressive model / SAR) where there is a spatial correlation in the bound variable and the spatial error model (spatial error model / SEM) where there is a spatial correlation. than that mistake.

In the economic field, especially in terms of regional income, when referring to Law Number 32 of 2014 concerning Regional Government, each region is given the authority to regulate its own region. In order for regional autonomy to be implemented to reduce the dependence of regional governments on the central government, especially in terms of finances, with the hope that each region is able to manage its finances freely, an appropriate basis is needed to increase the ability to explore. its own financial potential. Local government policies must be formed by taking into account the factors that can affect regional income, so that the utilization of existing resources in the region

can be carried out optimally. However, it should be reminded that the economic condition of an area is always influenced by the surrounding area, such as the people of Bogor City who need supplies of food sources such as vegetables from the area in Bogor Regency which causes buying and selling transactions to take effect. applies automatically, so that the economic conditions of the two regions may affect each other. Based on the background description, this study aims to analyze the factors that affect regional income in districts/cities in West Java Province and determine the impression of spatial dependence between regions. So that by knowing the factors that affect income, local governments can make a basis for increasing their income so that development for community welfare can be realized.

### Model Spatial Data Panel

The spatial data panel model is able to capture the existence of spatial interactions in spatial units and mass as a whole. The following is a static model of panel data that includes bounded variable spatial lagging and spatial error autoregression.

$$y = \lambda(I_T \otimes W_N)y + X\beta + (i_T \otimes I_N)\mu + \rho(I_T \otimes W_N)\varepsilon + v(1)$$

with

$y$  : vector of concern for the size dependent variable  $NT \times 1$

$X$  : the matrix of concern for the size-independent variable  $NT \times k$

$I_T$  : identity matrix size  $T$

$W_N$  : space-weighted matrix with diagonal 0

$\lambda$  : spatial autoregression parameter turned on  $y$

$i_T$  : unit of measure vector  $T \times 1$

$I_N$  : identity matrix size  $N \times N$

$\mu$  : mass vector at the same attention with a certain impression (not spatial autocorrelation)

$\rho$  : parameter of spatial autoregression in errors  $v_{it} \sim IID(0, \sigma_v^2)$  dan  $\varepsilon_{it} \sim (0, \sigma_\varepsilon^2)$ ;  $N$  is the number of absorption locations, and  $T$  is the serial number of the time of observation<sup>[7]</sup>.

As in classical panel data, individual effects can be treated either permanently or randomly. In a model with a random effect, the assumption is that the unobserved effect of the individual is not correlated with other independent variables in the model, in this case  $\mu_{it} \sim IID(0, \sigma_\mu^2)$ , and error  $\varepsilon$  can be written as  $\varepsilon = (I_T \otimes B_N^{-1})v$  (2)

with  $B_N = (I_N - \rho W_N)$ , then

$$u = (i_T \otimes I_N)\mu + (I_T \otimes B_N^{-1})v$$
 (3)

and variance covariance matrix of  $\varepsilon$  is

$$\Omega_u = \sigma_\mu^2(i_T i_T^T \otimes I_N) + \sigma_v^2[I_T \otimes (B_N^T B_N)^{-1}]$$
 (4)

Spatial autoregressive model / spatial lag (SAR) is obtained if the equation (1) value  $\lambda \neq 0, \rho = 0$ , and if  $\lambda = 0, \rho \neq 0$  as *Spatial Error Model* (SEM), then if  $\lambda \neq 0, \rho \neq 0$  as *General Spatial Model* (GSM).

Parameter estimation in the SAR and SEM models was carried out using the Maximum Likelihood method, the following is the log-likelihood function of the SAR model with a constant effect

$$\text{Log } L = -\frac{NT}{2} \ln(2\pi\sigma_\varepsilon^2) + T \ln|I_N - \lambda W_N| - \frac{NT}{2\sigma_\varepsilon^2} e^T e$$
 (5)

with  $e = y - \lambda(I_T \otimes W_N)y - X\beta$  and  $\ln|I_N - \lambda W_N|$  as Jacobian Determinant.<sup>[3]</sup>

Log-likelihood function of SEM with fixed effect is

$$\text{Log } L = -\frac{NT}{2} \ln(2\pi\sigma_\varepsilon^2) + T \ln|I_N - \rho W_N| - \frac{1}{2\sigma_\varepsilon^2} e^T [I_T \otimes (B_N^T B_N)] e$$
 (6)

with  $e = y - X\beta$ .<sup>[3]</sup>

estimation of  $\beta$  and  $\sigma_\varepsilon^2$  are

$$\beta = [X^T (I_T \otimes B_N^T B_N) X]^{-1} X^T (I_T \otimes B_N^T B_N) y$$
 (7)

$$\sigma_\varepsilon^2 = \frac{e(\rho)^T e(\rho)}{NT}$$
 (8)

$$\mu_i = \frac{1}{T} \sum_{t=1}^T (y_{it} - x_{it}\beta)$$
 (9)

Whereas log-likelihood from model with random effect is :

$$\text{Log } L(\beta, \sigma_\varepsilon^2, \phi, \lambda, \rho) = -\frac{NT}{2} 2\pi - \frac{NT}{2} \ln \sigma_v^2 + T \ln|A| - \frac{1}{2} \ln [T \phi I_T + (B_N^T B_N)^{-1}] + (T-1) \ln|B_N| - \frac{1}{2\sigma_v^2} u^T \Sigma^{-1} u$$
 (10)

with  $\phi = \frac{\sigma_\mu^2}{\sigma_\epsilon^2}$ ,  $\bar{J}_T = \frac{J_T}{T}$ ,  $E_T = I_T - \bar{J}_T$ , dan  $A_N = (I_N - \lambda W_N)$ ,

$$\begin{aligned} \Sigma &= \phi(J_T \otimes I_N) + I_T \otimes (B_N^T B_N)^{-1} \\ \Sigma^{-1} &= \bar{J}_T \otimes (T\phi I_N + (B_N^T B_N)^{-1})^{-1} + E_T \otimes B_N^T B_N \\ |\Sigma| &= |T\phi I_N + (B_N^T B_N)^{-1}| |(B_N^T B_N)^{-1}|^{T-1} \end{aligned}$$

Parameter estimation is carried out by an iterative procedure until a convergent estimation result is obtained, with the formula

$$\beta = (X^T \Sigma^{-1} X)^{-1} X^T \Sigma^{-1} A y \tag{11}$$

$$\sigma_v^2 = (A y - X \beta)^T \Sigma^{-1} (A y - X \beta) / NT \tag{12}$$

## II. METHODS AND MATERIAL

To perform modeling with spatial panel, data is required for each location and series of periods. The data from this study use secondary data sourced from the Statistics Indonesia of West Java which includes data from 26 districts and cities from 2009-2018<sup>[2]</sup>. Detail of data which are used in this methods can be viewed in Table 1.

TABLE I  
VARIABLES

Variables	Explanation
Y	District/city local government revenue
X <sub>1</sub>	Population
X <sub>2</sub>	Percentage of working people
X <sub>3</sub>	Average length of school

The stages of analysis carried out in spatial panel data modeling are as follows:

1. Data exploration to see the characteristics of the data in general.
2. Form a weighting matrix.
3. Using the Breush-Pagan test to determine the effect of location or time on panel data.
4. Testing with the Lagrange Multiplier (LM) test. The LM test has been developed to test the presence of random effects and correlations from serial or cross-sectional panel data models. Baltagi<sup>[1]</sup> derived a combined, marginal and conditional

test for conditions of random influence and spatial correlation on the spatial model of panel data.

- a. The LM test is to find out whether there is a random effect on the data assuming there is no spatial autocorrelation, the hypothesis is

$$H_0 : \sigma_\mu^2 = 0 \text{ (asumsi } \lambda = 0) \quad H_1 : \sigma_\mu^2 \neq 0 \text{ (asumsi } \lambda \neq 0)$$

Test-statistic

$$SLM_1 = \frac{LM_1 - E(LM_1)}{\sqrt{Var(LM_1)}} \quad , \text{ with } LM_1 =$$

$$\sqrt{\frac{NT}{2(T-1)}} G^2; G = \frac{\bar{u}'(J_T \otimes I_N)\bar{u}}{\bar{u}'\bar{u}} - 1; u$$

is error from Least Square Total

Reject  $H_0$  if statistics  $LM > \chi^2_{(\alpha,1)}$ , if there is no random effect, the next stage is 3.b, but if there is a random effect, then proceed to stage 3.c

- b. To find out whether there is a spatial effect on the model, the hypothesis is

$$H_0 : \lambda = 0 \text{ ( } \sigma_\mu^2 = 0)$$

$$H_1 : \lambda \neq 0 \text{ ( } \sigma_\mu^2 \neq 0)$$

Test-statistics

$$SLM_2 = \frac{LM_2 - E(LM_2)}{\sqrt{Var(LM_2)}} \quad , \text{ with } LM_1 =$$

$$\sqrt{\frac{N^2 T}{b}} H^2; H = \frac{\bar{u}'(I_T \otimes (W + W')/2)\bar{u}}{\bar{u}'\bar{u}}, b =$$

$$tr(W + W')^2 / 2.$$

Reject  $H_0$  if  $LM > \chi^2_{(\alpha,1)}$

- c. To find out whether there is a spatial effect with a random effect, the hypothesis is

$$H_0 : \lambda = 0 \text{ ( } \sigma_\mu^2 \neq 0)$$

$$H_1 : \lambda \neq 0$$

Test-statistics

$$LM_\lambda = \frac{\hat{D}(\lambda)^2}{\left[ (T-1) + \frac{\hat{\sigma}_v^4}{\hat{\sigma}_1^4} \right] b}$$

$$\begin{aligned} \text{with } \hat{D}(\lambda)^2 &= \frac{1}{2} \hat{u}' \left[ \frac{\hat{\sigma}_v^4}{\hat{\sigma}_1^4} (\bar{J}_T \otimes (W' + W)) + \right. \\ &\left. \frac{1}{\hat{\sigma}_v^4} (E_T \otimes (W' + W)) \right] \hat{u}. \quad \text{and, } \hat{\sigma}_1^4 = \\ &\frac{\hat{u}'(\bar{J}_T \otimes I_N)\hat{u}}{N} \end{aligned}$$



$$\hat{\sigma}_v^4 = \frac{\hat{u}'(E_T \otimes I_N)\hat{u}}{N(T-1)}, \hat{u} \text{ is error from least square methods.}$$

Reject  $H_0$  if  $LM_\lambda > \chi^2_{(\alpha,1)}$

- Hausman test is done by comparing estimators with random and fixed effects and testing whether there is a random effect on the data. Mult and Pfaffermayr (2011) developed the Hausman test in the spatial case, with the formula  $H = NT(\hat{\theta}_{FGLS} - \hat{\theta}_W)^T(\hat{\Sigma}_W - \hat{\Sigma}_{FGLS})^{-1}(\hat{\theta}_{FGLS} - \hat{\theta}_W)$

With  $\hat{\theta}_{FGLS}$  dan  $\hat{\theta}_W$  is *Generalized Least Square* (GLS) and estimation with fixed effect, whereas  $\hat{\Sigma}_W$  dan  $\hat{\Sigma}_{FGLS}$  is coefficients of estimation from matrix variance-covariance, with  $(H_0)$  is model has random effect. Reject  $H_0$  if  $H > \chi^2_{(\alpha,k)}$ ; k is number variables in model<sup>[7]</sup>

- Analyze spatial panel data using the maximum likelihood estimation method
- Estimation of panel data parameters, AR / MA if there is a random effect.
- Selection of the best model

### III.RESULTS AND DISCUSSION

#### Data Exploration

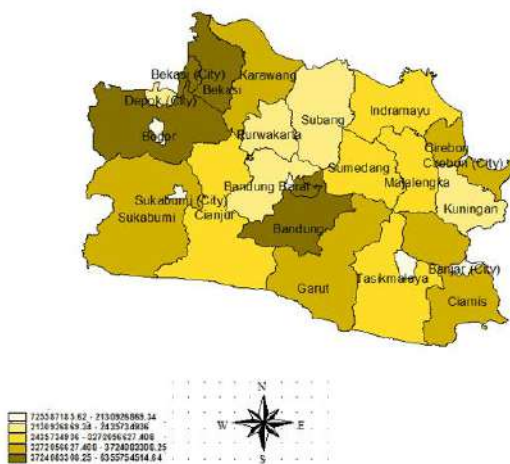


Figure 1: Map of Regional Income in Regency/City of West Java

From Figure 1, it can be seen that the region with high income, namely Bandung, Bogor, Bekasi, and Bekasi City, with a minimum regional income in 2016. In several regions, relatively the same color was found, so it is suspected that there is a spatial influence between regions.

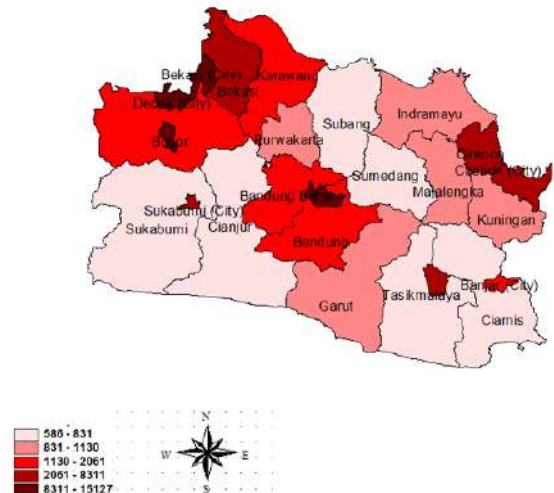


Figure 2: Population Density Map in Regency/City of West Java

From Figure 2 regarding population density, urban areas tend to be densely populated, such as Bogor City, Bandung City, Depok City, and Bekasi City, which affects the surrounding population density, such as Bandung City, which is densely populated, directly intersects with Bandung and Bandung Barat whose population is also quite dense.

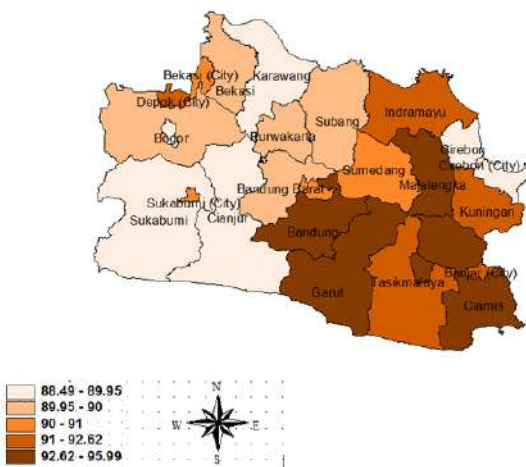


Figure 3: Map of Percentage of Population Working People in

Regency/City of West Java

From Figure 3, it is known that the area with the highest percentage of the working population is Garut, Bandung, Majalengka, Ciamis, and Tasikmalaya City. However, the percentage in each region is not much different from other regions, only around 88.49% - 95.99%.

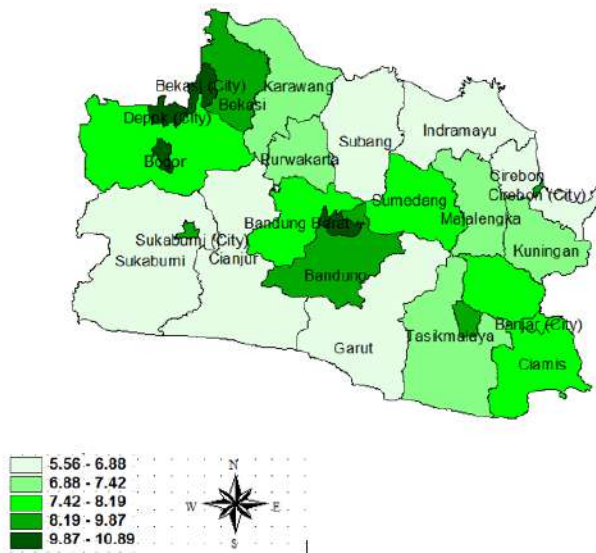


Figure 3: Map of Average Years of Schooling in Districts/Cities of West Java

From Figure 4, it can be seen that urban residents tend to have more than 8 years of education. In Bandung City, Bogor City, Depok City and Bekasi City, the population has an education of more than 9 years or up to college.

The weighting matrix used in this analysis is obtained by the queen contiguity method which defines the relationship of intersections between locations where the side-angle intersection defines  $bobot_{ij} = 1$  for the location that is side by side (common side), or the corner point (common vertex) meets the location of concern,  $bobot_{ij} = 0$  for other locations [5].

Weighted



Figure 5: Map of Regency/City of West Java

For example in Sukabumi, by looking at the map of the province of West Java in Figure 5, the neighbor locations that are in direct contact with the district. Sukabumi, namely Cianjur, Sukabumi City, and Bogor are given a weight of 1. After all neighboring areas have been recorded, then standardization is carried out on the rows. The same is done for each district and city so that a weighting matrix can be formed.

Breusch-Pagan Test

TABLE II  
BREUSCH-PAGAN TEST

Effect	$\chi^2(df)$	p-value
Time and individual	390,1 (2)	< 0,000
Time	90,7 (1)	< 0,000
Individual	299,4 (1)	< 0,000

If a significance rate of 5% is used, then the decision is:

1. Time and individual effect

P-value < 5%, then reject  $H_0$  which means there is sufficient evidence to state that there is at least one effect (time or individual) on the model.

2. Time effect

P-value < 5%, then reject  $H_0$ , which means there is sufficient evidence to state that there is an effect of time on the model.

### 3. Individual effect

P-value <5%, then reject Ho, which means there is sufficient evidence to state that there is an individual effect on the model.

From the results above, it can be concluded that there is a significant effect which caused by time and individuals on local government revenue data in districts/cities of West Java Province. So it is very possible if there is a spatial effect between the observation locations.

### Lagrange Multiplier (LM) test

TABLE III  
LAGRANGE MULTIPLIER TEST

LM-test	$H_0$	p-value
$SLM_1$	$\sigma_\mu^2 = 0 (\lambda = 0)$	< 0,000
$SLM_2$	$\lambda = 0 (\sigma_\mu^2 = 0)$	< 0,000
$LM_\lambda$	$\lambda = 0 (\sigma_\mu^2 \neq 0)$	< 0,000

From the results of the LM test in Table 3, information is obtained that based on the test, p-value < 5%, so it can be concluded that there is a random effect on the data, while based on the  $SLM_2$  test, the p-value <5%, so there is a spatial autocorrelation in the data. Then from the test results  $LM_\lambda$ , p-value < 5%, the test results show that there is a spatial autocorrelation with a random effect on the data. So that the next District/City Government Revenue data in West Java will be modeled using the spatial panel data method with random effects. The random effect that exists can occur because time has a significant effect on the data.

### Hausman test

By using a significance level of 5%, from the Hausman test results is p-value > 0.05, there is not enough evidence to reject Ho, so the spatial panel data model follows the random effect model.

### Spatial Panel Data Model

Then the data will be modeled with the Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), and General Spatial Model (GSM) with random effects. The results of the estimated parameters for the three models are given in Table 4.

TABLE IV  
ESTIMATED PARAMETERS

Model	Panel Model	SAR	SEM	GSM
Parameter				
$\hat{\beta}_1$	0,24 ***	0,06	0,014	0,012
$\hat{\beta}_2$	144,10***	44,21**	38,871 **	28,852 *
$\hat{\beta}_3$	-546,64**	-8,06	21,682	-25,246
Intercept	-7506,15**	-3161,7*	-1753,6	800,76
$\lambda$	-	0,67***	-	-0,54 ***
$\rho$	-	-	0,742**	0,870***
$\phi$	-	7,089**	6,253***	8,074 **
$\theta$	0,7737	-	-	-
The goodness of fit				
$R^2$ -adj	21,23%	92,79%	97,64%	93,62%
AIC		3183,117	3177,008	3156,785

with : \*\*\*( $\alpha = 0,001$ ), \*\*( $\alpha = 0,01$ ), \* ( $\alpha = 0,05$ )

From Table 4, it can be seen that based on  $R^2$ -adj, the panel data model with random effect is not very good when used in the estimation, which means that the regional income of districts/cities in West Java can be explained by the factors contained in the panel data model only 21.23%, this may be due to the spatial effect between regions. Meanwhile, from the results of spatial panel data modeling, the SEM model with random effect was chosen as the best model because it produces the smallest MSE value, with  $R^2$ -adj of 97.64%, although the AIC value generated by the SEM model is greater than GSM, but not too much different. The model formed is

$$\hat{y}_{it} = 0,01438x_{it1} + 38,8710x_{it2} - 8,0698x_{it3} + \mu_i + 0,7423 \sum_{j=1}^{26} w_{ij}\phi_{jt}$$

In the SEM model with random effects, it is known that the variable that has a significant and positive value is the percentage of the working population ( $X_2$ ), so that if the local government wants to increase its regional income, the government must increase employment opportunities to provide greater opportunities for residents to be able to work. The potential of human resources in the area will be optimally empowered, such as through cooperation with investors to develop the natural potential in the area which will automatically absorb labor in the area, so that local government revenues can increase through tax levies.

#### IV.CONCLUSION

Based on the results and discussion, panel data modeling of regional income in districts/cities in West Java province by adding spatial elements gives better results than the classic panel data model. The SEM panel model with random effect is better at explaining diversity than the SAR or GSM model with an  $R^2 - adj$  value obtained of 97.64%. While the variable that has a significant positive effect is the percentage of the working people ( $X_2$ ).

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# Automatic Solar Operated Lake Cleaning Floating Machine

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## ABSTRACT

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This paper is focus on design and fabrication of Automatic solar operated lake cleaning floating machine. This project basically concentrated to clean the lake. Based on the current problem in the lake, we designed and fabricated a floating machine. Our project is remotely operated lake cleaning machine, aim to be preventing human accident and minimize error during the operation. Also, in order to minimize the emission, we used electric energy as an energy resource for our project.

Keywords : Lake Cleaning, Unmanned, Eco-Friendly, Garbage

## I. INTRODUCTION

Lake pollution is a major issue in India. Over a thousand of aquatic animals and plants are affecting by pollution. Lake is major source of fresh water for human beings, plants and animals. By executing the plan and based on the implementation, we found problem that are occurs in river and lake in India<sup>[1]</sup>. We get an idea about a remote-control system from this paper, where the sewage cleaning machine is remotely operated. In order to diminish the spreading of diseases to human. It moreover progresses the rack of life and tangible quality nourishment items. Within the proposed systems, the machine is working with inaccessible control to clean the sewage. Consequently, this framework maintains a strategic distance from the impacts from the sewage waste<sup>[2]</sup>. Utilizing methods would be efficiently Because it frequently covers an expansive domain of exercises and joined with

credibility to getting influenced by distinctive afflictions from the diverse type of microorganisms display within the sewage whereas cleaning with human contact<sup>[3]</sup>. This venture is a programmed oceanic vehicle that can be remotely worked for cleaning the water bodies. By utilizing Robots, but we are making it by inaccessible control without using the robot, hence making within affordable price<sup>[4]</sup>. The extent is centered on the plan of an electric driven vehicle that can recover control using solar vitality innovation. In this project they implemented solar power has energy to drive the vehicle<sup>[5]</sup>.

By investigating a few of the journal papers, we came across the thought to develop our venture. The automatic solar operated floating machine is utilized to clean the squanders, Plastics and other squander flotsam and jetsam from the lake for the clean water asset. Nowadays, IC engine is used to clean the lakes. But in IC engine will emit a lot of pollutant particles

for the environment, due this IC engine are more toxic to the environment. So we designed a solar operated floating machine, in order to reduce the pollution. In this project, we used a solar panel that will convert solar energy into electrical energy. Also, our project is remotely operated and fully automated (up to 100 seconds), it will prevent human accident error during the operation.

## II. OBJECTIVE

To design and fabricate Automatic solar operated lake cleaning floating machine. To reduce pollution which is being thrown from human beings to lake. To reduce the human effort and time consumption in collecting garbage from the lake. To make an eco-friendly and economically reliable machine.

## III. METHOD

Methodology is a project planning procedure in which all the project's major and minor processes, whether logical or creative manufacturing application steps, are systematically defined. Methodology is one of the most important aspects of project planning, as it considers all conceivable factors and their impacts on the project's outcome for the most efficient and effective project management.

The following is a list of the methods or practices used in this study:

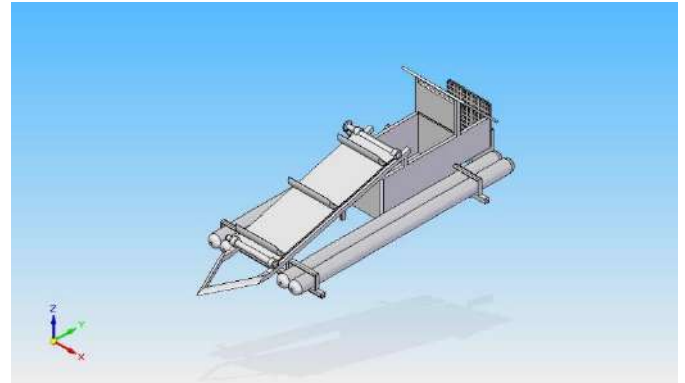
### A. Literature Review

The journal papers were evaluated in order to understand and study the most recent developments in the field of waste management and garbage collection in lakes. A literature review survey can assist us in gaining a basic overview of the overall activity in our specific field. It also aids us in implementing more advanced work in our research.

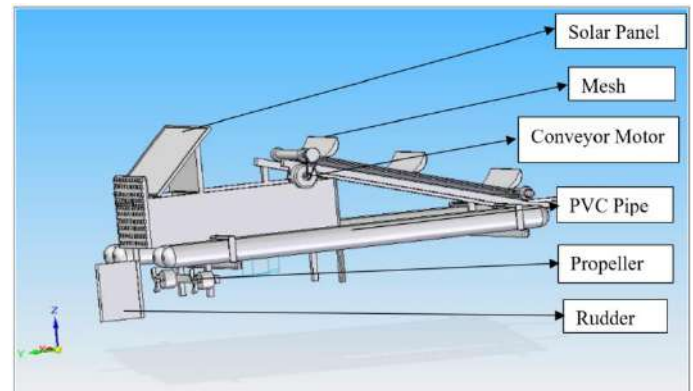
### B. Designing

In this method we have designed our project which is "Automatic solar operated lake cleaning floating machine" by using solid edge software to know the

actual dimensions of the machine. The design made on software will be useful in the fabrication part where we will know exact idea how the project will look like. Design also important for the assembly part of the project where we need to connect the working part.



**Fig 3.1:** Isometric view of Automatic solar operated lake cleaning floating machine



**Fig 3.2:** 3D Model of the project

TABLE 1. DESIGN CHARACTERISTICS OF SOLAR OPERATED UNMANNED LAKE CLEANING MACHINE

COMPONENTS	SPECIFICATIONS
Battery type	Lead acid
Battery specification	6v, 5ah
Battery connection for controller	series
Battery connection for conveyor	parallel
Object detector	Arduino UNO, ultrasonic sensor and GSM SIM 900a.
Propeller motor	DC 10000 RPM 12V
Conveyor motor	DC 800 RPM
Solar Panel type	Polycrystalline

SolarPanel specification	12v, 20 Watt
Bearing	2 bolt flange bearing
Mesh	Stainless steel
Chassis	Mild Steel
Controller	HH707K
Directioncontrol motor	DC 12V Gear motor
Conveyor Belt type	Incline Rubber net Conveyor
Propeller	Plastic material
Propeller dimension	6 inch
Machine dimension	52 x 36 x 26 inches

**Battery**

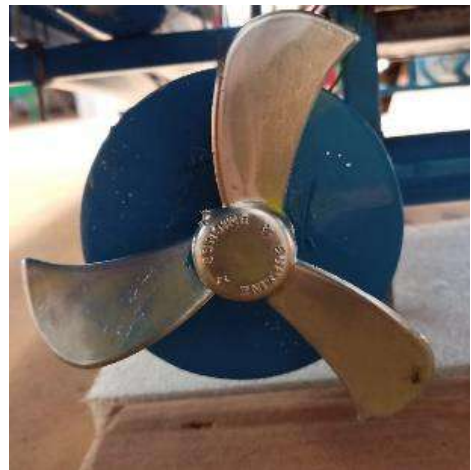
We used 4 Rechargeable 6v 5amp lead acid battery two are connected in series arrangement and other two connected in parallel. Each battery carries a weight of 0.73kg. Lead acid battery are economical,in order to reduce the cost we used this.



**Fig 3.3:** Rechargeable lead acid battery

**Propeller Motor**

We used 12volt DC motor with 10000 rpm for propeller to move the machine.we required only high RPM motor .low torque will not affect movement of the machine .the propeller is attached to the motor shaft.



**Fig 3.5:**Propeller



**Fig 3.4:**DC

12volt 10000

RPM motor

**Conveyor**

Conveyor are used to lift the garbage's present in the water. We used rubber net conveyor, it will give more friction compared to belt conveyor and also stable compared to the chain conveyor. It's 1.2 metre length and width, 0.34 metre. Also used mesh to support the conveyor to take garbage's.



**Fig 3.6:** Mesh



**Fig 3.7:**Rubber Net

### Conveyor motor and chain sprocket arrangement

12 V DC motor is used for conveyor system. In which motor and rotating shaft are connected by chain and sprocket arrangement. The specification of DC motor is 800rpm and torque is 6kgcm.



Fig 3.8:12 volt DC motor



Fig 3.9: Chain sprocket arrangement

### PVC pipe

PVC pipe are used for floating the machine. We used four pipes of 4 feet and 4 inchdia.it will give stability in the water for floating the machine. Theentire weight will distribute to this four pipe.



Fig 3.10: PVC Pipe

### Solar panel

A Solar panel 12V,20Watt is used for our project. Type of the solar panel is polycrystalline solar panel is connected to the battery.it is helpful to recharge the battery.



Fig 3.11:Solar panel

### Obstacle Detection Circuit

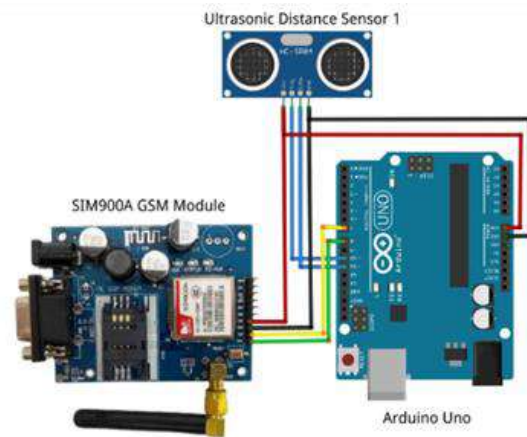


Fig 3.12:Obstacle Detection Circuit

It is a combination circuit the ultrasonic sensor used will detect the obstacles and send message to the receiver or mobile

### Hardware RequirementsObstacle Detection Circuit

1. Arduino UNO
2. UltraSonic sensor HC-SR04
- 3.GSM SIM 900a Modem
4. Jumper Wire

### Website

To make public aware of lake cleaning by creating website and to publishing lake cleaned data on the website. If any queries, they can contact with us after going to contact page.



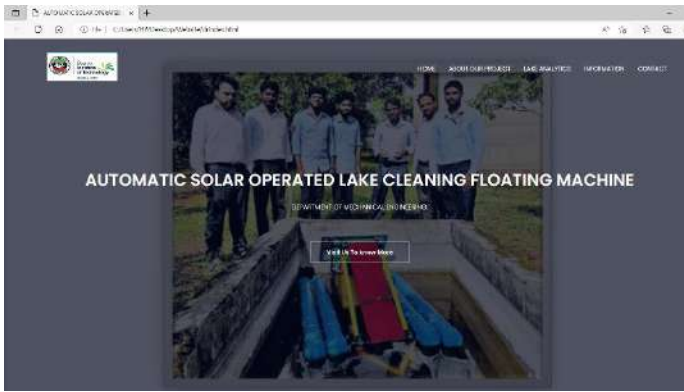


Fig 3.13: Home page of website



Fig 3.14: Home page of website and project demonstration page

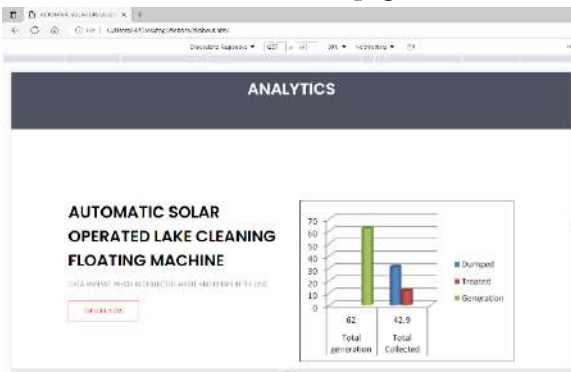


Fig 3.15: Analytics page



Fig 3.16: Contact page

**C. Fabrication**

For project to be accomplished and model to be created fabrication part plays very vital part in our project. Fabrication is the continuous process carried out in

order to create something. Basically, fabrication involves welding, Joining and assembling the parts based on the design of our project "Automaticsolar operated lake cleaning floating machine".



Fig 3.17: Isometric view of Automaticsolar operated lake cleaning floating machine.

**D. Final Result**

Final goal of our project fabrication work has successfully been completed. We have successfully conducted the test of our project and met required objectives.

**E. Advantages**

- As it is cleaning the lake it's make sure that it's eco-friendly and protecting living organism from danger.
- As our project is remotely controlled it reduces human error, Risk of life and Accidents during the operation.

**F. Disadvantage**

- There is still some disadvantage such as weight balance of the system as we used mild steel it will apply more weight on the pipes. Also, when wind hit the machine, there will be less stability.

#### IV. CONCLUSION

The design and fabrication of "Automatic solar operated lake cleaning floating machine" was built. We successfully completed the project. The project is environmentally friendly, reduced human effort and also reduce human error. The overall cost is high, but can be reduced with changes in material used. Low maintenance required.

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Journal URL : <https://ijsrset.com/IJSRSET12293185>

# Artificial Intelligence Assisted Solar Biomass Hybrid Dryer for Drying Cocoa

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## ABSTRACT

This journal paper aims to design and fabrication of artificial intelligence assisted solar biomass hybrid dryer for drying cocoa. This work mainly concentrates on offering an authentic and reliable solution to the drying of cocoa beans. Commercially available solid edge software was used for designing the solar biomass hybrid dryer for drying cocoa. Based on the research and calculation, done the fabrication of solar biomass hybrid dryer for drying cocoa which aims to minimize manpower and time consumption in drying cocoa beans.

**Keywords:** Cocoa dryer, Hybrid dryer, Solar dryer, Biomass dryer, Ecofriendly.

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## I. INTRODUCTION

Cocoa beans are widely used in different areas for various applications such as supporting brain health, cure for diseases it acts as a good source of antioxidant, regulating cholesterol level in the blood and it helps for the prevention of skin cancer and diabetes and it is also mainly used for manufacturing of chocolates [1].

The traditional ways of drying cocoa seeds are two ways such as open air drying and solar roof heat drying. So this drying methods use to take 3 to 4 days for drying in open air drying and solar roof drying. There will be sudden changes in weather so it may affect the quality of cocoa beans. For good quality of cocoa seeds the moisture content should be maintained 5% to 7% [2]. In these methods of drying its difficult to maintain this moisture content level so, came across with the concept of making “artificial intelligence assisted solar biomass hybrid cocoa dryer for drying cocoa”.

In this work, designed that if the weather changes it will not affect the cocoa seeds. We made a hybrid dryer it can dry cocoa seeds quickly by using simultaneously solar heat and biomass heat. So, it will reduce the time of drying and for maintaining the moisture content with the help of artificial intelligence to continuously check the moisture content in the seed. So, it will reduce labour for monitoring the drying of cocoa seeds and it will maintain the criteria and the quality of seeds will be good.

## II. OBJECTIVES

To design and fabricate artificial intelligence assisted solar biomass hybrid cocoa dryer. To use artificial intelligence to maintain the moisture content to 5% to 8% which helps to maintain good quality cocoa beans. To reduce the time of cocoa drying. To improve the quality of cocoa beans and to reduce the labor cost. To

make an eco-friendly and economically reliable machine.

**III. METHODS**

In this methodology it's a process of project planning and executing where all the major and minor steps of the project either it may be logical or creative fabrication application steps are systematically explained. Methodology is one of the major components in project planning where all the possible elements and their results effects are relatively considered for the most appropriate and effective project management.

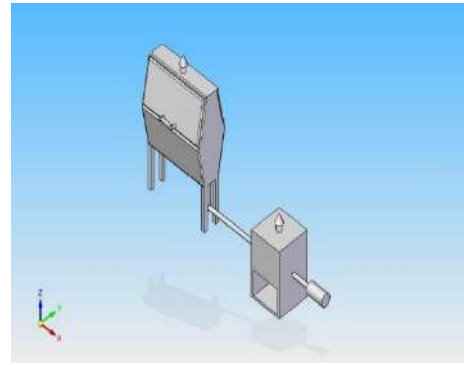
In the present work, collection of methods or practices done are as follows:

**A. Literature Review**

The journal papers are reviewed because to acknowledge and study the recent trends in the field of cocoa seeds drying process. Surveying of literature review helps us in easy understanding of the overall activities in our specific topic. It also helps us to implement further modification of work in our research.

**B. Designing**

Completely designed the model of the solar biomass hybrid dryer for drying cocoa by using solid edge software according to the actual dimensions as shown in fig.1, which was useful during the period of fabrication work. Fabrication work carried out according to the actual design and dimensions. Designing of any product or machine is an important. Because, each and every dimension that gives very significant. So, every part is interconnected to each other during the assembly. And used Arduino software to feed a program in the Node MCU board.



**Fig. (1) CAD Model**

Table1. Represents the design characteristics of artificial intelligence assisted solar biomass hybrid dryer for drying cocoa.

**TABLE I  
DESIGN CHARACTERISTICS**

Metal Sheet	16-gauge metal sheet
Metal rod	Mild steel rod
Glass	Fiber glass
Pipe	Mild steel pipe
Blower type	Air blower 220v/600w
Control board	Node MCU
Moisture sensor	LM393 Moisture sensor
Temperature sensor	DS18B20 temperature sensor
Display	16*2 LCD display
Battery	5v/1a

**C. Fabrication**

Fabrication is a sequence of events which is done to create something from the scratch rather than just assembling it. In this fabrication work is the building of artificial intelligence assisted solar biomass hybrid dryer for drying cocoa from the scratch. Building each part individually and assembling or welding it together is the major goal of our project. Below figure shows different parts and assembled parts.

## D. Components



**Fig. (2)** Dryer Chamber

### Dryer Chamber

In this drying chamber kept cocoa inside the chamber as shown in fig.2. It has a capacity of drying one kilograms of cocoa seeds. Inside the chamber the moisture sensors and temperature sensors are placed and it sense the moisture content of the seeds and chamber temperature.



**Fig. (3)** Connecting Pipe

### Connecting Pipe

This connecting pipe is connected with biomass chamber and dryer chamber. Fig.3 represents the connecting pipe which carry hot air from biomass chamber to the drying chamber.



**Fig. (4)** Biomass Chamber

### Biomass Chamber

In this biomass chamber we burn biomass and it heats the pipe as represented in fig.4. The external air from blower it forces the heated pipe air towards the chamber. Biomass was used mainly for two reasons one is to dry cocoa seeds quickly and second reason is to use dryer in unseasonal time or in rainy seasons.



**Fig. (5)** Air blower

### Air Blower

Fig.5 illustrates the Air blower is used to force the hot air towards the chamber. The specification of Air blower is of 220v/600w and it carries hot air in 30 miles/hour.



**Fig. (6)** Moisture sensor controller

**Moisture Sensor Controller**

In this the controller used is NODEMCU board. The program used is #c program and uploaded into the control board. The sensors used are LM393 Moisture sensor and DS18B20 temperature sensor. The moisture sensor senses the moisture content of the cocoa seeds and displays in the display and even the temperature is displayed of the inside chamber. The display used is 16\*2 LCD display as shown in fig.6.

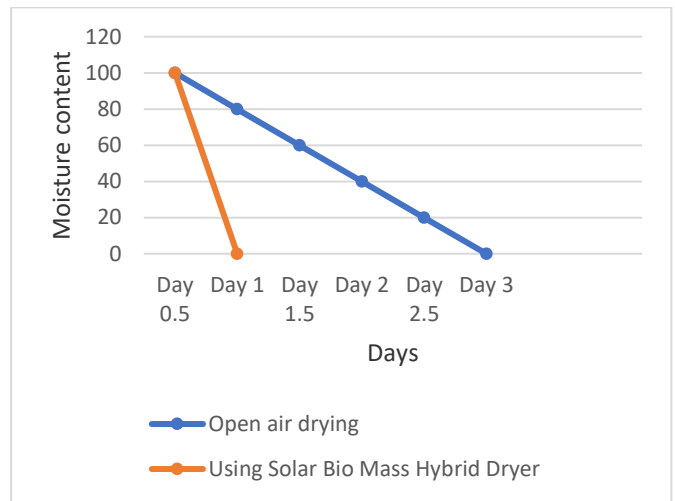


**Fig. (7)** Assembled Parts of Artificial intelligence assisted solar biomass hybrid dryer for drying cocoa

**Assembled part**

Figure.7 represents the complete assembly of the artificial intelligence assisted solar biomass hybrid dryer for drying cocoa.

**IV. RESULTS AND DISCUSSION**



**Fig. (7)** Moisture V/S Days Graph

In Traditional method such as Open-Air Drying, it takes approximately 3 days to dry the cocoa seeds, whereas in the proposed method “Artificial Intelligence assisted solar Bio Mass Hybrid Dryer” takes 1 day for drying the same. Final aim of our project fabrication has successfully been completed. We have successfully conducted the test of our project and met required objectives.

Since it will reduce the time of cocoa drying and it will improve the quality of cocoa seeds from dust particles, it also reduces the labour cost. By using artificial intelligence, we can detect the moisture content 5% to 8% which results into obtain good quality of cocoa seeds. Less spoilage or less wastage of dried products. Better prices due to postponed market serve. Different value creation possible since dried products have higher margins. High hygienic standards (no dust, no pollution, no fungus, no animals, no foreign materials etc.)

The initial cost and maintenance for this project is high and drying process involves with some chemical reactions begins during foaming, which causes to a decrease in the sharpness, contracting and acidity of cocoa seeds

## V. CONCLUSION

Artificial intelligence assisted solar biomass hybrid dryer for drying cocoa prototype was designed. Normally in open air it will take 3 to 4 days for drying cocoa seeds and it will get affected by the dust particle. By using artificial assisted solar biomass hybrid dryer for drying cocoa, get good quality of cocoa seeds by drying, reduce the time duration of 2 days and also, monitor the moisture content from the sensor controller. Other benefits include the ease of operation, no skilled manpower required for monitoring. Thus, during rainy season when sun radiation is low, can dry the cocoa seeds by burning bio-mass fuel. Therefore making the dryer use full in all-weather condition.

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# Portable Electric Ploughing and Levelling Machine

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## ABSTRACT

This journal paper is primarily based on the layout and fabrication of transportable electric powered ploughing and leveling machine for the operations like ploughing and leveling the farming land and doing away with undesirable weeds from farm and also sand desires to be opened in order that atmospheric air flows thru sand. Our mission is of a single wheel cart that runs thru a motor with battery and established with a ploughing and leveling blades. This device may be operated routinely and manually too. Basic solid aspect software is used to layout our assignment. Based on the studies, carried out the fabrication of portable electric powered ploughing & leveling machine in a manner this is affordable to the small scale farming.

**Keywords** : Electric plough, electric powered leveling, battery powered, transportable design

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## I. INTRODUCTION

This machine is designed for small agriculture discipline<sup>[1]</sup>. This device is portable so that it can be carried everywhere we desired to carry out the ploughing and levelling operations on the land. This machine is green and occasional price compared to the conventional tractors<sup>[2]</sup>. It is lower priced for farmers folks that can't find the money for conventional tractor

to perform the same operations<sup>[3]</sup>. This machine consists of set of 3 blades for ploughing operation and in the back of that sliding mechanism is established for levelling blade and single wheel is mounted thru a connecting rod onto which is the small angles are welded to hold a gripping contact with the ground and additionally for the loosening of the soil and also to attain uniform rotation with the assist of electric motor<sup>[4]</sup>.



The operation of a transportable electric powered ploughing and levelling device involve strolling behind the device. This machine includes electric powered motor, battery, chain sprocket, wheel angles, bearing, electric & wiring, mounts and joints, assisting frames, screw and fitting, bicycle wheel, the system is pushed by way of electric motor which uses a sprocket chain association to drive the pulling wheel. A battery is used to operate electric motor with forks via soil. The cultivator blades allow for clean and slim ploughing exactly as required for farming. Due to the easy fabrication of machine, the device renovation is very low.

## II. LITERATURE REVIEW

Journal papers are referred for the study and understanding cause and additionally to take into account a recent updates inside the place of the portable electric ploughing and levelling machine. Literature survey allows in knowledge of all of the activities undertaken in this topic. It additionally facilitates in implementation of the more automation and upgradation of factors in the research.

## III. OBJECTIVES AND METHODOLOGY

The objective of this venture is to present the repute of the cutting-edge traits and implementation of Agricultural and description the capacity for future programs. The important goal is to lessen the human effort within the small agricultural fields via the use of this machine which is used for ploughing the land and levelling the land.

Methodology is a process of project planning where all the major and minor steps of the project either it may be logical or creative fabrication application steps are systematically explained. Methodology is one of the paramount components in project planning where all the possible factors and their results effects are relatively considered for the optimum and effective

project management. In the present work, the collections of methods or practices are done as follows:

### Working

The machine carries of electrical motor (3000 RPM), batteries (24 V), chain sprocket, connecting rods, and blade mountings and joints and so forth. The machine runs by way of a electric powered motor that's connected to a fly wheel thru a sprocket chain arrangement to drive the pulling wheel. A battery is specifically used to run a motor with blades via soil. The cultivation blades plays a easy and correct ploughing exactly wished for farming. The device is constructed in a form that its miles mild in weight and also it's miles portable, Hence its price is less.

### Designing

For modelling commercially available solid edge software was used for the designing of system in fashions are produced in exceptional perspectives for the knowledge and accurate layout. The figure1 shows the design of the portable electric ploughing and levelling machine in solid edge software.

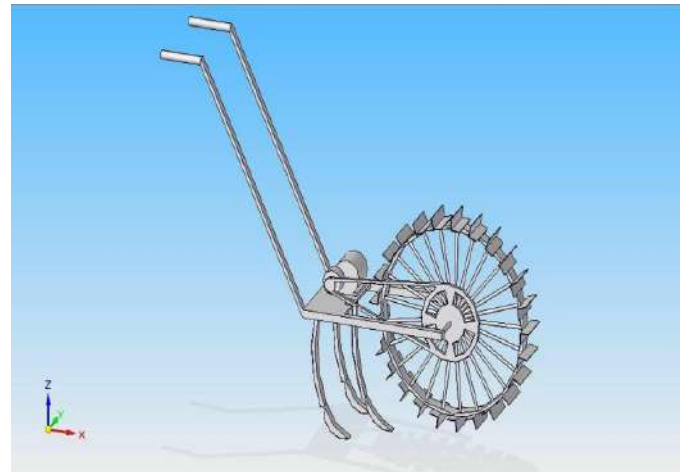
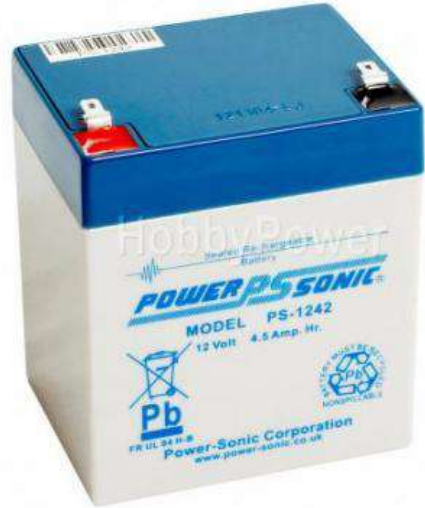


Figure 1. Isometric 3D Mode

Table 1. Represents the design characteristics of portable electric ploughing and levelling machine.

**Table 1.** Design characteristics

Battery type	Lead acid
Battery specification	2 x 12v, 7ah
Motor type	DC Geared Motor
Motor specification	24v, 3000rpm
Motor power	250Watts
Machine dimension	42x10x42 inches



**Figure 3.** Battery

**Components**

**Electric Motor**

Here the motor used is of a 24V and 3000 RPM and it's far 250 watt, here the motor is attached with a gear that is similarly linked to a fly wheel through a series sprockets to pressure a wheel. This motor is pushed by means of 24V batteries.



**Figure 2.** DC Motor

**Battery**

The batteries are extended up to 24V (12V batteries), If the batteries are fully charged it is able to run the system up about from 5 to six hours. It is a rechargeable lead ion battery.

**Ploughing and Levelling Blades**



**Figure 4.** Blades

Blades are specifically used for ploughing the ground, loosening the soil and doing away with the waste weeds from the ground. Approximately those blades may be digs up to a few to 4 inches into the ground. These blades are approximately 1 toes lengthy linked to a major body although a nut and bolt mechanism.

**Driving Wheel**

Driving wheel is set up of small angles which makes a gripping touch with the floor and fly wheel is hooked up to the riding wheel for the rotation, the entire frame is attached to a riding wheel through a connecting rods.



**Figure 5.** Driving Wheel

### **Fabricated the Machine**

The following up of many research paper, Accumulating a statistics approximately assignment, Collecting of uncooked substances and components, Fabrication of the machine via using the uncooked materials and machine components, Checking the operating of device, Presenting the record and research paper.



**Figure 1.** Portable Electric Ploughing & Levelling Machine

### **Advantages**

Fully computerized operation, No alternative gas is wanted, therefore the whole device runs on a 24V battery, Easily transportable, clean to perform and renovation is low, Machine is so value-effective, whilst it is compared to the tractor, Reduces a human effort and replaces the animal power, Reduces the ploughing time.

### **Disadvantages**

The major disadvantage of the portable electric powered ploughing and levelling machine is that it cannot be used in large farming area.

## **IV. FINAL RESULT**

Final destination of our assignment is to complete the fabrication system of our machine, transportable electric ploughing and levelling system with the sure operations like ploughing and levelling and to behaviour an indication of machine.

## **V. CONCLUSION**

After a usual study and by way of finding solutions, we have nicely designed a portable electric powered ploughing and levelling machine with a specific operation that's built with use of DC motor of 24V that is of the 3000rpm and the 250watt, which drives the whole device via a driving wheel. Here, the preliminary fee is high and but reduces the human effort and it's far green too.

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# Design and Fabrication of Trailer Disc Braking System

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## ABSTRACT

This journal states the component which is absolutely subject to the braking mechanism, where the main contrast is that the regular trailer axle is been changed with the new hub and the front part of the trailer, as pole of the trailer and farm truck is been given an extra part of slowing down control. This part is the single chamber which is the principal part to work the brakes. At the point when the driver applies a critical brake because of latency, it comes over on the working vehicle. As the cylinder pushes the oil forward from the pipe it applies the brakes and the trailer stops with the working vehicle. The accidents can be prevented by implementing it. The semi-truck is a separable trailer hauling loads around 6-7 tons. It is found that because of an extreme burden on the trailer in India there are questionable jerks on the tractor trailer. The farm vehicle and the trailer have the likelihood to break down or fall. This might hurt the driver, the street, and the existence of individuals who are around the farm vehicle while the mishap happens.

**Keywords :** Cylinder Pushes, Trailer Disc Braking System, Aluminum Brakes

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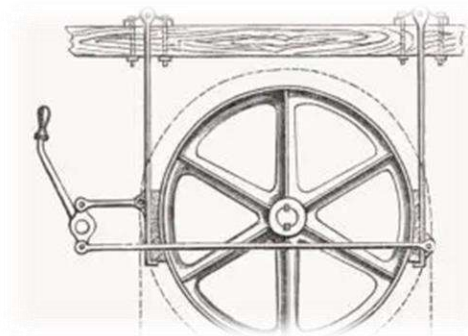
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## I. INTRODUCTION

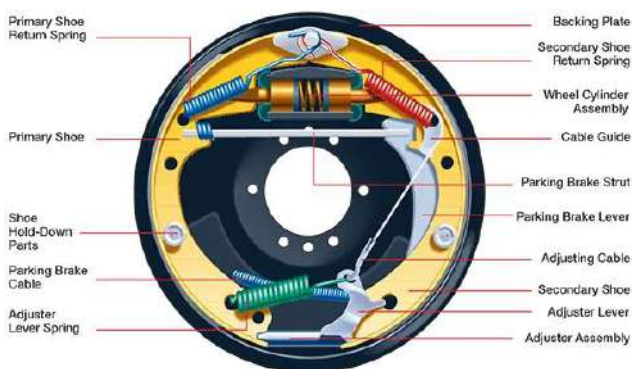
The first documented case of brakes in use turned into in historic Rome. These easy brakes had been composed of a lever that after pulled, pressed a timber block onto the outdoor of a metallic covered wheel. The number one pressure for braking with this tool turned into friction. This approach turned into powerful because of the sluggish speeds at which the carts traveled; however, it turned into an insufficient shape of slowing runaway carts. This approach of

braking turned into used for hundreds of years with little layout improvement [1].



**Fig 1:** Lever Brake Example

When the rubber-covered wheels were created by the Michelin brothers' wooden blocks were replaced with drum brakes. Louis Renault invented drum brakes in 1902. Instead of applying a block to the outside of the wheel, drum brakes were mounted inside of the wheel hubs. This helped minimize debris blockage and reduce the loss in braking friction. Drum brakes are still in use in cars as handbrakes due to the large amount of force needed in order to overcome the brake force while at rest. With the introduction of the assembly line, cars became heavier and faster, which created a need for a more powerful braking system. Malcolm Longhead [2] created a four-wheeled hydraulic braking system. The hydraulic system uses lines filled with hydraulic fluid rather than cable driven braking systems. The main advantage to hydraulic braking systems is that they can apply a greater braking force than cable systems. Cable brakes fatigue faster than hydraulic brakes due to a constant tension that the cable is under. Hydraulic brakes allowed the driver to apply less force onto the brake pedal while still stopping in a same short distance.



**Fig 2:** Drum Brake Example

Throughout braking history, the issue of overheating has been a constant problem. Heat happens when the brake pads interact with the slowing down surface. The main factor in scattering heat is having a bigger surface region for the brake to chill off. Disc brakes have a huge surface region presented to the air, which assists it with staying cooler. There are openings and notches cut into the rotor of the stopping mechanism to permit water and garbage to be moved off the

slowing down surface and limit impedance, which causes loss of slowing down force.



**Fig 3:** Disk Brake Example

Disk brakes started becoming popular in vehicles during the 1950's even though they were invented around 1902 [3]. Disk brakes are attached inside the rim of the vehicle and spin in unison with the wheel. When driver applies the force to brake pedal by foot the brake fluid travels through hydraulic cables and becomes amplified by the power braking system attached to the engine; this in turn pushes the brake fluid against the caliper which which uses frictional force to slow the vehicle. Faster vehicles need brake pads and calipers to be made of different materials to replicate the same braking distance needed to stop slower less advanced vehicles, due to the greater amount of inertia that is trying to be stopped. Most commonly found in brake rotors are spheroidal graphite iron, steel, aluminum, and carbon tool steel. Production cars use cast iron brakes due to the amount of abuse that they can handle without cracking or failing. Steel brakes have a lighter weight and heat capacity, but lack durability in repeated uses. Heat can disperse faster with layered steel brakes because adding layers to simple steel brakes allows for a stronger material that can withstand a more rigorous workload. Aluminum brakes have the lowest weight of all vehicle rotors.



**Fig 4:** Brake Rotors Example

Brake pads have been made with different materials throughout the years depending on the intended use. Asbestos [4] was the most popular material due to its ability to absorb and disperse heat. After scientific studies, asbestos has been found to be a highly toxic material and has been banned from use in vehicles in the United States. With asbestos illegal to use, brake manufacturers were forced to create safer brakes from a material that will not harm the general public. Organic brakes are made from materials that can withstand heat, for example; glass and varieties of rubber are mixed with a heat resilient resin to produce safer brakes.



**Fig 5:** Brake Pads

The advantages of using organic brake pads are that they are usually quieter and are easier to dispose. Even

so, organic brakes are not typically used because they wear easily and dust particles collect between the pad and wheel, which decreases the braking surface. With a lighter weight to slow down, motorcycles use organic and ceramic brake pads. They are the most effective type of brake pads but are the costliest. The most common type of brake pad is made with a mixture of several types of metals. These metallic brakes are durable while still being cost efficient. The negative factors for using metallic brakes are that they work best when warm and it may take longer to slow down at first when driving in cold weather. With advances in material science, brakes will continue to improve to match the advances in car technology. A hydraulic brake is an arrangement of braking mechanism which uses brake fluid, which has glycol ethers or diethylene glycol, to transfer pressure from the controlling mechanism to the braking mechanism[5].

#### **B. Why we need to have Hydraulic braking system**

- Preceding the pressure driven stopping mechanism the kind of slowing mechanism utilized was mechanical slowing mechanism, so presently the inquiry emerges on the off chance that we as of now have mechanical slowing mechanism so why water powered slowing mechanism? [6] Let's simply find out.
- The brake force created by pressure driven slowing mechanism is created by the hydraulic hose pipe and system of control is applied to series of vehicles.
- Frictional need amount in the event of mechanical stopping system was extremely high because of the contribution of many complex components, which is all around lesson to the ideal level with the presentation of the pressure driven stopping mechanism which has exceptionally fewer moving parts when contrasted with the mechanical one.
- Brake disappointment chances on account of water driven stopping mechanism are exceptionally less when contrasted with the

mechanical framework because of the immediate association between the actuator (brake pedal or switch) and the brake plate or drum.

- Plan intricacy on account of mechanical slowing down was extremely high which is diminished with the presentation of the pressure driven stopping mechanism which has a straightforward and effortlessly gathered plan.
- The support on account of mechanical stopping mechanism was high because of the contribution of perplexing and a greater number of individuals which isn't an issue with the pressure driven slowing mechanism as it has a straightforward plan with less moving parts.

## II. OBJECTIVE

- In order to lesser the accident due to lack of braking system in the tractor trolley
- As hydraulic braking system is used quick result may be obtained
- Used as life saver project as 80% of the accident are stop from happening
- Mostly applicable in agricultural field but can also be applicable in another field
- Efficient in travelling while carrying load

## III. METHOD

Methodology is a process of project planning wherein all the major and minor steps of the project whether it may be logical creative fabrication application steps are neatly explained. Methodology is one of the prime components in project planning where all the possible factors and their aftermath effects are relatively considered for the optimum and effective project management. In the present work, collections of methods or practices done are as follows:

### A. Literature review

Journal papers are reviewed in order to study and understand the recent updates in the field of electric power tillers. Surveying of literature review helps in simple understanding of the overall activities in our

topic. It also helps us to implement further up gradation of work in our research.

### Characteristics

Brakes are frequently defined in line with numerous traits including:

**Peak pressure** – The top pressure is the most decelerating impact that may be obtained. The top pressure is frequently extra than the traction restricts of the tires, wherein case the brake can purpose a wheel skid.

**Continuous energy dissipation** – Brakes normally get warm in use, and fail while the temperature receives too excessive. The finest quantity of energy (strength in line with unit time) that may be dissipated thru the brake without failure is the non-stop energy dissipation. Continuous energy dissipation frequently relies upon on e.g., the temperature and velocity of ambient cooling air.

**Fade** – As a brake heats, it is able to end up much less powerful, known as brake fade. Some designs are inherently vulnerable to fade, whilst different designs are rather immune. Further, use considerations, including cooling, frequently have a huge impact on fade.

**Smoothness** – A brake this is grabby, pulses, has chatter, or in any other case exerts various brake pressure might also additionally result in

skids. For example, railroad wheels have little traction, and friction brakes without an anti-skid mechanism frequently result in skids, which will increase renovation charges and ends in a "thump thump" feeling for riders internal.

**Power** – Brakes are frequently defined as "effective" while a small human software pressure ends in a braking pressure this is better than standard for different brakes within side the equal class. This belief of "effective" does now no longer relate to non-



stop energydissipation, and can be puzzling in that a brake can be "effective" and brake strongly with a mild brake software, but have lower (worse) top pressure than a much less "effective" brake.

**Pedal experience** – Brake pedal experience encompasses subjective notion of brake energy output as a feature of pedal tour. Pedal tour is stimulated through the fluid displacement of the brake and different elements.

**Drag** – Brakes have numerous quantities of drag within side the off-brake situation relying on layout of the device to house general device compliance and deformation that exists beneath Neath braking with capacity to retract friction fabric from the rubbing floor withinside the off-brake situation.

**Durability** – Friction brakes have put on surfaces that have to be renewed periodically. Wear surfaces consist of the brake footwear or pads, and additionally the brake disc or drum. There can be tradeoffs, for instance a put-on floor that generates excessive top pressure might also put on quickly.

### C. Components of water driven brake

Now that we grasp water power, we ought to research the different parts which make up the strain driven brake. The entire easing back instrument can be isolated into the going with chief parts:

1. Expert chamber (Lever)
2. Lines
3. Fluid
4. Slave chamber (Caliper)
5. Cushions
6. Rotor

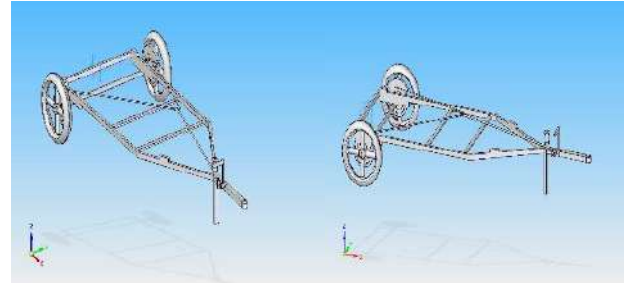
### D. Fabrication

Fabrication is a sequence of events which is done to create something from its root rather than just assembling it. In this research fabrication work is the

building of trailer disc braking system. Building each part individually and assembling or welding it together is main goal of our project.

### E. Designing and fabrication

As we have designed our project based on braking installation on trailer, as the step of designing we have done on solid edge with a dimension and calculation based on trailer.



**Fig 6:** Dimetric and Trimetric View

Fabrication of trainer disc brake system consist of many joints with welding operation done on MS steel and disc brake system added as a design created which is connected to single cylinder with the perfect dimension and process the fabrication have been created and successfully, we find our output.



**Fig 7:** Trailer Disc Braking System

## F. Final result

Final goal of this research is to complete a fabrication of a trailer disc braking system effectively for the optimum market conditions.

## F. Advantages

- It requires less effort to stop the vehicle.
- Disc brakes generates less heat
- Installation and service is easy in disc brakes
- They are easy to control
- Disk brake cannot get self-locked.
- Comparatively disc brakes have high toque transmitting capacity in small volume
- The braking torque is proportional to the actuating force in disc brakes
- For both directions of rotation of the disc, the disk brake is equally effective
- Disc brake doesn't wear down the rims.
- In wet condition it will skid less.
- Aesthetic value of your bike will increase with Disc brakes

## G. Disadvantages

- Timely service is required as the disc brakes are more prone to noise
- The rotor covers the brake easier than the drum brake system.
- Power booster is needed for higher clamping force as disk brakes are not self-energizing
- Comparatively more expensive than drum brake.
- Components used in this brake are too many thus increase weight.

## IV. CONCLUSION

This project has been successfully designed and fabricated. This hydraulic disc brake will fulfill the task of installing the effective braking system to the tractor trailer. Hence it will help the people who risk's their life while driving a tractor with trailer. Also, this will help the transportation to the hill and congested area with ease. This simple hydraulic brake system is cheaper and easier to install compared to drum brake system, as trailer tire disc does not have any hub space to fix the drum brakes. This hydraulic brake system could find a great scope in future for all trailers.

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# Development of Velocity Measurement Device and Calibration Using SHPB and Ballistic Impact Setup

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## ABSTRACT

A velocity measurement device was developed to measure the velocity of the striker bar of Split Hopkinson Pressure Bar (SHPB) set up. It measures the range of velocity magnitudes for different size of striker bars. The velocity measurement device measures velocity of the striker bar for varying pressure values. The readings were calibrated under freefall, SHPB and also using a ballistic impact testing setup present at the authors facility. The device was developed to produce consistent readings and these readings were tabulated.

**Keywords:** IR sensors, velocity measurement, Arduino, striker bar, SHPB, ballistic impact.

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## I. INTRODUCTION

In engineering, it is very essential to characterize material properties. Some of the most essential mechanical properties are Modulus of Elasticity, Yield stress, and Fracture toughness. Conventionally, determination of such is possible in materials testing laboratories, at low speeds only (Quasi-static). To ensure product quality and reliability under impact conditions such as those encountered in dropping of personal electronic devices, vehicle collision, and sports impact, the mechanical responses of materials under such loading conditions must be characterized accurately. However, high-rate loading conditions are beyond the scope of conventional material testing machines. A Kolsky bar, also widely known as a split Hopkinson pressure bar (SHPB), is a characterization tool for the mechanical response of materials deforming at high strain rates ( $10^2 - 10^4 \text{ s}^{-1}$ ). Split Hopkinson Pressure Bar has been extensively used for

the characterization of material properties at high rates, where the results are a family of stress-strain curves with the strain rate as a parameter [Zhao, H., Gary, G) [1996][1]. Generally, material response depends on the rate of deformation. In seemingly slow rates of loading (global) the rates of deformation can be very high locally. Knowledge of material behaviour at high strain rates is essential. Such studies started in 1940s by Hopkinson and Kolsky. It was evident that, the material properties vary with strain rate [Bo Song and Weinong Chen][2]. The Hopkinson pressure bar was first suggested by Bertram Hopkinson in 1914 as a way to measure stress pulse propagation in a metal bar. Later, in 1949 Herbert Kolsky refined Hopkinson's technique by using two Hopkinson bars in series, now known as the Split-Hopkinson bar, to measure dynamic stress-strain response of materials. Split Hopkinson Pressure Bar (SHPB) is a well-established experimental technique for testing of materials under high strain-rates [Frantz, C.E, Follansbee, P.S, Wright

W.J][3]. Parameters and performance of the experimental setup have to be tailored for the tested materials as for SHPB with gas-gun the maximal strain and maximal strain-rate achievable in the specimen are very limited. Strain in the specimen is proportional to the wave length of the incident pulse and to its amplitude whereas strain-rate is proportional to the incident pulse amplitude [Rohrbach et al., 2011][4]. Thus, these two most important parameters are proportional to the length of the striker bar and its impact velocity. In this paper, a simple analytic prediction model for calculation of the striker bar velocity is introduced.

### 1.1 SHPB SETUP

The Split Hopkinson Pressure bar setup consists of a striker bar, incident bar, transmission bar and the striker bar is made to impact one end of the incident bar by using pressurized air through a gun barrel. Measuring the velocity of this striker bar is very essential while determining the mechanical properties of a particular material during its analysis in SHPB setup.



The Split Hopkinson Pressure Bar experimental technique, consists of a specimen, the tested material, sandwiched between two elastic bars. A right-traveling compressive stress pulse is generated in the input bar. When the pulse reaches the bar-specimen

interface, it is partially transmitted through the specimen and partially reflected. The reflected and transmitted pulses are measured by strain gauges located in the input and output bars. The recorded signals can be used in the data analysis to determine the strain history of the specimen. The compressive pulse is generated by the impact of a striker bar against the input bar. The striker is usually accelerated by a gas gun specially developed for this purpose. Since its invention, the SHPB has undergone several modifications. It was adapted to do tensile tests [Lindholm et al., 1968][5], torsion tests [Bassim et al., 1999][6], among other variations presents several of these variations the SHPB has undergone over the time. As part of a program to characterize material behaviour under dynamic conditions, a SHPB is being designed in the authors institution, which demanded for a mathematical analysis of the striker bar velocity.

### 1.2 STRIKER BAR SPECIFICATIONS :

Material – Stainless steel 416

Young's modulus – 200 GPa

Density –  $7700 \text{ kg/m}^3$

Mass of striker bar – 0.707 kg



Fig.1.2 Striker bar

## II. DESIGN METHODOLOGY

- Setting range of IR sensors
- Programming the Arduino board
- Experimental testing of the velocity measurement under freefall, SHPB setup and ballistic impact setup.
- Tabulation of the readings and checking for consistency.

### III. EXPERIMENTATION

Based on the design methodology, the first step towards the development of a velocity measurement was selecting the desired sensors for velocity measurement. [T. Fila, 2018][7], consideration of pressure loss and coefficient of friction between the striker bar and gas gun are negligible and working according to adiabatic process with drag effects for deriving the velocity of the striker bar.

#### 3.1 IR SENSORS

Two photodiodes or Infrared sensors are being used for the velocity measurement



Fig.3.1 IR sensors mounted near the gun barrel

IR sensor specifications :

- Sensing range: 0.03 – 0.8 m.
- Input voltage: 5V DC.
- Current consumption: 300mA.

The gun barrel which contains the striker bar has a length of 1000 mm and has 2 holes at the end of the

barrel. The IR sensors are mounted next to the holes provided on the gun barrel as shown in the figure 3.1. The center distance between these two holes is 50 mm. Setting a definite range to pick signals is a very crucial step while mounting the sensors. The range of these sensors were set to a required limit, in other words, it was made to sense the surface of the Teflon present on the striker bar as shown in figure 1.2 as it passes through the gun barrel.

#### 3.2 CIRCUIT DIAGRAM OF THE VELOCITY MEASUREMENT DEVICE

Once the range in the IR sensors were set and mounted, the necessary circuitry connections were made within the velocity measurement device.

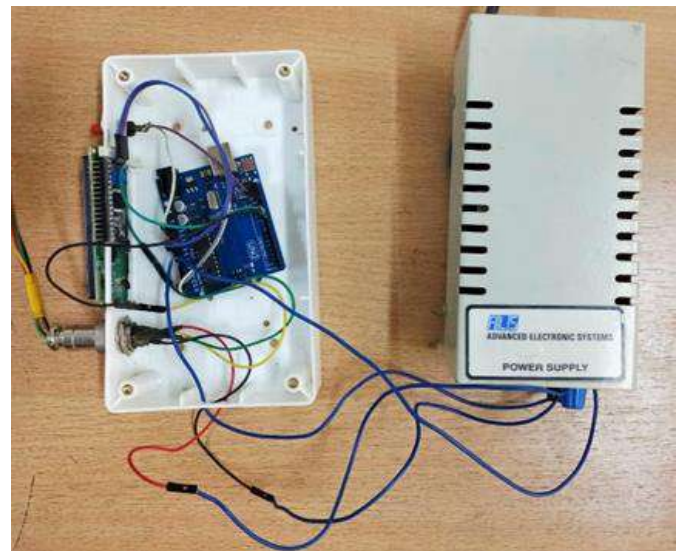


Fig 3.2a Image of the velocity measurement

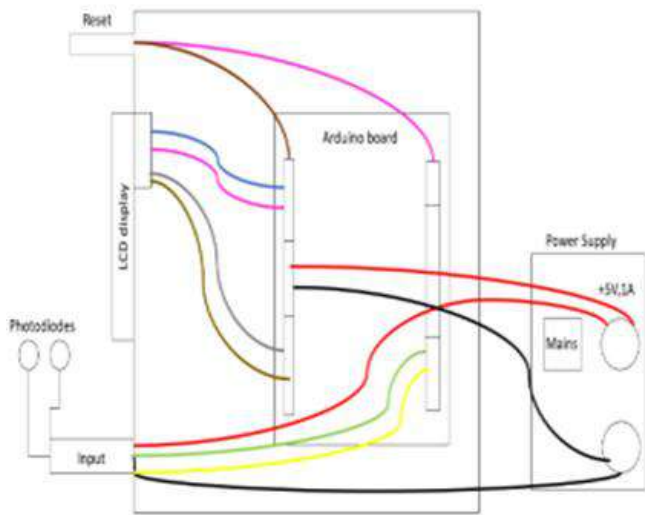


Fig 3.2b Circuit diagram of the velocity measurement device

Figure 3.2b gives an easier understanding of the necessary circuitry connection made within the velocity measurement device which has input from the two sensors mounted next to the gun barrel and also connected to a +5V, 1A power supply.

### 3.3 ARDUINO PROGRAMMING

An Arduino based velocity measurement device was opted as it has better reprogrammable capabilities. For this, an Arduino UNO board was used. A program was manually coded using the Arduino software and input into the Arduino board present in the velocity measurement device with the help of an Arduino cable. The Arduino program takes in input from the IR sensors. When the striker bar passes within the range of sensor 1, it gets turned ON and when it passes within the range of sensor 2, sensor 2 picks up the signal. The input sent to the Arduino board by these sensors is the time taken by the striker bar to pass within the range of the 2 sensors. The distance between the 2 sensors is input into the Arduino board that is, 50 mm. Using a simple formula of velocity  $v = \frac{d}{t}$ , distance being 50mm and time being the input from the sensors, the velocity is calibrated by the Arduino board and it is displayed onto a 16x2 LCD display. It is also essential

to have software libraries installed in the Arduino software such as Liquid crystal library for displaying the results obtained onto an LCD display.

### 3.4 Calibration of the Velocity Measurement Device

The velocity measurement developed was calibrated by measuring the velocity of a freely falling object. The object of a known weight was dropped from a known height as shown in the figure 3.4a and 3.4b. A set of trials were carried out and consistent readings were obtained during this process. The analytical readings were then compared with experimental readings.

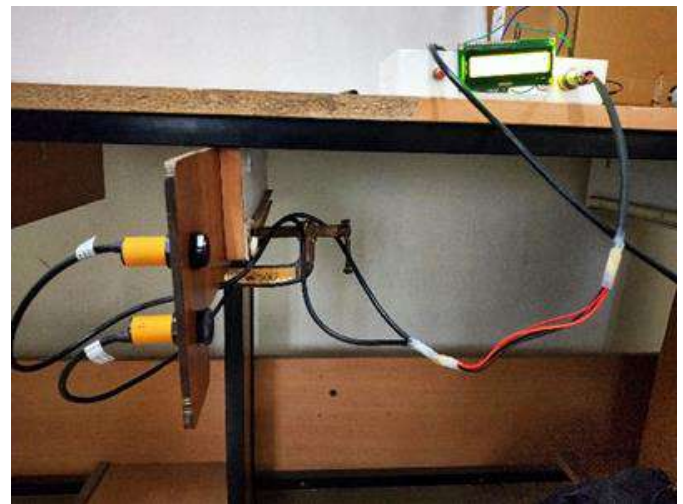


Fig – 3.4b Setup used to measure velocity of freely falling object

The analytical formula used here is,  $v = \sqrt{2gh}$

Where, g - acceleration due to gravity, h - height

The height being 0.3 m and g is  $9.8 \text{ m/s}^2$

The readings were then tabulated along with the analytical readings.

Experimental velocity of a freely falling body in m/s	Analytical reading
2.33	2.62
2.40	
2.41	
2.47	
2.43	
2.36	
2.42	
2.46	
2.75	
2.51	

### 3.5 CALIBRATION OF VELOCITY MEASUREMENT DEVICE USING BALLISTIC IMPACT SETUP

The velocity measurement device was tested on the ballistic impact testing setup to determine the velocity of the bullet when passing through the gun barrel. It was observed that the experimental readings obtained from this procedure yielded consistent results for varying pressure values. The results were tabulated.

Pressure (bar)	Experimental Velocity (m/s)
0.5	14.86
	15.43
	13.80
	13.94
	14.10
1	19.78
	20.13
	23.45
	22.08
	19.03
1.5	25.05
	27.54
	28.28
	26.90
	24.67
2	31.97
	30.79
	33.16
	30.94
	31.97
2.5	35.01
	39.18
	37.88
	39.20
	38.25
3	48.02
	51.96
	50.82
	47.41
	48.60

### 3.6 CALIBRATION OF VELOCITY MEASUREMENT USING SHPB SETUP

The velocity measurement device was also used in the SHPB setup to determine striker bar velocity in the gun barrel. It was observed that the velocity measurement device yielded consistent readings for varying pressure values. The readings were tabulated.



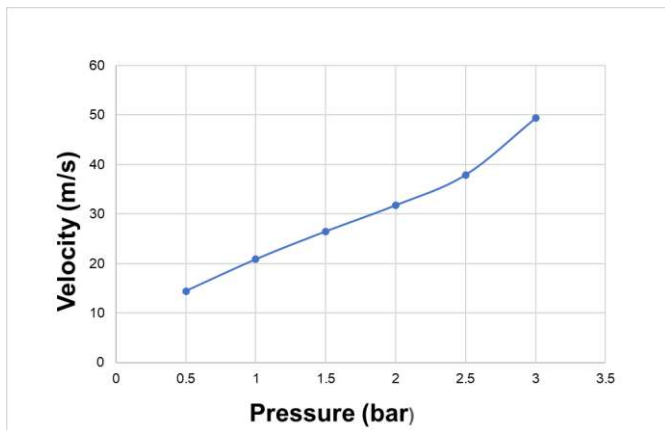
Pressure (bar)	Velocity(m/s)
1	4.70
1.5	6.79
2	9.46
2.5	11.32

**Specifications of SHPB :**

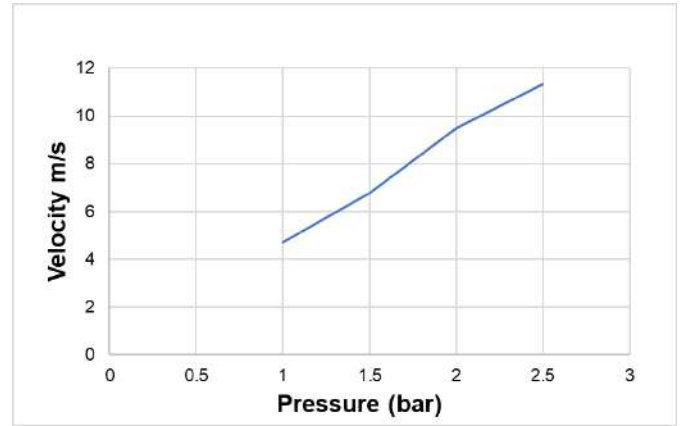
- Mass of striker = 0.727 kg
- Striker bar length = 0.3 m
- Striker bar cross sectional area =  $3.22 \times 10^{-4} m^2$
- Gun barrel length = 1 m
- Barrel diameter = 0.025 m
- Distance travelled by striker = 0.7 m
- Diameter of striker bar = 0.02025 m

**IV.RESULTS**

Pressure vs velocity graphs were plotted for the various readings obtained from the above experiments in order to observe the consistency of the velocity measurement device.



Pressure-Velocity graph for readings obtained from Ballistic impact apparatus



Pressure-Velocity graph for readings obtained from SHPB setup

**V. CONCLUSION**

A velocity measurement device was developed and it has specific applications in areas that include high speed or dynamic impact, (High strain rate domain) namely SHPB and ballistic impact.

- The velocity readings were calibrated under freefall, ballistic impact setup, SHPB apparatus and it was observed that the velocity measurement device generated consistent readings for various pressure values.
- The IR sensor with a better range was used for better accuracy.
- The Arduino board was programmed to ensure that the IR sensors detect signals even in micro seconds to detect signals at high velocity due to higher pressure.
- The velocity measurement device can be used in the SHPB setup for further testing and research.
- The device can be optimized by implementing better sensing devices.

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# Stress Wave Propagation in Bamboo Solid Bar

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## ABSTRACT

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Studies on stress waves in solids and liquids, and shock waves in gases are topics to the specialists in our country, find only in very few places in our engineering curriculum. This paper narrates stress wave propagation in solids (bamboo) in general and stresses in compression test using Universal Testing Machine. Theoretical fundamentals for studying stress waves in bars are briefed. The experimental stress-strain results for ball-bar impact on bamboo solid material were studied and discussed. Also uniaxial compression test was carried out on solid bamboo material.

Keywords: Stress Waves, Compression Test, Stress-Strain, Bamboo

## I. INTRODUCTION

Stress is the internal resistance of a body to external forces applied on it. In case of an elastic body subjected to external impact, part of the body which is close to the point of application of load is highly stressed while the far end is not aware of the impact [1]. The implication is that the effect of impact gets conveyed from the point of impact of the load to the other segments of the solid body by stress waves.

A stress wave is form of acoustic wave that travels with a finite velocity in a solid body. The stress wave will undergo multiple reflections and eventually attain equilibrium after a certain interval of time, this phenomenon is known as Stress Wave Transmission and Reflections [2]. These disturbance waves created locally will be transmitted to remote areas through the body as well as over the surface and are known as body waves and stress waves respectively. Body waves are

compressive-tensile stress waves and surface waves are shear waves.

A uniaxial compression test under quasi-static condition was carried out on solid bamboo material using universal testing machine. Experimental studies were done on five bamboo specimens. A maximum compression of about 18-25mm was applied. The area under the load versus displacement curve tells us the amount of energy absorbed. The respective yield stresses, ultimate stresses and compression strength was calculated and tabulated for the bamboo material.

The material and methods used and some basic theoretical equations used to find the properties of the material were explained in this paper. Experiments were performed and results so obtained are described and discussed.

## II. METHODS AND MATERIAL

Bamboo is a natural material which grows abundantly in the tropical countries. It is an anisotropic and heterogeneous material due to the structure composed of lignin matrix reinforced with fibres aligned in the longitudinal direction of the culm and therefore its properties vary at every point [4]. It is of two types, hollow bamboo and solid bamboo. The material used for this experiment is solid Bamboo. It is one of the oldest construction and building material used with vast range of functions and applications like domestic household products, agricultural and industrial use.

An attempt was made in this paper to study the stress waves and to characterize the mechanical property of solid bamboo bar. The method used to study the stress waves and to characterize the properties of the bamboo material are impact of ball-bar on the solid bamboo bar of 1000mm length and diameter 20mm and compression test on solid bamboo bar of length 29mm and diameter 24mm using Universal Testing Machine.

## III. RESULTS AND DISCUSSION

### a. Compression Test

The case of a solid bamboo bar being compressed is shown in Figure 1.

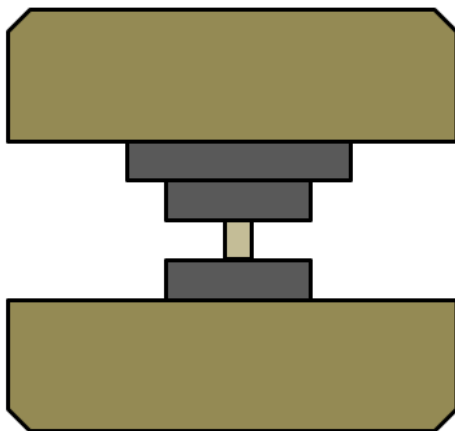


Figure 1. Schematic of bamboo compression test

Tests were carried out using an electronic universal testing machine of 400kN capacity. Specimens were placed on the bottom plate of the machine. Compression was caused by bringing the crosshead down on the specimen in a velocity control mode at a constant crosshead speed of 2mm/min. The experimental parameters such as the crosshead speed, specimen dimensions were input into the computer before start of each test. Loads and displacements measured with the transducers was fitted into the UTM and continuous load versus displacement data is obtained. The data is streamed into a computer which provided real time load - displacement curves. Experimental setup of bamboo for compression test is shown in Figure 2.



Figure 2. Universal Testing Machine

- 1) Machine frame
- 2) Cross head
- 3) Servo control
- 4) Desktop
- 5) Computer control
- 6) Specimen

The specimens were prepared and polished to be free of dents, nicks and scratches. The solid bamboo bars were cut into the required length of around diameter 24mm and length 29mm. The formula's used for calculating are same as the ball-bar impact test. Experimental studies on solid bamboo bar without nodes for five end preparations subjected to uniaxial, quasi-static compressive loads are reported and discussed. The formula's used to calculate the stress and strain of the material are as the same as of the ball-bar impact test and equation (3) and (4) are used.



Figure 3. Specimen before compression test



Figure 4. Specimen after compression test

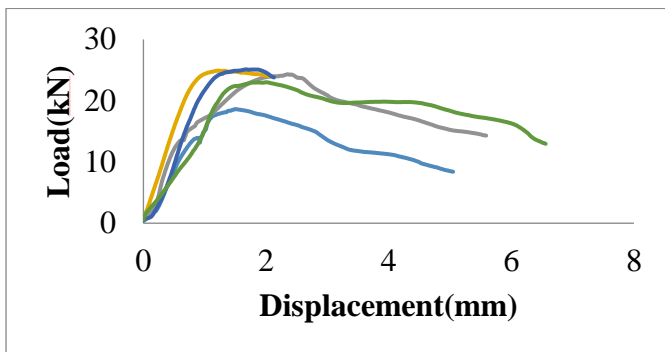


Figure 5. Comparative Load – Displacement curves under uniaxial compression

A typical load versus displacement curve obtained during compression of the specimens is shown in Figure 5. The curve shows a gradual linear increase up to a certain point which is the elastic zone. The highest load point defined as the peak point is around 25kN as seen in the graph. The maximum displacement for the above graph is around 6 - 7mm. The specimen then develops an inverted bulge and several cracks running axially is observed. There were many circumferential

delaminated strips curling outwards. The area under load versus displacement graph gives us the amount of energy absorbed during the process.

The test was stopped at a compression load of about 18 – 25mm. From Figure 3 and Figure 4 it is seen that there are many circumferential delaminated strips curling outwards. There is a circumferential crack separating the outer and inner zones. The crushing, deformation and fractures start from the top face in some specimens and from bottom face in some others. The ends move outwards and the central zone bows inside. The material in the deforming zone in the periphery is seen to delaminate, crack (axially) curl and bend outwards.

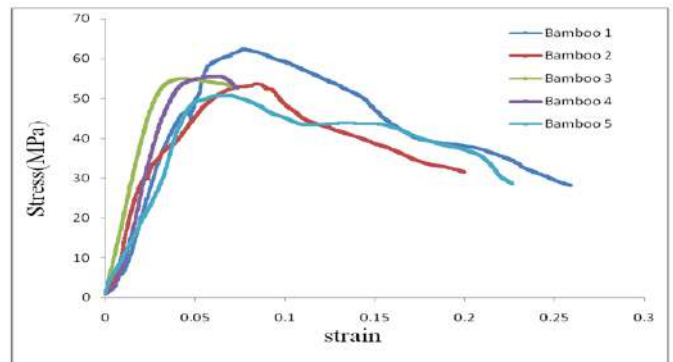


Figure 6. Strain-strain curves for series of specimens

Figure 6 shows the stress-strain curves for a series of specimens. The highest ultimate stress is around 62.32 N/mm<sup>2</sup> as seen from the graph. The range of maximum strain or the fracture point from the graph is around 0 – 0.3. The physical form of the stress-strain curves, the magnitude, stiffness and strength are nominally same. The area under load versus displacement graph gives us the amount of energy absorbed during the process, which is obtained using the HM13 software and tabulated.

Table 1. Experimental results under uniaxial compression of bamboo

Specimen no.	Area of specimen (mm <sup>2</sup> )	Yield Stress (N/mm <sup>2</sup> )	Ultimate Stress (N/mm <sup>2</sup> )	Energy absorbed (Joules)
Bamboo 1	298.768	46.6	62.32	64.125
Bamboo 2	452.571	30	53.69	99.169
Bamboo 3	452.571	31.29	55.01	40.593
Bamboo 4	452.571	32.57	55.46	37.651
Bamboo 5	452.571	30.18	50.82	115.228

**b. Ball- Bar Impact**

A spherical metal ball of diameter 30mm is coaxially impacting a solid bamboo bar at velocity 'v' which has quarter bridge strain gauges with 350Ω mounted on them is shown in Figure 7.

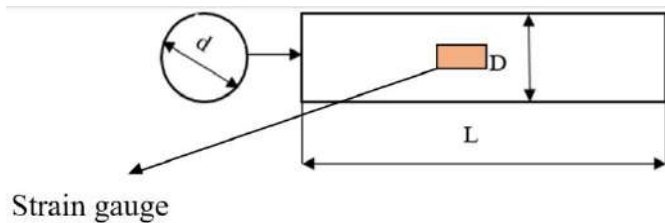


Figure 7. Schematic of Ball-Bar Impact

It comprises of test bar (solid bamboo), the striker ball, angle velocity measurement, strain gauges, strain gauge amplifier and oscilloscope. Strain gauges (quarter bridge configuration) is mounted on the test

- $V = \sqrt{2 * g * h}$

Where, v = velocity of the ball

g = acceleration due to gravity

h = height from the equilibrium position

----- (1)

bar. A 30mm steel ball bearing is used as the impactor to strike the bar. The angle of release is noted and the height of the pivot from the centre of the ball provides the velocity of impact. A straight bar of solid bamboo of 20mm diameter with 1200mm length is considered. The setup has wooden plank base with number of vertical posts that helped to suspend the strain gauged test bar and the striker. To strike the bar with the ball, the latter that is hung by threads tied pivoted to the first two posts on the base was pulled, holding the threads and released.

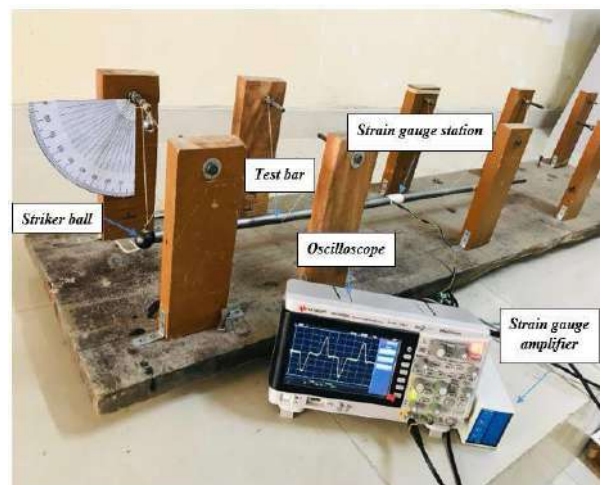


Figure 8. Experimental setup

A uniaxial compressive wave is introduced in the test bar by impacting the striker ball coaxially to the test bar. The stress wave propagates to specimen. The stress waves in the test bar are monitored by strain gauges mounted at the central section of the bars and amplified using a strain gauge amplifier. The output is recorded on a digital storage oscilloscope in the form of velocity versus time graph. This graph is later converted into stress versus strain graph. The formulas mentioned below were used for theoretical calculations.

- $h = l - l * \cos\theta$  ----- (2)

Where, h = height from the equilibrium position  
 l = length measured from ball center to hinge point  
 θ = drop angle of the suspended ball in degrees

- Strain,  $\epsilon = \frac{\Delta v}{V * Gain * G.F * B.F}$  ----- (3)

Where, Δv = change in output voltage  
 V = velocity of the ball  
 Gain (G) = amplifier gain: 1000  
 Gauge factor (G.F): 2.0  
 Bridge factor (B.F): 2.6

- Stress,  $\sigma = \epsilon * E$  ----- (4)

Where, ε = strain  
 E = modulus of elasticity

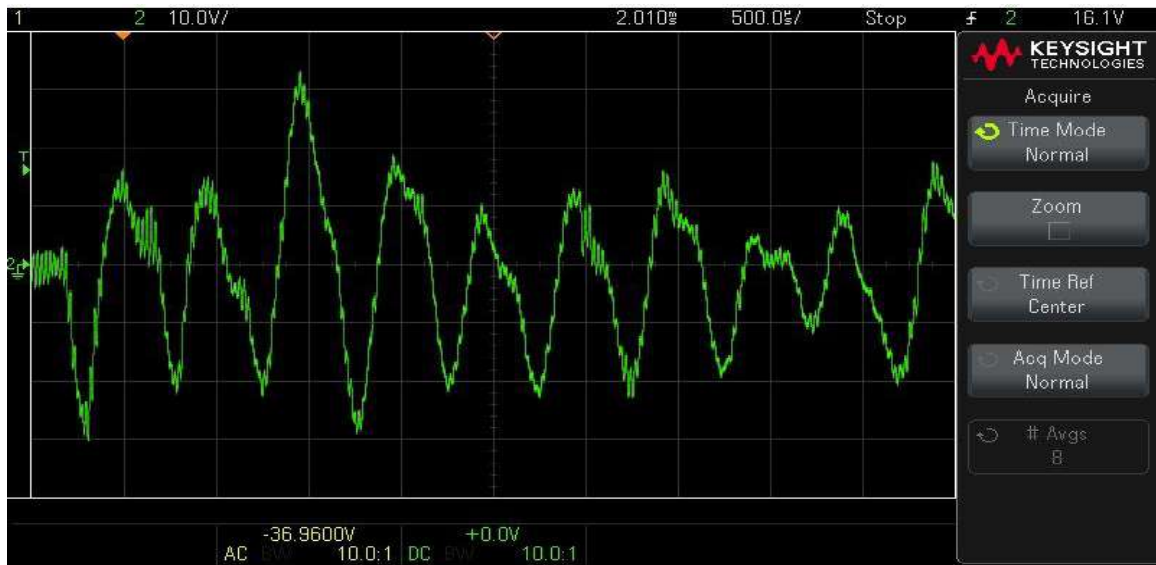


Figure 9. Experimental graph (voltage – time data from DSO)

In DSO (Figure 9), we will get voltage versus time graph. The ball is impacted on bamboo bar there will be no signal and only straight line will be seen in DSO. When the ball is impacted on the bamboo bar the wave starts to propagate inside the bar and once the waves passes through strain gauges it will pick the signal continuously. The waves are more disturbed because of the vibrations in the bamboo bar or it is because of the ball which has not been hit at the centre of the bar. The down side wave is incident waves and the upside wave is the reflected waves. These nature of waves will be continued for certain interval of time until it gets stilled.

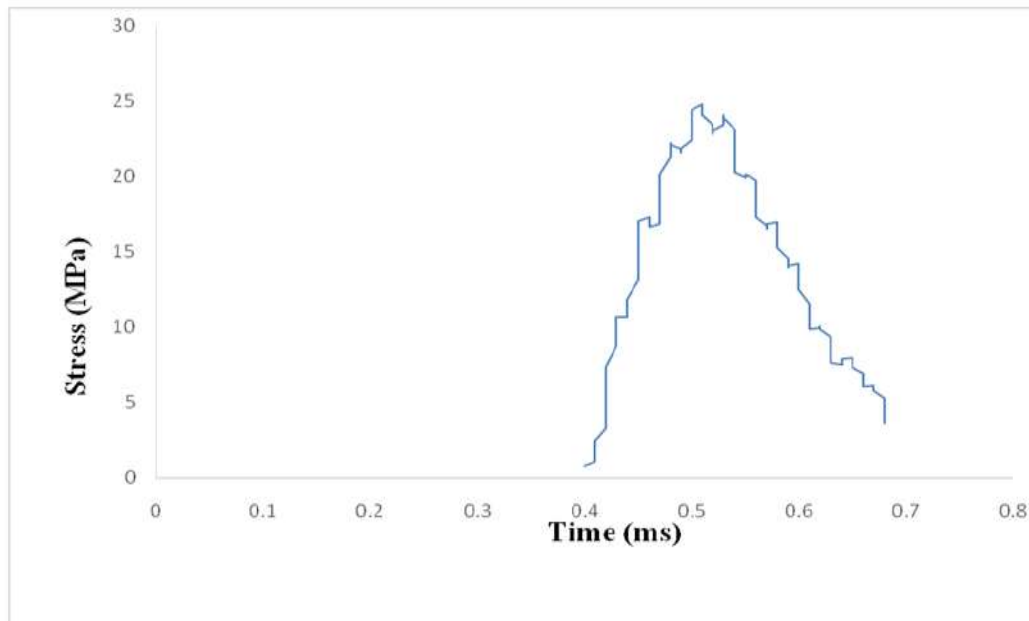


Figure 10. Analytical graph

Figure 10 shows us the stress versus time graph. It is only one wave form, Incident wave which is first picked by the strain gauge once the ball is impacted on the bamboo bar. The following table shows the results for the series and test for same angle and impact for the bamboo bar. It is seen that the results are consistent. The Young modulus obtained from the experimental were is 5GPa agreeable with literature[4].

Table 2. Experimental results for Ball-Bar impact

Test No.	Release angle (degree, $\theta$ )	Stress (MPa)	Strain	Young's modulus (GPa)
1	90	169.2	$3.384 \times 10^{-3}$	5
2	90	171	$3.67 \times 10^{-3}$	5
3	90	174.3	$3.8 \times 10^{-3}$	5
4	90	172.7	$3.71 \times 10^{-3}$	5
5	90	173.4	$3.76 \times 10^{-3}$	5

#### IV.CONCLUSION

In the ball-bar impact test the values for stress, strain and Young's modulus were calculated for solid bamboo bar at same release angle ( $\theta$ ) and velocity of the striker ball. The stress versus strain graph was extracted from

velocity versus time graph. In the compression test it is seen that none of the specimens tested failed in Euler buckling mode. This is because of the aspect ratio (length to diameter) was nominally kept as 1. The maximum load, the point at which the cracks begin to appear was noted down. The values of yield stress, ultimate stress and tensile strength was calculated and tabulated.

#### V. ACKNOWLEDGMENT

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# A Novel Vote Counting System Based on Secure Blockchain

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## ABSTRACT

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It has long been difficult to create a safe electronic voting system that provides the transparency and flexibility provided by electronic systems, while maintaining the fairness and privacy of present voting methods. Voting, especially during elections, is a technique where participants do not trust one another since the system might be attacked not just by an outsider but also by participants themselves (voters and organizers). The traditional methods of voting systems find it challenging to maintain the characteristics of an ideal voting system since there is a chance of tampering with results and disturbing the process itself. As a result, the effectiveness of the voting system is increased by translating the characteristics of an ideal voting system into digital space. It greatly lowers the expense of the elections and the work of the inspectors. In this essay, we'll use the open-source Blockchain technology to suggest a new electronic voting system's architecture. New chances to create new kinds of digital services are being provided by Blockchain. Numerous elements of our life have been altered by Blockchain technology, including the ability to save digital transactions via the Internet, confirm their legitimacy, license them, and provide the greatest level of security and encryption. This system offers a distributed architecture for storing the data, which distributes the data among many servers. In addition to maintaining voter identity outside of the vote count, this technology makes the voting process transparent.

**Keywords:** Voting System, Blockchain, Trust, E-Voting, Security, e-government.

## I. INTRODUCTION

People have the most freedom to make decisions and choose an effective leader in a democracy. Election

results serve as the last say on that choice [1]. Voting for the candidates that have chosen to participate in the election is how it is done. According to the words of Abraham Lincoln, "of the people, by the people, for

the people," the candidate with the most votes will win the election and become the new leader. Voting, especially during elections, is a technique where participants do not trust one another since the system might be attacked not just by an outsider but also by participants themselves (voters and organizers). Because of the potential for tampering with results and disturbing the voting process, traditional voting methods [2] struggle to maintain the qualities of a perfect voting system. As a result, the effectiveness of the voting system is increased by translating the characteristics of an ideal voting system into digital space. It greatly lowers the expense of the elections and the work of the inspectors. The method of voting has been a subject that is constantly changing in this environment [3]. The main force behind this progress is the goal to make the system visible, verifiable, and secure. Given its importance, ongoing attempts have been undertaken to increase the voting system's overall effectiveness and robustness.

One of the cutting-edge technologies, Blockchain has solid cryptographic underpinnings that enable apps to take advantage of these capabilities to produce robust security solutions. In this application, block chain technology aids in preserving the security against cyber-attacks. Information security issues can be solved with the use of encryption methods [4]. Voting, and especially election-related voting, is a process where players lack faith in one another since both the system and its users (voters and organisers) are capable of attacking it [5]. We will try to showcase certain Blockchain-enabled electronic voting methodologies in this article, together with their findings and recommendations.

There are several nations that are attempting to implement electronic voting, but the issues of validity and proof among other things need to be given extremely careful thought by governments, technologists, and ultimately the general public. This research proposed a system built on an adaptive block chain that could identify the problems that arise during voting, would aid in choosing an appropriate

hashing algorithm, is beneficial even in choosing modifications to the Blockchain [6], and would aid in safeguarding the content of block data. The Internet of Things (IoT), cryptocurrency, service supply chains, and other businesses all employ Blockchain technology. Blockchain contributes to enhancing the security of the ledger's transactions by preventing data from being altered, falsified, or corrupted by chain members. Transparency, fraud protection, and decentralisation are among other benefits of Blockchain technology [9].

## II. RELATED WORK

This highlights and examines a number of papers relating to Blockchain-based electronic voting systems that have the potential to address the issues with security and privacy in electronic voting systems. David Shaum invented the first electronic voting system in the early 1980s. Voting was done using public key cryptography, which also protected voter anonymity. The Blind Signature Theorem was applied to ensure that there were no connections between voters and ballots [10]. Blockchain technology may be used to address the issues with digital voting, claims the research paper "Digital Voting with the use of Blockchain Technology" by Andrew Barnes, Christopher Brake, and Thomas Perry [11]. It provides a basic explanation of Blockchain technology, the distinction between e-voting and i-voting, and how a Blockchain network functions. The servers are set up and votes are transferred via DVDs in the existing voting method. In the study, a Blockchain-based solution is suggested for this problem. Both offline and online registration options are available for the user. According to Nir Kshetri [12], each voter is regarded as a wallet, and there can only be one transaction at a time between Wallets. Because the candidates are viewed as the wallet's recipient. Actually, the vote is the exchange of money between all of the candidates' or recipients' wallets. The technology utilised in this study is blockchain-enabled electronic voting, which

makes use of an encrypted key and user IDs that cannot be changed.

According to T. G. Rossler [13], using remote internet voting will improve voter convenience, boost voter trust, and boost voter turnout. The study found that electronic voting is the best advancement since it not only offers more voter convenience but also maintains security. In this method [14] developed by Sagarshah et al. & Kashif et al., block chain-based voting assures block chain implementation utilising distributed ledger technology, enabling the peer-to-peer network to detect the questionable nodes. A decentralised node for electronic or online voting is provided by Blockchain technology. Due to the benefits of end-to-end verification, distributed ledger technologies like Blockchain have recently been employed to create electronic voting systems [15]. Crowcroft [16] suggests practical hashing strategies to assure data safety, such as block construction and sealing. Blockchain algorithm with consensus-based technique is employed. The benefits include their own architecture and a superior hashing technique. In their proposal for e-voting, N. Aditya Sundar, M. V. Kishore, and Ch. Suresh [17] suggest employing RSA for voter registration and MD5 for voting. MD5, however, is less effective than SHA-256. As a result, we suggest using the SHA-256 technique to encrypt the votes in this project. A member of the SHA-1 family is SHA-256 [18]. For the numerous requirements for an e-voting system, Kang et al. suggests a solution utilising a Blockchain [19]. Because the voter's voting result is not stored in the Blockchain during the implementation of this electronic voting system, the actual voter cannot verify that his or her vote was properly reflected in the results. Instead, an encrypted voting result is sent to the calculator by using a uniform password. A brand-new technology dubbed the Blockchain-based electronic voting system has been introduced by Cosmas et al. [20]. To present the new system, they offer a method that combines Blockchain technology with double envelope encryption. The three parts of the developed system are the voter's side, the electoral

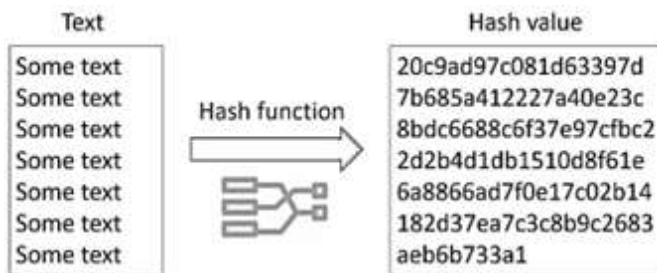
commissions, and the BC network. A unique key is generated by Ha et al. based on voter biometric authentication and utilised for signatures. The encryption key is probably revealed if the voter's biometric data is made public [21]. Transactions are sent to each candidate's address using a different address during the voting process.

Zhang [22] suggests a local voting system based on the blockchain to aid in decision-making for the networks of its peers. It safeguards privacy and makes cheating detection and repair possible. Blockchain algorithm with distributed consensus is the approach employed. Elections may be utilised as a Blockchain component of Smart Contracts, Peer to Peer networks, Consensus, and Two Phase Validation, which is a benefit (decryption pvt key, smart contract verification). A Blockchain as a Service is presented by Fririk et al. [23] to construct a new e-voting system. Smart contracts are used in the proposed service to provide complete authenticity for both the voters and the election itself. In order to prevent compelled voting and increase security, the authors have also built up the BC utilising Go-Ethereum permissioned Proof-of-Authority (POA) as a private network. Estonia was the first nation to allow voters to cast ballots using just an electronic national identity card and the Internet. The voting ID card was created with an integrated circuit, a Java chip platform, and a 2048 bit PIN for security [24].

### III. BLOCKCHAIN

A Blockchain is similar to a data structure that stores and distributes all of the transactions that have been carried out since its inception. It functions primarily as a distributed decentralised database that keeps an exhaustive list of continuously accumulating and expanding data records protected against illegal manipulation, tampering, and alteration. A peer-to-peer payment system that enables monetary transactions across the Internet without depending on trust or the requirement of a financial institution was initially proposed by Satoshi Nakamoto (a pseudonym)

[25]. A system with a high byzantine failure tolerance, such as Blockchain, is safe by nature [27]. In order to develop a money that could be transferred via the Internet and rely only on cryptography to safeguard the transactions, Bitcoin is regarded as the first implementation of the Blockchain idea. Blocks of transactions are organised into a data structure called a Blockchain. Each block in the chain is connected to the one before it. The foundation of the stack is the initial block in the chain. A Blockchain is a stack of newly produced blocks that are added one on top of the other [28]. A hash that is written on the header identifies each block in the stack. The Secure Hash Algorithm (SHA-256) is used to provide a fixed-size, 256-bit hash that is essentially distinctive. The National Security Agency (NSA) created the widely used algorithm in 2001 and utilised it as the protocol to protect all federal communications [29]. Any amount of plaintext may be entered into the SHA-256 algorithm, and it will encrypt it to a 256-bit binary value. The SHA-256 function is a one-way operation that always yields a 256-bit binary result. The fundamental reasoning behind SHA-256 encryption is depicted in figure 1.



**Figure 1.** The Function of the SHA-256 Hash

Each header provides data that connects a block to its preceding block in the chain, forming a chain that is connected to the foundation, the very first block ever generated. Each block's encrypted hash found in its header serves as its principal identification. A digital fingerprint that was formed by merging two different types of data, first the data about the newly created block and then the second preceding block in the chain. A block is submitted to the Blockchain as soon as it is

created. When new blocks are received, the system will monitor them and update the chain accordingly. So, because to its solid cryptographic underpinnings [30], Blockchain has been utilised more and more to prevent fraudulent transactions across [31] many domains. The numerous issues that were raised in these early attempts at online voting may all be resolved by Blockchain. The security of an Internet connection is unimportant to a Blockchain-based voting application since any hacker who gains access to the terminal will be unable to influence other nodes. Voters can cast their ballots successfully without disclosing their identities or political affiliations to the general public. Because each ID can be linked to one vote, no fakes can be made, and tampering is impossible, officials may tally ballots with complete confidence.

#### IV. CURRENT ISSUE

Voting, especially during elections, is a technique where participants do not trust one another since the system might be attacked not just by an outsider but also by participants themselves (voters and organizers). Voter and election data are extremely important for [32] a democratic country. Secure digital identity management is one of the most pressing technological issues now facing e-voting systems, but it is not the only one. Before the elections, every prospective citizen should register with the voting process. Their information must be in a format that can be processed digitally. In addition, any information that involves them should keep their identification information private.

#### V. PURPOSE

Our purpose is to use Blockchain technology to address the problems associated with electronic voting. E-voting with Blockchain support might enhance voter access and decrease voter fraud [33]. The voting process need to be impenetrable. No group with a desire for power should be allowed to influence and rig

elections. When the most crucial conditions are met using a Blockchain, [4] only registered voters will be permitted to cast ballots. The mechanism forbids any communication between the voters' identities and the votes they cast. Once cast, votes are irrevocably recorded and cannot, under any scenario, be altered or edited. Voting procedures should be transparent. The auditor should be able to see the voting process in the event that there is an audit of the election. Voters shouldn't attempt to rig the system by casting multiple ballots or by changing their votes.

## VI. NECESSITY

In this part, we give a concise explanation of the need and how the suggested system satisfies it. To protect a voter's privacy, the system makes use of Blockchain cryptographic features. More specifically, as soon as a voter registers with the system, Blockchain generates a voter hash, which serves as the voter's unique identification inside the Blockchain [34] and is safeguarded against misuse thanks to the collision resistance quality of the cryptographic hash. Because of this, a vote's traceability is likewise non-trivial, safeguarding the voter from coercion. All eligible users must register using distinctive identifiers, such as official papers, to demonstrate their status. Additionally, our system uses finger printing technology to provide a robust authentication mechanism that guarantees that only approved voters [35] may access the system. Additionally, the system can prevent multiple voting thanks to the usage of biometrics. The suggested method allows voters to cast their ballots in the manner they like and generates a cryptographic hash for each such occurrence (transaction). This is necessary to establish verifiability, or to determine whether a particular vote was counted. Nevertheless, having this hash does not allow for the extraction of voting-related data. The system's voting procedure requires little user input because to the system's user-friendly web-based interface. For example, fingerprinting is used as an authentication

method to eliminate the need to memorise usernames and passwords. Additionally, the workflow as a whole is integrated, allowing for smooth user interaction. A user is given their specific transaction ID in the form of a cryptographic hash after properly casting their vote. This transaction ID can be used by a user to determine whether their vote was counted. However, this procedure, which was established to lessen threats while acting under pressure, does not allow a user to observe how they voted. As a result, we think the research provided here significantly adds to what is already known about using Blockchain technology to create a safe digital voting system.

## VII. PREREQUISITE

A voting application has been supported by the system in the real-world setting while taking into consideration certain needs like privacy, eligibility, convenience, receipt-freeness, and verifiability. With the suggested approach, safe digital voting is achieved without sacrificing usability.

### 7.1. Hashing

The usage of hash functions ensures the security of the Blockchain. With the use of hashing, one may apply a hash function to the data that computes a comparatively unique result for data of practically any size. As long as the data hasn't changed, hashing can enable users to independently receive input data, hash it, and generate the same outputs. Cryptographic hash functions come in a variety of forms, including SHA-0, SHA-1, SHA-2, SHA-3, BLAKE-2, etc. According to a research, SHA-1 is the quickest, taking 708.3 ms for short sequences and 909.3 ms for lengthy sequences, outpacing MD-5, SHA-256, and SHA-512 [36]. Since the SHA-1 lightweight hash function is vulnerable to attacks, SHA-256 can take its place in the information exchange process. Because of SHA-256's strong anti-collision properties, voting systems are immutable and less vulnerable to assaults. The National Security Agency developed SHA-2 (Secure Hash Algorithm 2)

in 2001 as a replacement for SHA-1. The SHA-256 algorithm is one variant of SHA-2. A 256-bit value is produced using the patented cryptographic hash algorithm SHA-256. Data is changed into a safe format during encryption so that it cannot be read unless the receiver possesses a key. The data may be as big as you like when it's encrypted, and it's frequently the same size as unencrypted data. In contrast, data of any size may be translated to data of a certain size via hashing [38]. For instance, SHA-256 hashing would reduce a 512-bit string of data to a 256-bit string. One of the most secure hashing algorithms available is SHA-256. The US government mandates that its agencies use SHA-256 to secure specific sensitive data. Even though the precise mechanics of SHA-256 remain classified, we do know that it is constructed using a Merkle-Damgard structure that was itself generated using the Davies-Meyer structure from a specialised block cypher.

### 7.2. Eclipse

Java is used to develop the Eclipse IDE. It primarily comprises of a base "Workspace" and a plug-in system so that we may expand the capability of the IDE by adding new features to it through plugins. Eclipse is compatible with all of the main operating systems, including Windows, Mac OS, Linux, etc. It offers strong capabilities that may be utilised to create whole projects. Almost all of Eclipse's features are plugins. By adding plugins to the IDE, we may increase the capabilities of Eclipse and use it for new programming languages, version control systems, or UML. supports a variety of source knowledge features, including code editing with syntax highlighting, grading, a macro definition browser, and folding and hyperlink navigation. good visual code debugging tools are available. Eclipse features a fantastic user interface with drag-and-drop UI design capabilities. supports source navigation, the traditional make framework, and the administration of many tool chains for project development.

### 7.3. MYSQL

It's important to comprehend the database before you can understand MySQL. Software that stores an organized collection of records is known as a database. The user will have no trouble using it or managing it. Because data is arranged into tables, rows, columns, and indexes, we can quickly retrieve crucial information [39]. MySQL has a strong data security layer that shields private information from outsiders. Additionally, MySQL encrypts passwords. Because MySQL enables multi-threading, scaling is simple. It can manage practically any volume of data, up to 50 million rows or more. A 4 GB maximum file size is the standard. The maximum amount of data we could theoretically store would be 8 TB. According to several benchmark tests, MySQL is one of the most fast database languages.

### 7.4. Apache Tomcat

Tomcat's full name is "Apache Tomcat." It was created in a collaborative, open environment and made its debut in 1998. The Java Servlet API and the first Java-Server Pages used it as their reference implementation at first. Even though it is no longer the recommended implementation for either of these technologies, people still see it as their top option. Sun Microsystems developed Tomcat before giving the code base to the Apache Software Foundation. Nowadays, a lot of businesses utilise Apache Tomcat since it implements a lot of the Java EE specs. It may be downloaded, installed, and used without charge by anybody, anywhere, making it the top option among new users and developers. Due to its wide customization possibilities, lightweight design, and great flexibility, a user may operate it in any way they like and it will function flawlessly.

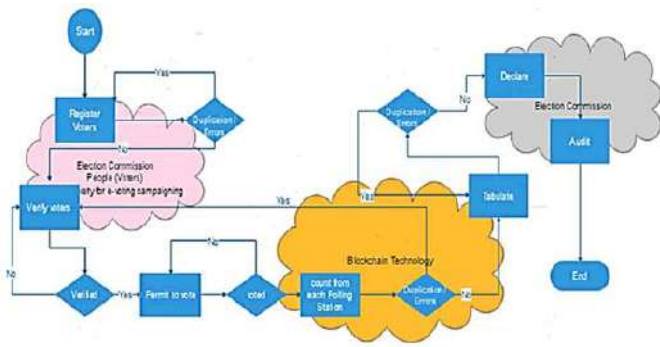


Figure 2 The Student Data Flow Diagram

VIII. PROPOSED SYSTEM

Three parts make up the project: users, the electoral commission, and Blockchain technology. Members of the election commission will register candidates for office, users or voters, and monitor the outcome. Voters would be permitted to change their password and log in to cast their votes once they had been confirmed by EC members. The voter can view the candidates in his or her state and district before casting a ballot. The Blockchain [40] seen in figure 2 will encrypt and store these votes. SHA-256 is the algorithm used to encrypt the votes. Voters cannot amend their vote or log out after casting their ballot. The flow of all transactions is logged in the database, so if any network user tries to tamper with it, it would be quite obvious. Any modifications to earlier transactions result in a new hash code, which alerts the auditor to any attempts to tamper with the database [41].

For access to the application depicted in figure 3, this module must first verify voters and Election Commission members [42]. The Election Commission members can use this module to register candidates and voters and view the results displayed in Figure 4.

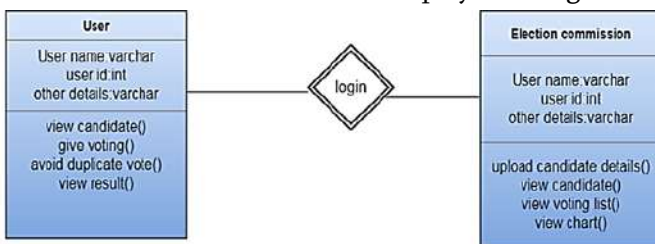


Figure 3 The Network module

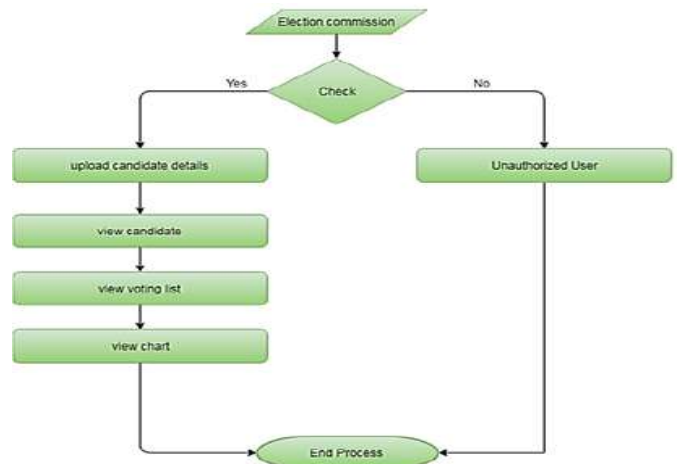


Figure 4 The Flow Diagram for Election Commission Member

An authenticated voter may login, view the candidates for whom he may cast a ballot, and do so just once. This module assists in tallying the votes cast for a candidate and displays them as the different graphs in figure 5.

```

1 // SHA-256
2 import java.io.*;
3 import java.math.BigInteger;
4 import java.security.MessageDigest;
5 import java.util.*;
6
7 public class SHA256 {
8     public static void main(String[] args) {
9         try {
10             String str = "Hello World";
11             MessageDigest md = MessageDigest.getInstance("SHA-256");
12             byte[] hash = md.digest(str.getBytes("UTF-8"));
13             // Convert byte array into a hexadecimal string
14             BigInteger number = new BigInteger(1, hash);
15
16             // Convert message digest into hex value
17             StringBuffer hexString = new StringBuffer(number.toString(16));
18
19             // Pad with leading zeros
20             while (hexString.length() < 32) {
21                 hexString.insert(0, "0");
22             }
23             System.out.println("hashcode : " + hexString);
24             String sha256 = hexString.toString();
25             Connection con=Connection.getConnection();
26
27             String sql="select *from election order by id desc limit 1";
28             PreparedStatement pstmt=con.prepareStatement(sql);
29             ResultSet rs=pstmt.executeQuery();
30             if(rs.next()) {
31                 ResultSetMetaData rsmd=rs.getMetaData();
32                 System.out.println("hashcode : " + sha256);
33             }
34         } catch (Exception e) {
35             e.printStackTrace();
36         }
37     }
38 }

```

Figure 5 The SHA-256 Code

IX. FINDINGS AND EVALUATION

Members of the election commission can register the candidates running in the election depicted in figure 6 after logging in. The electoral commission members have the ability to verify and register voters. It is possible to obtain a list of every candidate running for office. After the vote is cast, the election commission can use a variety of graphs to view the results and declare a winner. If the voter tries to vote again or changes his vote, he will not be allowed to logon again. In the scenario depicted in figure 7, a pop-up would appear.



## X. CHALLENGES

Blockchain technology can be used to address several concerns with electronic voting, making it more convenient and cost-effective. The electronic voting systems based on Blockchain face major technological difficulties. Blockchain functions well for a limited set of users. However, as the network is used for widespread elections, the user base grows, increasing the cost and time required to process the transaction. Pseudonyms are used by Blockchain as usernames. This tactic does not guarantee total secrecy and privacy. The user's identity may be ascertained by looking through and analysing the transactions because they are open to the public [43]. While accuracy and security are two areas where Blockchain shines, people's confidence and trust are crucial for effective Blockchain electronic voting. The complexity of Blockchain may make it challenging for people to embrace Blockchain-based electronic voting, and it may eventually prove to be a substantial barrier to adoption for the general populace.

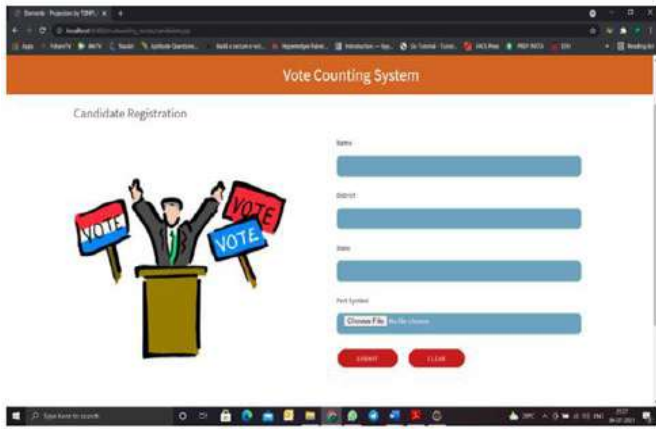


Figure 6 The Candidate Registration



Figure 7 The Voter Cannot Login Again

Once the elections are over, that is, when all of the voters have cast their ballots as illustrated in figure 8, the encrypted votes saved in the Blockchain network will be utilised to reveal the results. Various graphs would be used to present the results. With the use of these graphs in figure 9, the election commission members may announce the results.

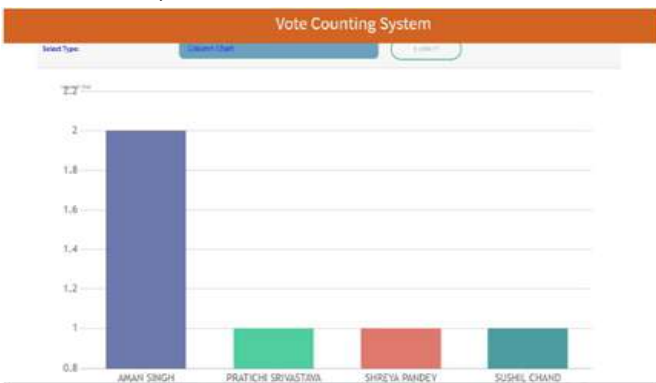


Figure 8 The Graphs for Results

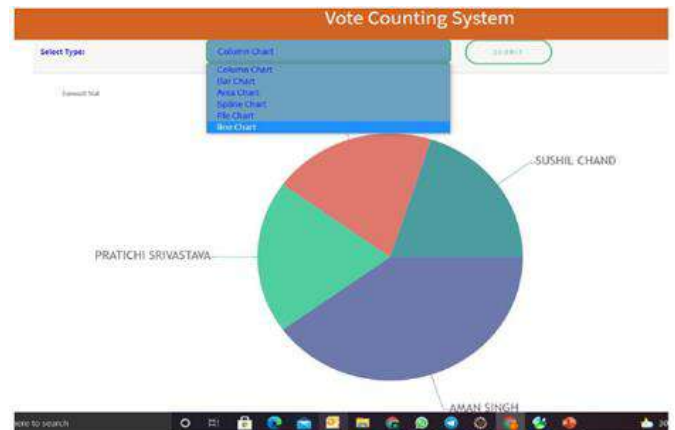


Figure 9 The Different kinds of graphs available

## XI. CONCLUSION

Any democracy must have an open voting process that satisfies the demands of the populace in order to give the appropriate individual the authority. Additionally, there are several problems with the current traditional voting systems, including a lack of security and transparency. A Blockchain-based electronic voting

### XIII. REFERENCES

system that we have created involves the encryption and verification of vote results. The Blockchain links each vote cryptographically, block by block. The suggested approach is effective in ensuring security for the votes that have the power to alter a person's whole life. The suggested approach protects the voter's anonymity by using block chains and hashing techniques. The foundation of Blockchain technology is comprised of hashing algorithms since hash functions are essential to its security and dependability. If the input data hasn't changed, hashing can enable users to independently receive input data, hash it, and generate the same outputs. The output size, file size, execution time, and algorithmic speed may all be used to study hashing algorithms. With the aid of the analysis, one may choose the kind of hashing method to use. Vote counting is completed significantly faster and with far more security than with traditional technologies. The suggested solution would make the voting process visible, verifiable, untraceable, unusable, and impossible to interfere with. E-voting would encourage more people to participate in elections throughout the world. The system would become trustworthy and fraud-resistant through the usage of Blockchain and hashing technology.

### XII. THE FUTURE OF WORK

The traceability component may be taken out of this application to make it better. The project's performance and efficiency can be improved by transferring it to hyper ledger fabric. The project can be executed on a big scale, such as the national voting system. Blockchain defences against quantum computer assaults are thus a potential field of study in the future.

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# Knowledge, Attitude and Perception Towards Covid19 Among the Indian Population During the End of The Second Wave

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## ABSTRACT

Coronavirus is a single stranded RNA virus caused by the SARS-CoV-2 virus. The first case was reported on December 1, 2019 then it was distinguished as coronavirus by Chinese authorities. Covid-19 is different from both MERS-CoV and SARS-CoV and is considered as the seventh member of the coronavirus family that affects people. These spread through droplets or by a virus that may travel in the air from the suspect to the nearby person. Based on the current status it is obvious that the elderly population is most affected. It primarily affects the upper respiratory tract followed by severe pneumonia. This study aims to assess and compare the Knowledge, Attitude and Perception of the general population in South India through a cross-section survey. Questionnaires were sent to 800 people out of which 500 responded. The data were collected using google form and the results were interpreted. Among the responses, it was clear that the population has acquired adequate knowledge about the pandemics and they tend to act wisely to overcome them.

**Keywords:** Covid-19, Knowledge, Attitude, Perception

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## I. INTRODUCTION

The first pneumonia case with unknown causes was identified on December 31, 2019, then the cause was found to be due to a novel virus [1]. This new kind of virus (SARS-CoV-2) was distinguished on 7<sup>th</sup> January 2020 by Chinese authorities. The first case was actually reported in Wuhan, China on 12<sup>th</sup> December 2019 and later spread vigorously across the world threatening public health and safety [2]. This led the World Health Organisation (WHO) to declare coronavirus disease (Covid-19) as a public health emergency on March 13, 2020. Seven human coronaviruses have been isolated

till now of which OC43, NL63, HKU1 and 229E cause mild symptoms but SARS, MERS and SARS-CoV-2 are responsible for severe respiratory syndromes. The primary host for the SARS-CoV-2 is the rodents from where it is imparted to other hosts through genetic recombination, deletion, insertion, and missense mutations [3]. Within a short period, coronavirus had undergone numerous recombinations (SNP variants) and produced new strains of altering virulence. Exactly 149 mutations were found in 103 sequenced SARS-CoV-2 genomes [4]. Affected persons showed a wide range of symptoms like fever, chills, cough, sore

throat, loss of taste or smell followed by severe pneumonia [5].

Since the first case of Covid-19 has been reported, the world has recorded 260 million cases and 5.2 million deaths within 23 months. Covid-19 seems to be fatal in 2% of cases and serious illnesses like dyspnoea, sepsis, septic shock, and organ failure were noticed in 20% of cases but 80% of cases had mild symptoms. In India, the first case was reported on the 27<sup>th</sup> of January, 2020. It was during the month of march Covid19 spread abruptly in India and the nationwide lockdown was imposed on March 24, 2020. The first wave in India started in March 2020, achieved a peak in September 2020 with more than 90,000 confirmed cases/day, and there was a steady decline in late February 2021. Eventually, Covid-19 restrictions were diminished markedly. Lineage analysis in India showed the emergence of new SARS-CoV-2 variants, B.1.617.1 and B.1.617.2, during April 2021, which might be the key reason for the sudden upsurge of 400000 confirmed cases/day [6]. As per a study by the Indian SARS-CoV-2 Consortium on Genomics (INSACOG) the variant B.1.617 was a dominant strain which may have fuelled India's second wave. The study of the mechanism of pathogenicity and virulence is not yet completed. A serious effort is currently being devoted to studying the virus in depth. Meantime Various types of vaccines were developed across the globe. But no specific drug or vaccine that targets the new strains of coronavirus has been developed and this situation possesses a consternation among the people with weak immune systems [7].

The Covid-19 crisis is assumed to be a long-term process, therefore the only way to succeed in this battle is to know the right information and act in a coordinated way. This study aims to determine the Knowledge, Attitude, Perception and general lifestyle of the public during July and August 2021.

## II. METHODS AND MATERIAL

### 2.1. Objective

This study was planned to assess and compare the Knowledge, Attitude and Perception of the general population in India with previous studies taken during this pandemic and to analyse the thoughts of the participants in order to overcome the pandemic in a better way.

### 2.2. Methodology

It was a cross-sectional study, based on a questionnaire-survey administered online via social media platforms. The questionnaire was framed in order to understand the following. 1. The basic knowledge about the disease through assessment questions based on the place of origin, symptoms, treatment methods and so on. 2. The attitude of the population towards the pandemic was based on how they would react if they are infected, and the remedial measures which they would take. 3. The questions on perception were based on whether an individual agrees with a common public perception or not. 4. General questions were included to bring a note of infected people, vaccination rate and so on.

### 2.3. Study design

A questionnaire, containing 19 questions was designed. It was then prepared as Google form and shared with the public through social media and individual email. Individuals who are Indian nationals and are above 18 years of age were included in this study.

## III. RESULTS AND DISCUSSION

### RESULTS

The questionnaire was sent to 800 individuals in India. Among them, 62.5% individuals came forward and assessed the questionnaire. The male participants were 224 (44.8%), and the female participants were 274(54.8)

### 3.1 Socio-demographic characteristics of the study participants

It was observed that the majority of the participants were from the age group 18-30 pursuing or completed undergraduate courses. People from age groups 31-40 (3.4%), 41-50 (2.2%) also responded. Interestingly people from the age group above 50 (2.4%) also responded to our queries.

### 3.2 Knowledge on Covid19

From the survey, it was evident that the majority of the respondents were quite aware of the origin (89%) and the symptoms (96.4%). But people had a mixed responses pertaining to the question on treatment methods (66.8%), post-covid symptoms (59.2%) or ending of the pandemic (69.8%). These clearly indicates that there is lack of scientific knowledge on Covid19.

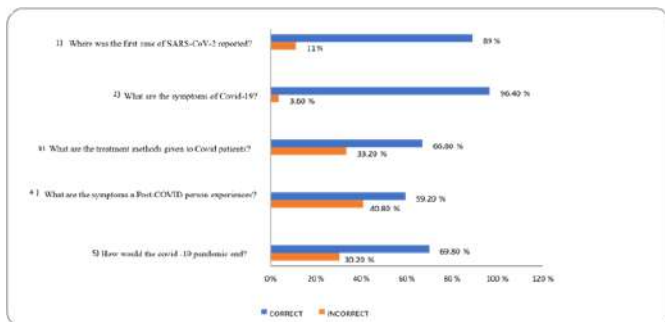


Figure 1: Knowledge among the participants related to Covid-19.

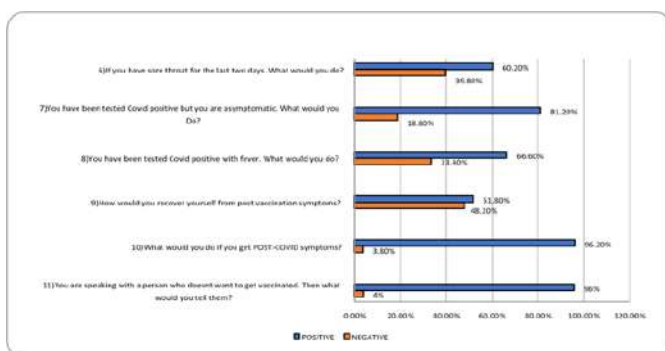


Figure 2: Attitude among the participants related to Covid-19.

### 3.3 Attitude of the participants

The survey apparently shows that the participants have good attitude towards covid 19. Nearly 75% of

the participants gave positive attitude towards Covid-19. Expect the one question about the post vaccination recovery which had almost equal positive and negative responses. It is also eminent that 96% of respondents showed positive attitude to post-Covid symptoms and vaccination myths.

### 3.4 Perception on Covid19

This bar graph illustrates that respondents had a clear perception towards covid 19. Most of the people (92%) strongly agree that they get Covid-19 updates only through media and also 83.8% said yes for their hygienic practices. On the other hand, nearly 95% of people responded that they were under mental stress during pandemic. It is obvious that people struggle for immediate adaption to a situation.

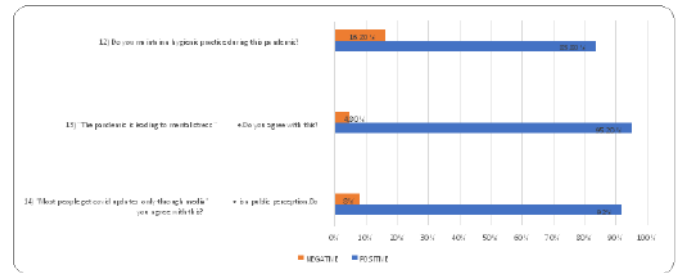


Figure 3: Public perception towards Covid-19

### 3.5 Common questions

Table 1 shows a set of general question which were commonly asked during the pandemic. It shows that majority (81.2%) of the participants have not been infected and 77.2% have been vaccinated. Majority of the population 63.6% prefer Covishield over other vaccines and 67.4% have been vaccinated with Covishield. Higher number of participants (20.2%) have reported arm-pain to be the major side-effect of vaccination.

Table 1: Other key questions towards covid 19

Questions	Response	Percentage
Have you been infected by Covid19 previously?	No	81.2%
	Yes	10%
	May be	5.2%
	Not sure	3.6%

Did you get your Covid vaccine?	Yes	77.2%
	No	22.8%
Which vaccine do you prefer?	Covishield	63.6%
	Covaxin	13.4%
	Sputnik5	8.2%
	anything	6.4%
	Covishield, Covaxin	3.6%
	Covishield, Covaxin, sputnik5	2.4%
	Covishield, Pfizer	0.2%
	Covishield, Sputnik5 Irrelevant	2%
What was the first dose you received?	Covishield	67.4%
	Covaxin	11.4%
	Sputnik V	1.2%
	Not yet vaccinated	18.4%
	Others	1.6%
Did you face any side effects with your vaccine?	Arm pain	20.2%
	Body weakness	5.2%
	Malaise	1.4%
	Fever	18%
	All of these	19.4%
	No side effects	9.4%
	Blanks	26.4%

## Discussion

The population has an acquired knowledge about the endemics and they tend to act wisely to overcome them, but pandemics are infrequent happenings. The number of recorded cases has grown exponentially, in each wave in India. Therefore, the Assessment of Knowledge, Attitude, Perception and general lifestyle of the population towards the Covid -19 pandemic has primo importance.

It is heartening to know that knowledge related to SARS-CoV-2 is high among respondents. This study shows that almost all the participants had a correct idea about the place of origin and symptoms of Covid-

19. The government has implemented audio clip of caller tune to bring awareness to the public which proves to be a successful effort from this data. A little more than half number of participants had knowledge related to treatment methods given to Covid-19. A better knowledge of the same would help the people understand and follow the government directives properly.

Better knowledge may result in positive perceptions and attitudes and therefore in good practices, and effective management of infectious diseases. The knowledge and attitude of the participants regarding the post-Covid symptoms were good. Though an astonishing majority of patients with post-Covid symptoms show good healing but the duration, and long-term outcome of post-Covid syndrome are largely unknown [8]. So, there occurs a need to guide the population about the clinical, diagnostic, and therapeutic management of post-Covid symptoms. Little less than three quarter number of participants had correct idea of how the pandemic may end which also provides proof that the participants were eager to get vaccinated.

More than half of the participants showed eagerness towards RT-PCR test and getting admitted in case if they experience any symptoms. This is a positive attitude which may help the government with maximum amount of testing's for covid. Majority of the participants showed a positive behaviour if they are tested positive but asymptomatic which is in accordance with the SOP (Standard operating procedures) guidelines of WHO and CDC.

Compared with other studies [9] where the participants showed mistrust in the effectiveness of the vaccine and preferred natural immunity over vaccine our survey reported the majority of participants who believed that vaccinating would prevent death. A systematic review of Covid-19 vaccine acceptance rates in different parts of the world revealed high acceptance in Malaysia, Indonesia and China and very



poor acceptance rates in Italy, Russia, United States and France [10].

Compared to other studies [11], our survey uncovered markedly reduced number of participants who agreed social media to be a major source of covid updates. The alternatives to this may be world meter, radios, television, aarogya setu app, Internet (websites, blogs, etc) Friends, relatives, and/or neighbours, Local government officials, Announcements at work and so on. But infodemic (harmful information) circulated in media remains to be a great challenge during this pandemic [12], because the majority of participants believed rumours as the major reason behind not getting vaccinated. A greater number of participants has reported that the pandemic is stressful which may be due to excessive time spent online. The pandemic has caused a lot of mental health problems which leads to physical inactivity, insomnia, anxiety, and depression [13]. This fact needs to be taken seriously as mental health improvement is very necessary to cope with life.

The Janata curfew ensured that the seriousness of the disease was impressed and reflected in people taking good preventive measures to protect themselves as well as break the chain of transmission. The Standard Operational Protocol (SOP) of WHO as a precautionary measure to avoid Covid-19 was found to be followed, as majority of participants agreed that they maintain a hygienic practice during this pandemic. A majority of the participants preferred a flexitarian diet. Compared with other studies [14], only a smaller number of participants in our survey believed that vegetables would give protection against Covid-19.

Vaccine inequity is giving the Covid-19 variants a free pass to run wild. Our survey shows three quarter of the participants have been vaccinated. A very few participants were ready to take any covid vaccine. Compared with other studies [15] our survey reported a high number of participants experiencing arm pain as the major side effect of post-vaccination before fever.

Balanced number of participants showed a practical approach for recovery from post vaccination symptoms.

A rapid diagnosis of SARS-CoV-2 variants, strict cohesion to preventive measures, precise diagnosis and treatment, appropriate and rapid launch of vaccination throughout the whole population without any inequity and reporting the correct number of infection rate and death rates would help to restrict viral transmission in the Indian community and help people understand the severity of the disease.

#### IV. CONCLUSION

The coronavirus is a deadly series. The news was filled with infection, sickness, disappointment, unemployment and death. In the beginning, exposure to those types of news made even the optimistic feel frustrated. Therefore, in order to neutralise or override these negative stimuli, there is a need to focus on positive stimuli to protect our physical and mental health and hope for things to get even more better.

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## Hydroxyapatite integrated with Carboxymethyl cellulose and Agar-Agar/I-Carragenan biopolymer composites for antimicrobial investigations

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### ABSTRACT

Biopolymer based composites have been extensively used as a promising materials for various biomedical applications such as scaffold preparation, drug delivery, etc. Hence, researchers have focused their attention on the development of novel biomaterials to cater the demand in the field of medicine. In this investigation, we report the preparation and characterisation of Carboxymethyl cellulose (CMC)/Agar-Agar/n-HAp and Carboxymethyl cellulose (CMC)/I-carragenan/n-HAp polymeric composites. The common biopolymer CMC used in this study was isolated from the plant source hemp as cellulose and then it was functionalized to carboxymethyl cellulose (CMC). The SEM images showed that the addition of nano hydroxyapatite induces considerable morphological changes in the surface and cross section of the composites. Thermal analysis was used to ascertain the thermal stability of the prepared materials. Further the antibacterial, antifungal, wound healing and anticancer efficiency of the composite films were evaluated and compared. The prepared bionanocomposites have potential therapeutic value for various biomedical applications.

**Keywords** : Biopolymer, Carboxymethyl Cellulose, n-hydroxyapatite, Bionanocomposite, antimicrobial.

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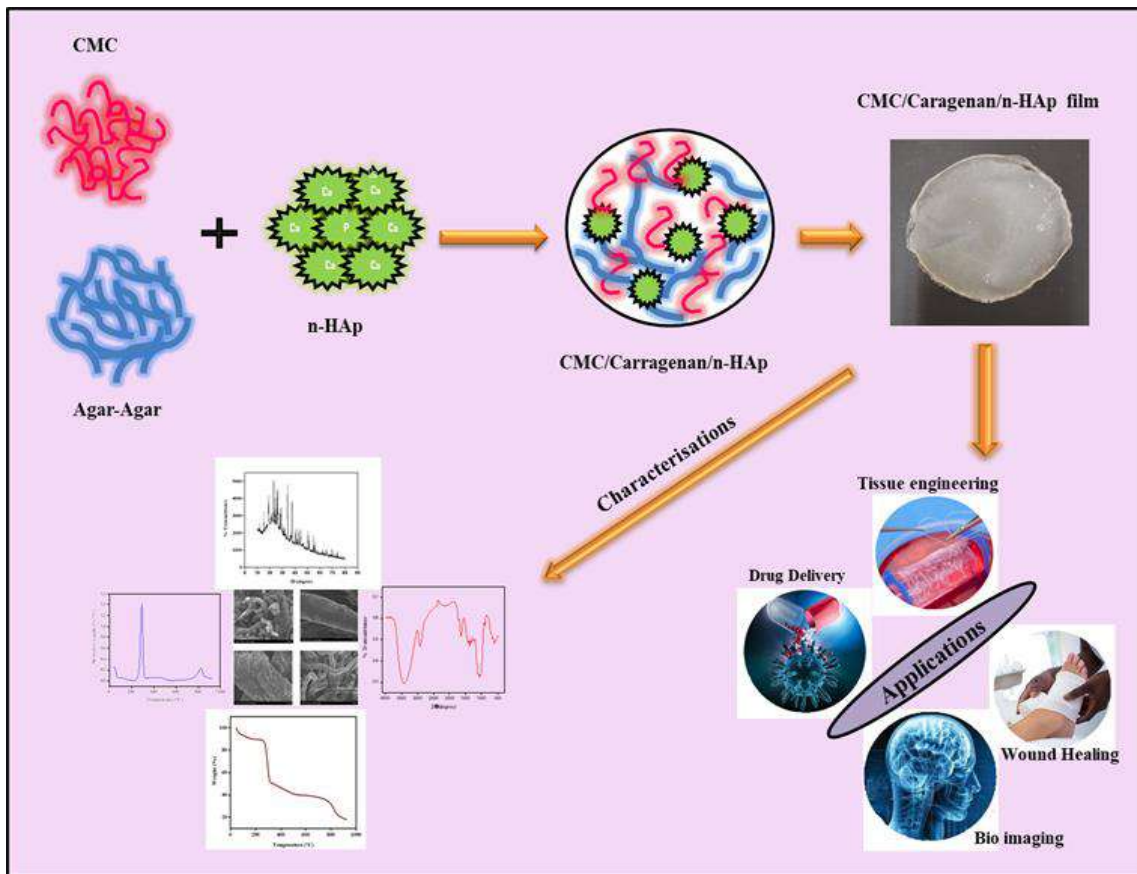
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## I. INTRODUCTION

The materials derived from renewable resources are increasing attention, both from the standpoint of developing innovative functional and structural macroscopic materials and from a basic scientific one [1,9,12,17]. Cellulose is a multifunctional bio-based renewable material with a variety of profitable features, including non-toxicity and biodegradability. The combination of significant value and low energy consumption makes cellulose extraction from agricultural waste is one of the best waste treatment substitutes. There are several ways for isolating and purifying cellulose, and combination of different treatments influences the shape of the fibres [2,15,22,27]. The surface area and aspect ratio of cellulose-based nanomaterials such as nano cellulose fibres, crystalline nanocellulose, cellulose composites, and so on are quite

high. Wood, cotton, flax, hemp, jute, ramie, straws, sugarcane bagasse, and fruit remnants are key sources of cellulose [5,47,55]. A cellulose derived Carboxymethyl Cellulose (CMC) is a potential example of such materials that has received a lot of attention in the past two decades. CMC has been proposed for usage in a wide range of industries, including structural plastics, smart coatings, cosmetics, medicines, and solar energy gathering [7,56-59]. Strong acid hydrolysis is typically used to create these CMC particles. Extensive research has been conducted on HAp/CMC composite gels [33-37]. The use of CMC as the fibre-reinforced phase in HAp/CMC composite gels, on the other hand, has not been documented [47-53].

CMC can be employed as a thickening, binder, stabiliser, suspending agent, or flow control agent [3,26,39,43]. It is also used in the ceramic and pharmaceutical industries to cover medicinal tablets.

Because of its biocompatibility and biological characteristics, Agar-Agar (AA) and Carragenan (CA) composites are an effective artificial articular cartilage repair material. These composite films gained increasing interest in use as an articular mending material due to its high porosity structure and high concentration of free water, which is comparable to that of natural articular cartilage. With this view point, the main objective of this investigation is to isolate cellulose from hemp and its corresponding conversion into CMC. In this paper, we report the preparation, characterisation and antimicrobial studies of CMC based composites such as CMC/Agar-Agar/n-HAp and CMC/I-Carragenan/n-HAp [6,25,29,31].

## II. MATERIALS AND METHODS

Raw hemp fibres scientifically named as *Cannabis sativa* was collected from local market. The obtained samples were separated from the kernels and then dried, crushed and sieved. Surface modification and bleaching were done with reagent-grade chemicals namely Sodium hydroxide, Sodium chlorite, n-Hexane, Ammonia, Sodium metabisulphite, Calcium nitrate tetrahydrate (CNT), Phosphoric acid (PA), Agar-Agar (AA), Carragenan (CA), Dimethylsulphoxide and Monochloroacetic acid (MCA).

### 2.1. Isolation of cellulose from hemp

Raw hemp fibers collected from local market were cleaned, dried, crushed and sieved. The desired amount of hemp fibers are soaked in 5% NaOH solution and stirred in a magnetic stirrer for 2hr [1-3]. The alkali in the fiber was removed by repeated washing with distilled water. Following the alkali treatment, the samples were bleached using acetate buffer (27 g Sodium Hydroxide and 75 mL glacial acetic acid diluted to 1 L distilled water) and aqueous Sodium Chlorite. Here the lignin content and the other non cellulosic components were removed. The slurry obtained was neutralized with acetic acid and washed with distilled water in order to maintain the neutral

pH. The resultant product was dried in an air oven for 3 hours [5-7].

### 2.2. Preparation of Carboxymethyl cellulose (CMC)

The obtained hemp cellulose was first treated with NaOH in order to mercerize it as shown in Figure 1. Then the fibers are treated with 150 mL of ethanol solution, which is used as a solvent with magnetic stirring [4,6,8]. Then, the etherification was commenced by adding 120% of monochloroacetic acid (MCA) drop by drop with constant stirring for 30 min to maintain cellulose to liquor ratio of 1:1.2. This process was continued for another 3.5 hours at 55°C [10,11]. The resultant product obtained was suspended in 200 mL of Methanol, neutralised with glacial acetic acid and then in absolute ethanol to remove the unreacted by products. The resultant sample was dried in air oven at 60°C and used for further composite preparation and characterisation [12-16].

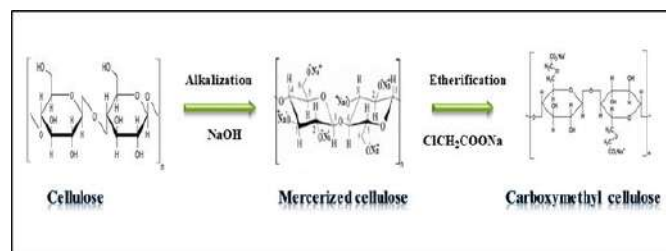


Fig 1. Synthesis of CMC from cellulose derived from hemp

### 2.3. Preparation of nano Hydroxyapatite (n-HAp)

Calcium nitrate tetrahydrate ( $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ ) (CNT), Phosphoric acid ( $\text{H}_3\text{PO}_4$ ) and Ammonia are used as starting materials for the preparation of nano Hydroxyapatite. n-HAp samples are prepared by solution precipitation method [35,36]. 1 M of Calcium nitrate tetrahydrate  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$  was prepared and ammonia solution is added to the CNT solution in order to maintain the pH by 10. To this solution 0.25 M of Phosphoric acid was added and stirred vigorously for about 1 hr (Figure 2) gelation started. The solution is kept for aging for 24 hrs. The precipitate formed is dried in oven. The dried n-HAp powder was washed with distilled water and calcined at 500°C for 1 hr [45,46].

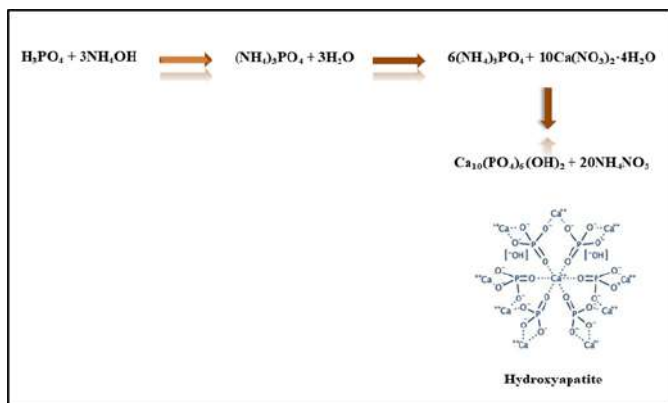


Fig 2. Synthesis of nano Hydroxyapatite

#### 2.4. Preparation of Polymer composites

The polymeric composite CMC/AA/ n-HAp is prepared by solution casting method. The ratio of CMC:AA:n-HAp taken is 5:4:1 for the preparation. Initially, CMC from hemp and n-HAp were dissolved in hot water separately and mixed [49,50-52]. Then the mixture is stirred for about few hours. To this desired amount of Agar-Agar dissolved in double distilled were taken and added to the previous mixture. The mixture is stirred vigorously for 2 hrs and cast on a teflon petri dish and dried in an oven [53,54]. Similarly CMC/CA/n-HAp nanocomposite was also prepared [4,8,57]. The images of the composite films are presented in Figure 3.

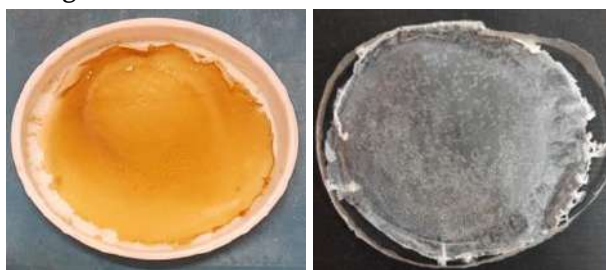


Fig 3. (a) CMC/AA/n-HAp composite film (b) CMC/CA/n-HAp composite film

### III. CHARACTERISATION METHODS

#### 3.1 IR spectral Studies

The interaction between CMC, n-HAp, Agar-Agar/Carragenan composite films was investigated using FTIR spectroscopy [1-3]. The samples were ground, mixed with KBr and pellet formed is used for the

analysis. FTIR spectrophotometer was used to record the spectra in the 4000–400  $\text{cm}^{-1}$  range.

#### 3.2 Thermal studies

The thermogravimetric measurements were made using TGA Q500 V20.10 Build 36 thermal analyzer [4,5]. All dried samples (45 °C, 24 h) were evaluated at 30 °C/min in a nitrogen environment and at a flow rate of 30 mL/min from ambient temperature upto 930 °C.

#### 3.3 XRD analysis

The XRD diffractograms of Cellulose (HC), CMC, n-HAp, CMC/AA/nHAp and CMC/CA/nHAp composites were recorded and analysed by Bruker D8 Advance Powder X-Ray Diffractometer [1,3,7]. The Average crystallite size of the samples was calculated using Scherrer's equation and percentage crystallinity was also calculated.

#### 3.4 SEM analysis

The morphology of the samples was studied using Scanning Electron Microscope Quanta 400E, Inspect E, Apre0 2S instrument. The Elemental composition of materials (EDAX) was also studied by FEI QuantaTM 3D FEG equipment in order to identify the presence of elements present in the sample [2,8].

#### 3.5 Antimicrobial studies

##### 3.5.1 Antibacterial Activity

Stock cultures were maintained at 4°C on nutrient agar slant. Active cultures for experiments were prepared by transferring a loop full of culture from the stock cultures into the test tubes containing nutrient broth, that were incubated for 24hrs at 37°C. The assay was performed by agar disc diffusion method [22,25]. The antibacterial activity of the composites CMC/AA/nHAp and CMC/CA/nHAp was evaluated.

##### 3.5.2 Antifungal Activity

The antifungal activity was performed for CMC/AA/nHAp and CMC/CA/nHAp composites. The stock cultures were maintained at 4°C on Sabouraud

Dextrose agar Slant. Active cultures for experiments were prepared by transferring the stock cultures into the test tubes containing Sabouraud Dextrose broth that were incubated at 48 hrs at room temperature [31-33]. The assay was performed by agar disc diffusion method.

### 3.5.3 Wound Healing Activity

The VERO cell line was used for Wound healing activity for composites CMC/AA/nHAp and CMC/CA/nHAp composites [11,55]. Serum free medium is used for this study.

### 3.5.4 Anticancer Activity

The anticancer activity was studied using MCF 7 cell line which is obtained from National Centre for Cell Sciences, Pune (NCCS). The cells were maintained in DMEM supplemented with 10% FBS, penicillin (100 U/ml), and streptomycin (100 µg/ml) in a humidified atmosphere of 50 µg/ml CO<sub>2</sub> at 37 °C and studied for CMC/AA/nHAp and CMC/CA/nHAp composites [41,43].

## IV. RESULTS AND DISCUSSION

### 4.1 FT-IR Studies

Comparing the FTIR spectras of cellulose, CMC, n-HAp, CMC/AA/nHAp and CMC/CA/nHAp composite films are shown in Figure 4. The large band observed between 3,600 and 3,200 cm<sup>-1</sup> for the composite is due to the stretching of O-H from intramolecular and intermolecular hydrogen bonds in cellulose, CMC, n-HAp, CMC/AA/nHAp and CMC/CA/nHAp [2,7,18,22,36]. For CMC/AA/nHAp composites, the adsorption frequency was 2369 cm<sup>-1</sup> due to the presence of PH stretching vibration. The stretching vibration of carboxylate anion caused the peak at 1750 cm<sup>-1</sup>, whereas lesser intensity peaks at 1460 cm<sup>-1</sup> were caused by the asymmetric deformation of CH<sub>3</sub>. The peak at 1299 cm<sup>-1</sup> shows the P=O stretching vibration. [3,44,49,51]. The peak at 1376 cm<sup>-1</sup> resulted in the OH bending vibration. The peak at 1011 cm<sup>-1</sup> was due to P-O-C stretching vibration, whereas the peak at 896 cm<sup>-1</sup> was

caused by out of plane of CH α Galactose ring of Agar in CMC/AA/nHAp. For CMC/CA/nHAp composites, The peak at 2920 cm<sup>-1</sup> shows the CH stretching vibration. The peak at 1741 cm<sup>-1</sup> stretching vibration of carboxylate anion. The P=O stretching vibration shows the peak at 1296 cm<sup>-1</sup>. The peak at 1248 cm<sup>-1</sup> shows the stretching vibration of S=O of sulphate esters. The peaks at 1011 cm<sup>-1</sup> is due to P-O-C stretching vibration [4,7,11,14]. The peak at 847 cm<sup>-1</sup> is for 3,6-anhydrogalactose-2-sulfate.

For CMC, the stretching frequency of the OH group causes a large absorption band at 3422 cm<sup>-1</sup>, while C-H stretching vibration causes a band at 2920 cm<sup>-1</sup> [5,11,17,45]. The existence of a new and strong absorption band at 1654 cm<sup>-1</sup> supports the stretching vibration of carboxyl groups (COO), and carboxyl groups as salts are allocated 1423 cm<sup>-1</sup> -OH bending vibration and C-O-C stretching are ascribed to the bands around 1101 cm<sup>-1</sup>, respectively [7,11,22,47,53]. The peak at 1376 cm<sup>-1</sup> was due to the OH bending vibration [11,44,50,56]. The 1,4-glycoside of cellulose was discovered at wavelength 896 cm<sup>-1</sup> region.

For n-HAp, the peaks for PO<sub>4</sub><sup>3-</sup> and OH<sup>-</sup> groups in the hydroxyapatite can be identified in the peaks at 560–610 and 1000–1100 cm<sup>-1</sup> must be due to PO<sub>4</sub><sup>3-</sup> [35,36,51,52]. For the OH stretching vibration, the peak position is at 3570 cm<sup>-1</sup>. The peak observed between 1654 & 1384 cm<sup>-1</sup> is due to the carboxyl group salts [41,55,57]. The weakness, disappearance and shift of the characteristic absorption band might have resulted from the interactions of different OH groups in the AA and CMC molecular chains [8,22,29,34,39]. This might imply the formation of new inter- and intramolecular hydrogen bonds, as well as a change in the conformation of CMC/AA/nHAp and CMC/CA/nHAp composites.

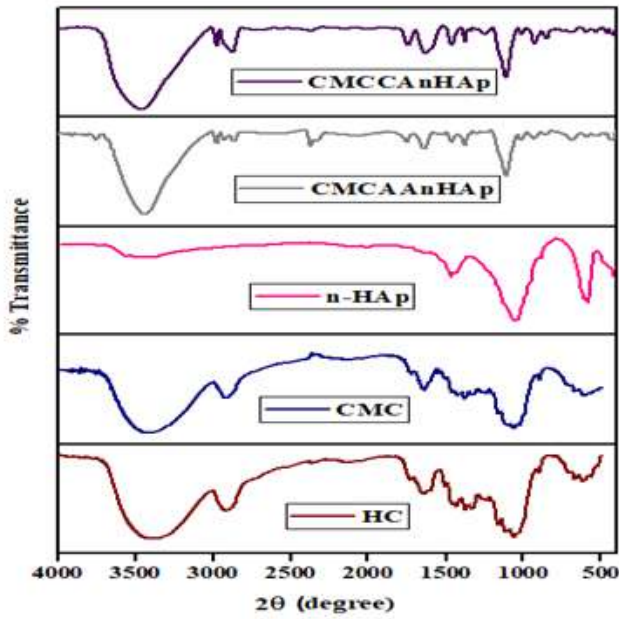


Fig 4. IR spectra for cellulose, CMC, n-HAp, CMC/AA/nHAp & CMC/CA/nHAp composites

4.2 XRD analysis

The X-Ray diffractogram for cellulose isolated from hemp, CMC, n-HAp and the composites CMC/AA/nHAp and CMC/CA/nHAp are shown in Figure 5. The average crystallite size of CMCs, n-HAp, CMC/AA/nHAp and CMC/CA/nHAp composite was calculated using scherrer's equation as 3.58nm, 19.9nm, 4.08nm, 25.85nm and 14.44nm respectively [17,21,29,47].

$$D = \frac{K \lambda}{\beta^{1/2} \cos \theta} \quad \text{---(1)}$$

where  $\lambda$  is the wavelength of x-rays,  $K$  is Scherrer's constant (0.94),  $\beta^{1/2}$  is the peak's full width half maximum (FWHM), and  $\theta$  is the Bragg's angle. The high value of percentage crystallinity of CMC showed the indication of effective hydrolysis which produces crystalline cellulose with removal of amorphous cellulose of chemically purified cellulose [18,37,44,59]. It could be observed that the crystallinity of the sample increases with the calcination temperature (500° C). The Ca/P stoichiometry of calcined HAp at 500° C temperature was analysed [23,36,45,49]. The typical peaks of AA and CA appeared in the diffraction patterns of

the CMC/AA/nHAp and CMC/CA/nHAp composites after blending with CMC and HAp, showing that the crystal structure of the n-HAp in the composite did not change after blending. Crystallinity percentage of CMC/AA/nHAp and CMC/CA/nHAp composite were calculated and observed to increase because of CMCs strongly interacted with the hydroxyl groups of Agar-Agar and Carragenan [33,39,48,59]. The average crystallinity were found to be 47%, 58.3%, 55.3%, 52.2% and 40.25% for cellulose from hemp, CMC, nHAp, CMC/AA/nHAp and CMC/CA/nHAp composites respectively. The Crystallinity index of the cellulose, CMC, n-HAp, CMC/AA/nHAp, CMC/CA/nHAp were calculated by the following equation,

Crystallinity Index

$$(CI) = \frac{A_{\text{crystalline}}}{A_{\text{amorphous}} + A_{\text{crystalline}}} \times 100 \quad \text{(2)}$$

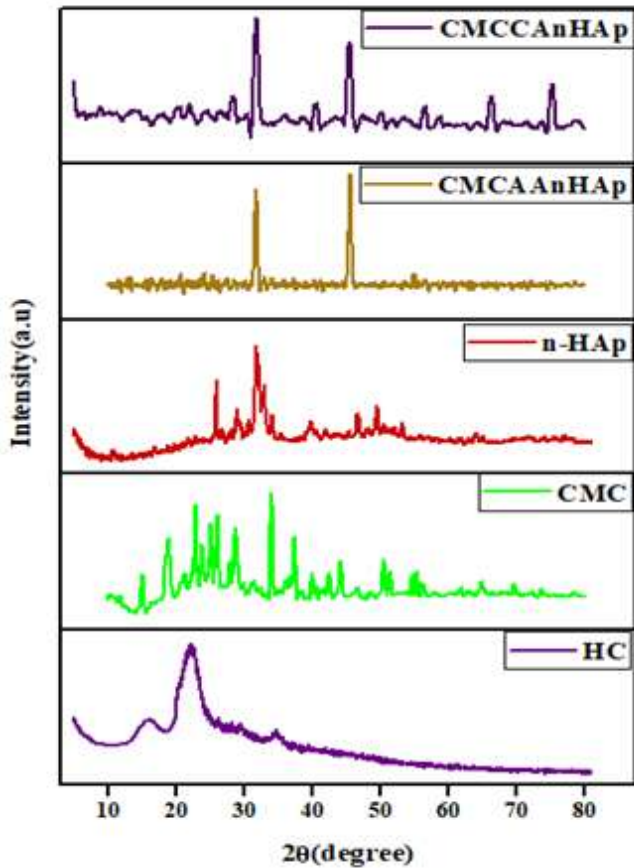
where  $A_{\text{crystalline}}$  is the area of crystalline curve,  $A_{\text{amorphous}}$  is the area of amorphous curve.

TABLE 1 Average Crystallite Size, Crystallinity Index and 2θ values of Samples

S.No	Sources	Crystallinity Index (CI)	Average Crystallite Size (D)	2θ Peaks
1	Cellulose from hemp	47%	3.58 nm	22.8°
2	CMC	49.3%	19.9 nm	36.9°
3	n-HAp	55.3%	4.08 nm	49.4°
4	CMC/AA/nHAp	46.2%	25.85 nm	45.67°
5	CMC/CA/nHAp	40.25%	14.44 nm	69.38°

The decrease in percentage crystallinity of composites shows their applications in medicinal field.



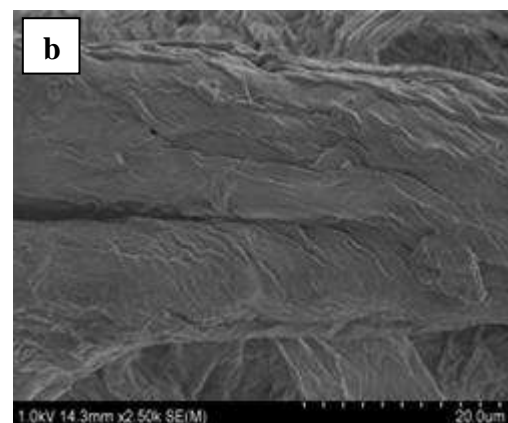
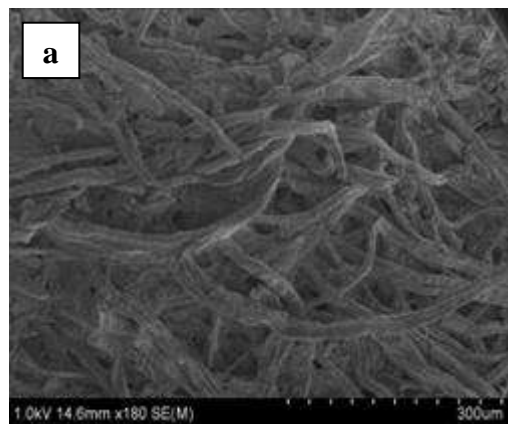


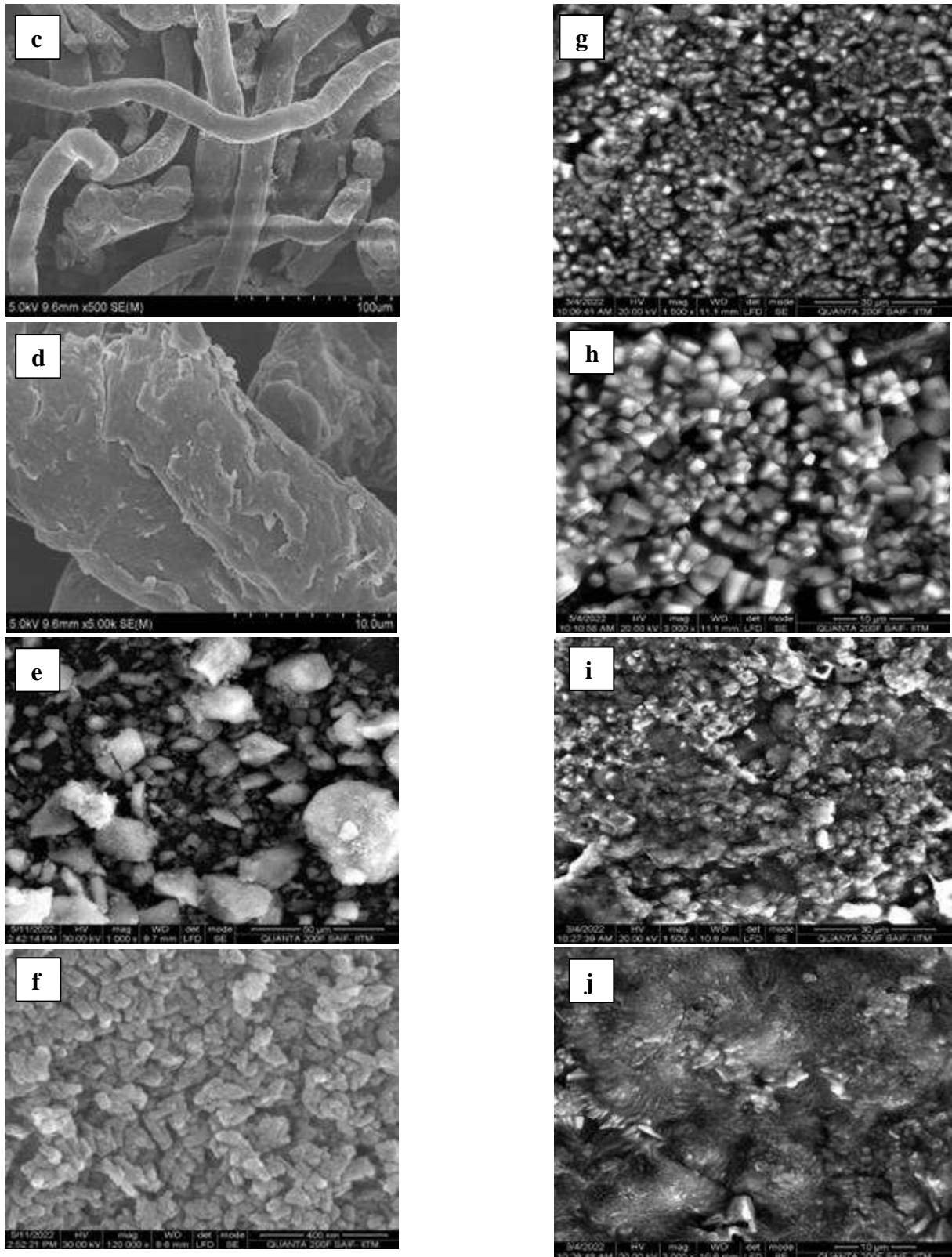
**Fig 5.** XRD patterns for prepared cellulose, CMC, n-HAp, CMC/AA/nHAp & CMC/CA/nHAp composites

### 4.3 Morphology analysis

The study of Field Emission Scanning Electron Microscopy (FESEM) revealed more specific information about the shape and size features of the CMC, n-HAP particles contained in the film. For cellulose prepared from hemp, the fibres were stiff rod like structure and still intertwined with each other (Figure 6 a, b). The fibres were separated into smaller bundles and their size was in the micron range [12,15,19,33]. In CMC, at two different magnifications, the surface morphology in distinct locations shows a nearly smooth surface with layers of flakes as shown in fig 6 c,d. The outer surface was rough and twisted, which might be due to the alkaline and bleaching processes utilised in the cellulose extraction procedure [15,28,37,45]. The size of the CMC crystals ranges from 14nm to 20nm. The n-Hydroxyapatite powders looked to be in a smashed angular form, and a high magnification

image revealed that each particle of nHAp is made up of nano-sized grains that appear as little brilliant spots and are pretty evenly spread over the image (Figure 6 e, f) [45,46,51,52]. The distribution of n-HAp particles in the composite film is seen in Figure 6 g, h, i, j. From the image it is very clear that the cubic shaped n-HAp particles are fairly well dispersed across the sample. There was no stacking found in the composite. The size of the n-HAp crystals ranges from 4nm to 10nm [15,24,33,46]. HAp particles can be homogeneously incorporated with Agar-agar/Carragenan and CMC matrix with good density, and the inorganic phase HAp bonding with organic phase in composite material with many small pores. The size of the CMC/AA/nHAp and CMC/CA/nHAP ranges from 21nm to 27nm and 12nm to 18nm respectively.



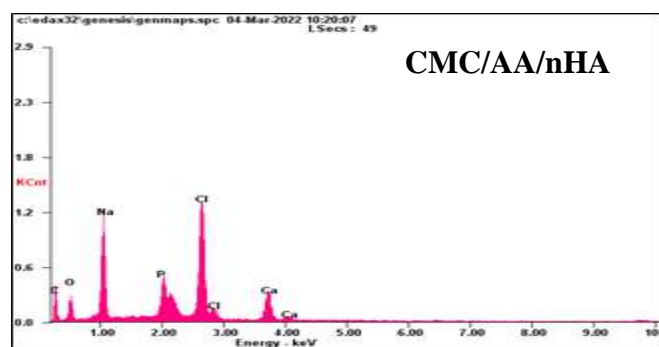


**Fig 5.** SEM images of (a,b) hemp (c,d) CMC (e,f) n-HAp (g,h) CMC/AA/nHAp (i,j) CMC/CA/nHAp

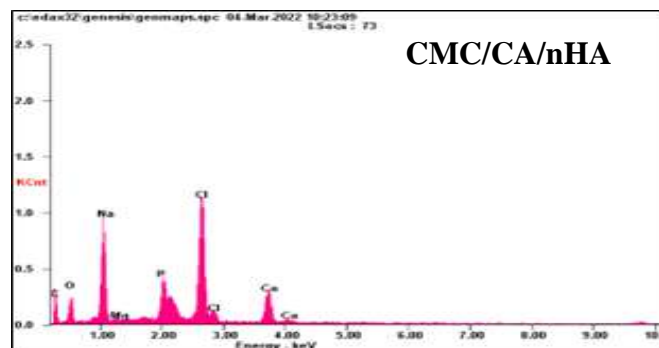
In comparison to CMC, composites shows morphological changes that confirms the interaction between the polymer and nano composites.

#### 4.4 Energy Dispersive X-ray Spectroscopy

The EDS spectrum reveals the chemical composition of prepared CMC/AA/HAp and CMC/CA/HAp composites [18,22,25,28]. Figure shows the energy dispersive ray spectra of prepared composites, which confirms the elemental composition of composite films. The EDS analysis confirms the presence of C, N, O, Na, P, Cl, Ca.



Sample	Element	Weight %	Atomic %
CMC/AA/nHAp	C	42.83	60.61
	O	13.67	14.53
	Na	15.11	11.17
	Mg	00.25	00.17
	P	05.05	02.77
	Ca	05.93	02.52



Sample	Element	Weight %	Atomic %
CMC/CA/nHAp	C	26.51	41.49
	O	28.03	32.93
	Na	05.57	04.55
	P	12.00	07.28
	Cl	10.18	05.40
	K	02.66	01.28

**Fig 7.** EDS Spectrum and Elemental percentage composition of CMC/AA/nHAp & CMC/CA/nHAp composites

#### 4.5 Thermal analysis

Thermogravimetric (TG) and Derivative Thermogravimetric (DTG) analysis were carried out in the range of 5°C to 600°C to evaluate the thermal stability and understand the phase changes of the prepared samples. The TGA and DTA thermograms recorded for the samples are shown in Figure 8. The moisture in the sample shown by the initial weight loss, occurred at 96°C [9,13,23,44]. The second weight loss occurred between 185°C and 390°C, indicating that cellulose is thermally stable. The evaporation of water molecule shows an endothermic peak at 109°C. A significant peak at 371.7°C for degradation, confirms the existence of cellulose isolated from hemp. The major decomposition of cellulose begins around 270°C, with a weight loss of 20% attributed to the inorganic moiety and a minimum weight loss of 10.40% beginning at 154°C [11,26,33,57]. The dehydration of the precipitating complex and the loss of physically adsorbed water molecules of the hydroxyapatite powder correlate to the first endothermic peak, which ranges from 90 to 295°C [35,45,51] with a peak at around 250°C [33,47,49]. This area has lost 16 percent of its weight. There was no peak with rising temperature from 295°C, except for a weight loss at the TGA curve in the temperature range, which is thought to be due to progressive dehydroxyllin in hydroxyapatite powder. For the composite CMCAAHAp, the first weight loss occurs at 150°C, was for the surface

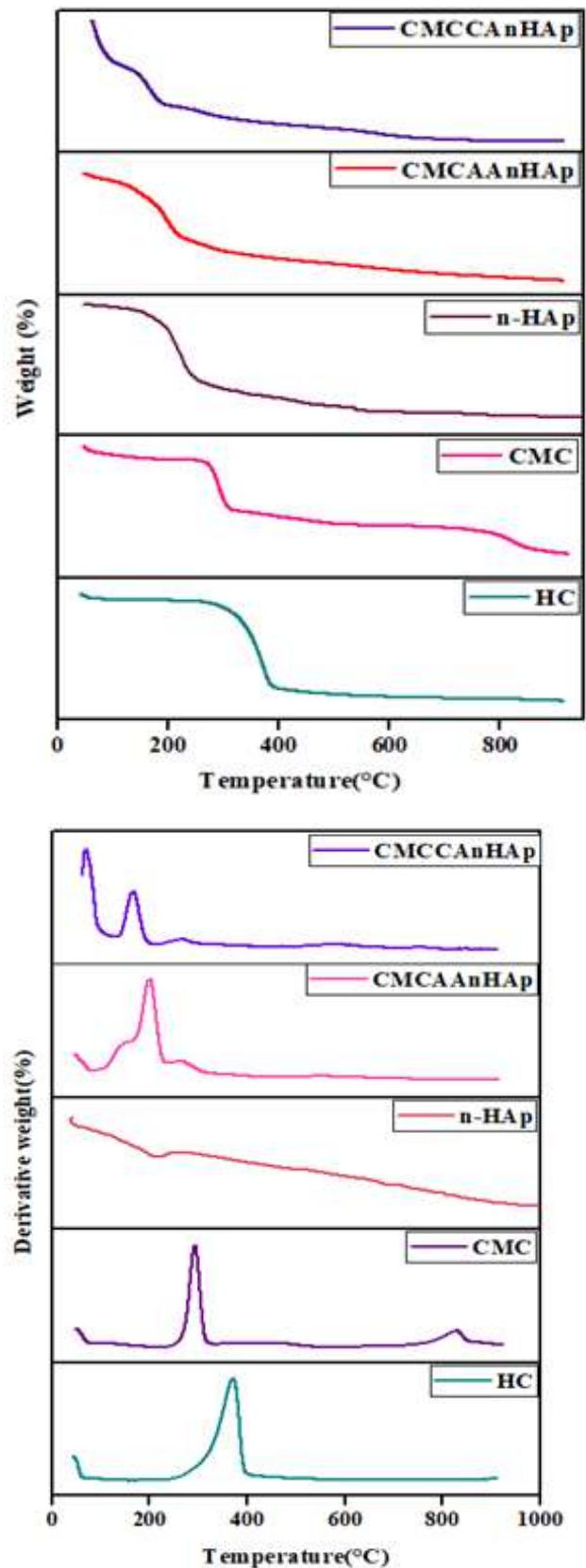
adsorbed water molecules. The second weight loss occurs at 400°C confirms the degradation of Biopolymer [31,36,55]. The third inflexion point occurs at 800°C shows the degradation of n-HAp. The first weight loss occurs at 120°C, was for the surface adsorbed water molecules. The second weight loss occurs at 400°C to 450°C confirms the degradation of Biopolymer. The third weight loss starts at 600°C shows the degradation of n-HAp.

**Table 2** Glass transition temperature ( $T_g$ ), Melting temperature ( $T_m$ ) and decomposition temperature ( $T_d$ ) for cellulose, CMC, n-HAp, CMC/AA/nHAp and CMC/CA/nHAp composites

S.No	Sample	$T_g$ (°C)	$T_m$ (°C)	$T_d$ (°C)
1	Cellulose from Hemp	75°C	383°C	391°C
2	CMC	78°C	275°C	380°C
3	n-HAp	-	238°C	290°C
4	CMC/AA/nHAp	45°C	220°C	260°C
5	CMC/CA/nHAp	40°C	189°C	225°C

The thermal parameters such as glass transition temperature ( $T_g$ ), melting temperature ( $T_m$ ) and decomposition temperature ( $T_d$ ) are presented in table 2.

The glass transition temperature ( $T_g$ ) values of the composites are lower than the CMC and n-HAp. This shows that these composites are more flexible which is one of the major criteria for designing thin films. Also the melting temperature ( $T_m$ ) and decomposition temperature ( $T_d$ ) are comparatively high which shows that the prepared composites are thermally stable.



**Fig 8.** TGA & DTA thermograms for cellulose, CMC, n-HAp, CMC/AA/nHAp & CMC/CA/nHAp composites

**4.6 Biomedical Applications**

**4.6.1 Antibacterial Activity**

Antibacterial activity of the samples was determined by disc diffusion method on Muller Hinton agar (MHA) medium for CMC/AA/nHAp and CMC/CA/nHAp composite films. Muller Hinton Agar (MHA) medium is poured in to the petri plate [40,44,52]. After the medium was solidified, the inoculums were spread on the solid plates with sterile swab moistened with the bacterial suspension. The discs were placed in MHA plates and add 20 µl of sample Concentration: 1000µg, 750µg and 500 µg were placed in the disc (Figure 9). The plates were incubated at 37°C for 24 hrs [42,55,59]. Then the antimicrobial activity was determined by measuring the diameter of zone of inhibition.

**Table 2 Zone of Inhibition of bacteria in 1000, 750, 500 µg/ml for CMC/AA/nHAp composite Film**

Organisms	Zone of Inhibition(mm)			Antibiotic (1mg/ml)
	Sample (µg/ml)			
	1000	750	500	
<i>Staphylococcus aureus</i>	-	-	-	26
<i>Pseudomonas aeruginosa</i>	14	11	7	39
<i>Enterococcus faecalis</i>	22	18	10	47
<i>Bacillus subtilis</i>	7	-	-	33
<i>Escherichia coli</i>	-	-	-	7



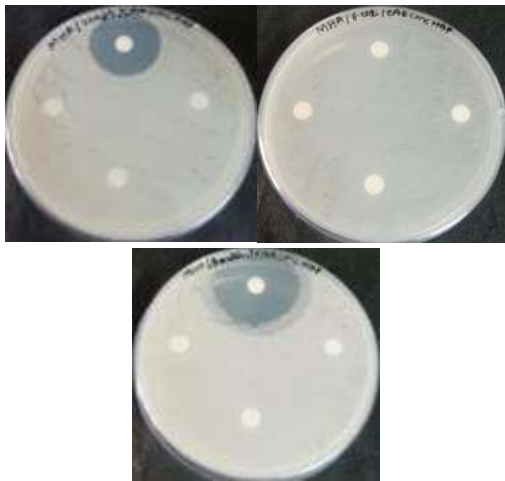
**Fig 9.** Images of Zone of Inhibition of *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis* in 1000, 750, 500 µg/ml

The result showed that *Enterococcus faecalis* has better antibacterial activity in 1000, 750, 500 µg/ml in CMC/AA/nHAp composite film.

**Table 3 Zone of Inhibition of bacteria in 1000, 750, 500 µg/ml for CMC/CA/nHAp composite Film**

Organisms	Zone of Inhibition(mm)			Antibiotic (1mg/ml)
	Sample (µg/ml)			
	1000	750	500	
<i>Staphylococcus aureus</i>	-	-	-	14
<i>Pseudomonas aeruginosa</i>	17	8	7	36
<i>Enterococcus faecalis</i>	12	9	8	46
<i>Bacillus subtilis</i>	-	-	-	32
<i>Escherichia.coli</i>	-	-	-	7





**Fig 10.** Images of Zone of Inhibition of *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* in 1000, 750, 500 µg/ml

The result showed that *Enterococcus faecalis* has better antibacterial activity in 1000, 750, 500 µg/ml in CMC/CA/nHAp composite film.

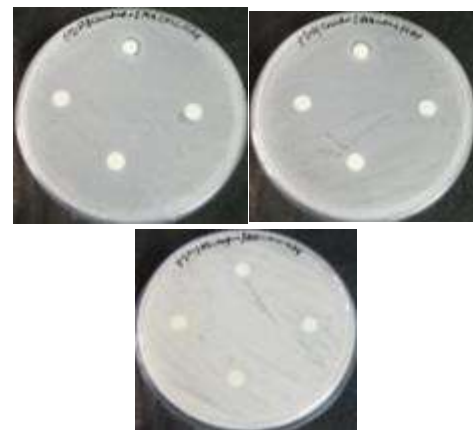
**4.6.2 Antifungal Activity**

**Agar disc diffusion method**

Antifungal activity of the Sample was determined by disc diffusion method on Sabouraud Dextrose agar (SDA) medium for CMC/AA/nHAp and CMC/CA/nHAp composites. Sabouraud Dextrose agar (SDA) medium is poured in to the petriplate [31,38,43]. After the medium was solidified, the inoculums were spread on the solid plates with sterile swab moistened with the fungal suspension. Amphotericin-B is taken as positive control. Samples and positive control of 20 µl each were added in sterile discs and placed in SDA plates [38,40,42]. The plates were incubated at 28°C for 24 hrs (Figure 11). Then antifungal activity was determined by measuring the diameter of zone of inhibition.

**Table 4** Zone of Inhibition of fungi in 1000, 750, 500 µg/ml for CMC/AA/nHAp composite Films

Organisms	Zone of Inhibition(mm)			Antibiotic (1mg/ml)
	Sample (µg/ml)			
	1000	750	500	
<i>Trichoderma viride</i>	8	7	7	8
<i>Rhizopus stolonifer</i>	-	7	-	7
<i>Candida albicans</i>	8	7	-	10



**Fig 11.** Images of Zone of Inhibition of *Trichoderma viride*, *Candida albicans*, *Rhizopus stolonifer* in 1000, 750, 500 µg/ml

The result showed that *Candida albicans* has better activity in 1000, 750, 500 µg/ml in CMC/AA/nHAp composite films.

**Table 5** Zone of Inhibition of fungi in 1000, 750, 500 µg/ml for CMC/CA/nHAp composite Films

Organisms	Zone of Inhibition(mm)			Antibiotic (1mg/ml)
	Sample (µg/ml)			
	1000	750	500	
<i>Trichoderma viride</i>	8	7	7	8

S.No	Sample	Measurement (%)
1	CMC/CA/nHAp	0.66
2	CMC/AA/nHAp	0.50
3	Control	0.72
<i>Rhizopus stolonifer</i>	8	- - 8
<i>Candida albicans</i>	8	7 - 10



Fig 12. Images of Zone of Inhibition of *Trichoderma viride*, *Candida albicans*, *Rhizopus stolonifer* in 1000, 750, 500 µg/ml

The result showed that *Candida albicans* has better activity in 1000, 750, 500 µg/ml in CMC/CA/nHAp composite films.

#### 4.6.3 Wound Healing Activity

The VERO cell line was used to check the Wound healing activity for CMC/AA/nHAp and CMC/CA/nHAp composites [11,40,42,]. The cells were seeded into the 6-well plate and incubated for 24 hrs. After incubation, the cells were observed for growth and assay was preceded. The medium was discarded and the plate was kept under microscope. A sterile tip was used and wound was created and wells were washed with sterile PBS in order to wash the detached cells. 1 ml of the sample was added to the well and incubated. Control well (without the sample) was also maintained [30-32,52]. After 24 hrs of incubation, the plate was observed for the growth of cells (Figure 13). The wound created time is considered as the measurement at the 0<sup>th</sup> hour. The wound closure percentage of the cells are calculated using the formulae,

$$\text{Wound Closure \%} = \frac{\text{Measurement at 0}^{\text{th}} \text{ hour} - \text{Measurement at 24}^{\text{th}} \text{ hour}}{\text{Measurement at 0}^{\text{th}} \text{ hour}} \times 100 \rightarrow (3)$$

Table 6 Wound closure measurement for CMC/AA/nHAp & CMC/CA/nHAp composite

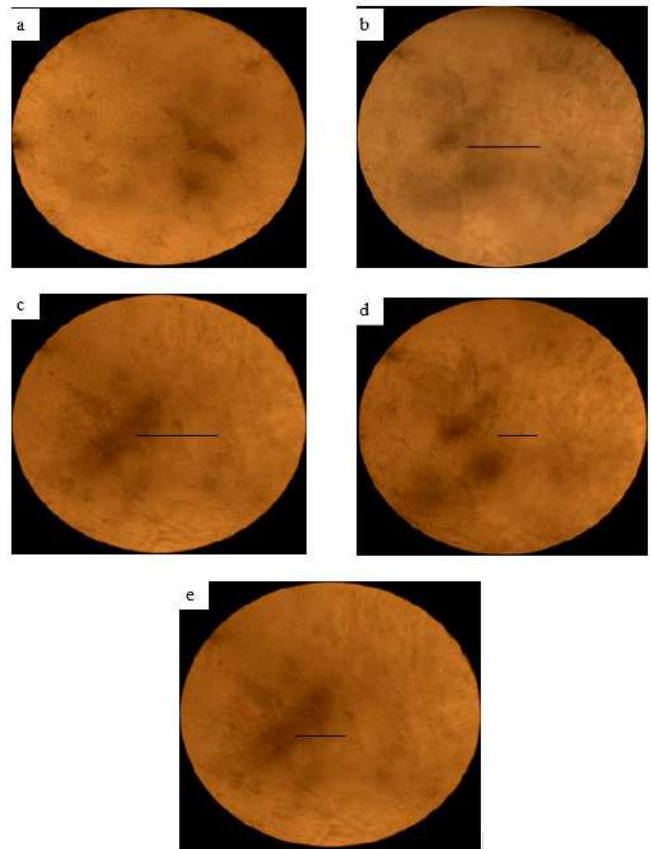


Fig 13. Images of wound healing activity of a. Normal cell line b. Wound created c. Control cell line d. CMC/AA/nHAp e. CMC/CA/nHAp

#### 4.6.4 Anticancer Activity

Cells (1 × 10<sup>5</sup>/well) were plated in 24-well plates and incubated in 37°C with 5% CO<sub>2</sub> condition. After the cell reaches the confluence, the various concentrations of the samples were added and incubated for 24hrs [46,50,55]. After incubation, the sample was removed from the well and washed with phosphate-buffered saline (pH 7.4). 100µl/well (5mg/ml) of 0.5% 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl--tetrazolium bromide (MTT) was added and incubated for 4 hours [23,27,33,40]. After incubation, 1ml of DMSO was added in all the wells .The absorbance at 570nm was measured with UV- Spectrophotometer using DMSO as the blank. Measurements were performed and the concentration required for a 50% inhibition (IC<sub>50</sub>) was

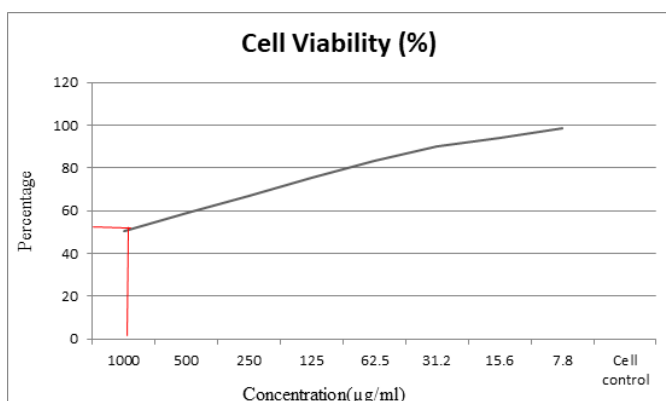
determined graphically. The % cell viability was calculated using the following formula:

$$\% \text{ Cell viability} = \frac{\text{A570 of treated cells}}{\text{A570 of control cells}} \times 100 \quad (4)$$

Graphs are plotted using the % of Cell Viability at Y-axis and concentration of the sample in X-axis [42,43]. Cell control and sample control is included in each assay to compare the full cell viability assessments.

**Table 7** Anticancer effect of CMC/AA/nHAp on MCF 7 cell line

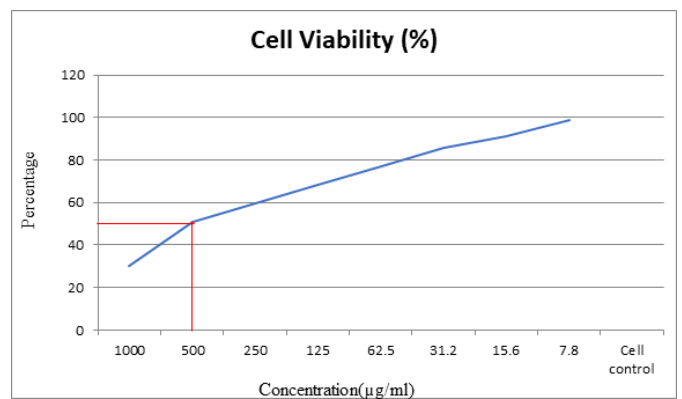
S.N	Concentration (µg/ml)	Dilutions	Absorbance (O.D)	Cell Viability (%)
1	1000	Neat	0.207	50.61
2	500	1:1	0.241	58.92
3	250	1:2	0.274	66.99
4	125	1:4	0.308	75.30
5	62.5	1:8	0.341	83.37
6	31.2	1:16	0.376	89.93
7	15.6	1:32	0.412	93.73
8	7.8	1:64	0.445	98.80
9	Cell control	-	0.409	100



**Fig 14.** Percentage Cell viability for CMC/AA/nHAp composite

**Table 8** Anticancer effect of CMC/CA/nHAp on MCF 7 cell line

S.N	Concentration (µg/ml)	Dilutions	Absorbance (O.D)	Cell Viability (%)
1	1000	Neat	0.164	30.20
2	500	1:1	0.275	50.64
3	250	1:2	0.323	59.48
4	125	1:4	0.371	68.32
5	62.5	1:8	0.418	76.97
6	31.2	1:16	0.465	85.63
7	15.6	1:32	0.512	91.29
8	7.8	1:64	0.560	98.6
9	Cell control	-	0.453	100



**Fig 14.** Percentage Cell viability for CMC/CA/nHAp composite

### V. CONCLUSION

In this investigation, we reported the preparation, characterisation and antimicrobial studies of n-hydroxyapatite (n-HAp) incorporated carboxymethyl cellulose and Agar-Agar/I-Carragenan composites. The prepared composites were structurally analysed using FT-IR, XRD and TGA/DTA techniques as well as morphology using HR-SEM analysis. The addition of nano hydroxyapatite particles in the polymer matrix altered the morphology. The antimicrobial studies such as antibacterial, antifungal, wound healing and anticancer activities were evaluated with the prepared



composite materials. The results showed that the composite materials possess inhibition against pathogens. This research demonstrates that the CMC/Agar-Agar/nHAp and CMC/I-Carragenan/nHAp nanocomposites are potential biomaterials for appropriate biomedical applications.

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### Conflict of interest

The authors declare that they have no conflict of interest.

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# Pollen Diversity of Sri Ram Narayan Khedia Government Degree College Banswada, Kamareddy District, Telangana State, India

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## ABSTRACT

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The present paper study on the study of pollen diversity of 31 plants from various gardens of Sri Ram Narayana Khedia Government Degree College Banswada, Kamareddy district, Telangana state, India. These plants some are medicinal, ornamental and tree members. The pollens of these plants have diversity of morphological characters viz., symmetry, shape, polarity, aperture patterns and sculpture. In the present study, a total of 31 plant species belongs to 19 families. The plants with Spheroidal shape pollen *Catharanthus roseus*, *Lantana camara*, *Bougainvillea spectabilis*, *Tridax procumbens*, *Pseuderanthamum*, *Ixora coccinea*, *Jasminum sambac*, *Hibiscus rosa-sinensis*, *Pulmeria alba*, *Euphorbia heterophylla*, *Cynodon dactylon*, *Ghompherna celosioides*, *Hibiscus syriacus*, *Tecomaria capensis*, *Turnera ulmifolia*, *Punica grantum*, *Cleome gynandra*, *Oxalis dilenii*, *Nerium oleander*, *Ghompherna globosa*, *Datura stramonium*, *Jatropa integrerrima*, *Cyanthillium cinereum*, *Delonix regia*, *Tecoma stans*. The plants with Symmetrical pollen is *Parthenium hysterophorus*. The plant with Irregular pollen shape is *Callaindra*. The plants with Cylindric pollen shape *Bauhinia racemosa*, *Crossandra infundibuliformis*. The plant with Boat shaped pollen is *Hymencallis littoralis*, are reported. This plant species diversity record which is helps to the identification of Indian pollen flora.

**Keywords :** Pollen diversity, pollen morphology and SRNK GDC-Banswad.

## I. INTRODUCTION

Pollen is a mass of microspores in a seed plant appearing usually as a fine dust. Each pollen grain is minute body, of varying shape and structure formed in the male structures of seed bearing plants and transported by various means to the female structures, where fertilization occurs. Pollen morphology has a great potential as a means of classification, and is frequently utilized to clarify taxonomic questions

(Nowicke & Ridgeway 1973, Wodhouse 1965, Nowicke & Miller 1990, Taroda & Gibbs 1986a, Diez et al. 1986, Miller & Nowicke 1989, Diez & Valdes1991). Hence the pollen grains are of great value in ascertaining purity of drug and identification. The significance of palynology in pharmacognosy and taxonomy is known since a long time. The branch of pharmacopalynology has attracted the attention of scientist in general and palynologists in particular equally. A large proportion of species which can

recognised from their pollen grains (Clarke 1977). Pollen grains and spores as a rule are only a few hundred of a millimeter in size called as bio-pollutants can be studied in an enlarged state and can be used as a solid mean for the identification, classification, and determination of affinity and so on of vegetation of a particular region.

Additionally given their remarkably symmetrical structure and surface patterns fresh and preserved pollen grains are can be recognizable under the microscope. Pollen is produced in such quantities that are a significant component of the airborne constituents of Earth's atmosphere, especially in areas over continents. Pollen grains come in a wide variety of shapes, sizes, and surface markings characteristic of the species. Pollen grains of pines, firs, and spruces are winged. The smallest pollen grain, that of forget-me-not, is 0.005mm in diameter. Corn pollen grains are large about 90-100um. Most grass pollen is around 20-25um. In most of the plants the mature pollen grain has a double wall. The exine often bears spines or warts, or is variously sculptured, and the character of markings is value for identifying genus, species. The spines may be less than in micron in length reffered to as spinulose (scarbate) or longer than a micron reffered to as echinate. Various terms also describe the sculpturing such as reticulate, a net like appearance consisting of elements separated from each other by lumen. These reticulations may also be reffered to as brochi.

Palynology is a brach of botany where we study the morphological characters of spore and pollen grains. The term palynology first introduced Hyde and Williams in the year 1944 . In our work we have gone through the characteristics features of pollen which are important to taxonomy. The apertural pattern and sculpturing pattern of pollen grains are very much significant in the identification of the taxa. Apertural pattern includes both simple and composite forms like tricolporate, tri-tetracolporate, triporate, and tetra hexa porate. The sculpturing diversity of palynotaxa is

indicated by reticulate, microreticulate, verrucate, and granular to psilate pattern

## II. METERIALS AND METHODS

The pollen used in this study were collected from various gardens of Sri Ram Narayana Khedia Govt. Degree College Banswada, Kamareddy district, Telangana state, India. Banswada is located at 18.38330N, 77.88330E having an average elevation of 371meters [1220feets]. It is in area of 15.96km<sup>2</sup>. weather 270C wind N/W at 8km/h. 59% humidity. The pollen compared with herbaria specimens of Botany deportment laboratory. The pollen were produced from newly dehised anthers under a dissecting microscope and placed in centrifuged and acetolyzed according to Erdtman. Permanent slides were made with the material mounted in glycerine jelly and sealed with paraffin and deposited in Department Of Botany Sri Ram Narayana Khedia Government Degree College Banswada, Kamareddy district, Telangana state, India. The pollen types and sub types are based on characters discernible in light microscope .The palyological terminology used in accordance with Erdtman. The process of acetolysis is mainly carried out to remove the protoplast contents of pollen grains acetolysis impacts chestnut brown colour to the pollen grains. Further it dears the wall making it more translucent which facilitates detailed study of its structure and sculpture ornamentation.

## III. RESULT AND DISCUSSION

The work on pollen allergy was initiated in the 1950's by Shivpuri in Delhi. Subsequently, Kaliwal and his colleagues reported important pollen allergens of Jaipur (Kasilwal et al., 1958). From south india Cassia, Ageratum, Salvadora, Ricimus, Albizia lebbeck and Artemisisa scoparia have been reported as important aeroallergens (Acharya. 1980; Agashe and Anand, 1982). Subbarao et al., 1985 recorded allergenicity to Parthenium hysterophorus pollen extracts in 34% of

allergic rhinitis and 12% Bronchial asthma patients  
Bangalore.

TABLE NO: 1 LIST OF POLLEN GRAINS DIVERSITY IN OUR COLLEGE CAMPUS

POLLEN DIVERSITY OF SRI RAM NARAYAN KHEDIA GOVERNMENT DEGREE COLLEGE BANSWADA, KAMREDDY DIST. TELANGANA						
S. No	COMMON NAME	SCIENTIFIC NAME	FAMILY	SHAPE	APETURE TYPE	ORNAMENTATION
1	Bright eyes	<i>Catharanthus roseus</i>	Apocynaceae	Spheroidal	Tricolporate	Perforate
2	West indian cantana	<i>Lanthona camara</i>	Varbenaceae	Spheroidal	Colporous, Tricolporate	perforate, Psilate
3	Carrot grass	<i>Parthenium hysterophorous</i>	Asteraceae	Symmetric al	Triozonocalporate	Non-loculate, echinate
4	Paper flower	<i>Bougainvillea galbera</i>	Nyctaginaceae	Spheroidal	Tricolporate	Baculate, Reticulate
5	Redpoder puff	<i>Callandra</i>	Fabaceae	Irrgular	Porous porate	Verrucate, psilate
6	Coat buttons	<i>Tridox procumbers</i>	Asteraceae	Spheroidal	Tetracolporate	Echinate
7	Purale false ernatheum	<i>Pseudoernathium</i>	Acanthaceae	Spheroidal	Tricolporate, colporate	Reticulate
8	Orchid tree	<i>Bauhinia variegata</i>	Fabaceae	Cylindric	Colporous, Tricopate	Reticulate
9	Nuru varahalu	<i>Ixora coccinea</i>	Rubiaceae	Spheroidal	Colporous, colporate	Microreticulate, Cutalate
10	Kanakambaralu	<i>Crossandra infandibuliformis</i>	Acanthaceae	Cylindric	Colpus, tricolpate	Reticulate, scabrate
11	Arabian jasmim	<i>Jasminum sambac</i>	Oleaceae	Spheroidal	Colpus, colpate, tricolpate	Reticulate
12	China rose	<i>Hibiscus rosa sinesis</i>	Malvaceae	Spheroidal	Porous, pantoporate	Echinate
13	White franigipani	<i>Pulameria alba</i>	Apocynaceae	Spheroidal	Colporous, tricoporate	Psilate
14	Fire plant	<i>Euphorbia heterophylla</i>	Euphorbaceae	Spheroidal	Colpus, tricolpate	Reticulate
15	Bermuda grass	<i>Cynodon dactylon</i>	Poaceae	Spheroidal	Ukus, ukarate	Microechenate, aerolate
16	Bachelors button	<i>Gomphrena celosioides</i>	Amaranthaceae	Spheroidal	Porus, pantoporate	Microechenate, lophate

17	Rose of sharon	<i>Hibiscus syriacus</i>	Malvaceae	Spheroidal	Porus, pantoporate	Echinate, perforate
18	Cape honeysuckle	<i>Tecomaria capensis</i>	Bignoniaceae	Spheroidal	colpus, tricolpate	reticulate
19	West indian holly	<i>Turnera ulmiafolia</i>	Passifloraceae	Spheroidal, circular	No-aperture	Clavate
20	Pome granate	<i>Punica granatum</i>	Punicaceae	Spheroidal	Colporus, colpate	Regulate
21	The beach spider lily	<i>Hymenocallis littoralis</i>	Amaryllidaceae	Boat shaped	Sulcus, sulculate	Reticulate, clavate
22	Shona cabbage	<i>Cleome gynandra</i>	Capparidaceae	Spheroidal	Colporus, tricolpate	Strilate, regulate
23	Southern wood sorrel	<i>Oxalis dillenii</i>	Oxalidaceae	Spheroidal	Colpus, tricolpate	reticulate
24	Oleander	<i>Nerium oleandra</i>	Apocynaceae	Spheroidal, circular	Tetraporate	Psilate
25	Globe amaranth	<i>Gomphrena globosa</i>	Amaranthaceae	Spheroidal	Pantoporate	Microechinate, Lophate
26	Moon flower	<i>Datura stramonium</i>	Solanaceae	Spheroidal	Tricolpate, colpate	Strilate, regulate
27	Peregrina	<i>Jatropha integrerrima</i>	Euphorbiaceae	Spheroidal	No-aperture	Crotan pattern, calvate
28	Little Iron weed	<i>Cyanthillium cinereum</i>	Asteraceae	Spheroidal, circular	Tricolpate	Microreticulate
29	Royal flower	<i>Delonix regia</i>	Fabaceae	Spheroidal	Tricolpate	Reticulate
30	Yellow bells	<i>Tecoma stans</i>	Bignoniaceae	Spheroidal	Tricolpate, colpate	Reticulate
31	Tulasi	<i>Ocimum sanctum</i>	Lamiaceae	Rounded	Porate	Spiny ornamentation

The present paper focused on pollen diversity in our college the survey conducted in July 2021 to March 2022. Total 31 palynotaxa belonging to 19 families. They are Fabaceae, Solanaceae, Asteraceae, Malvaceae, Poaceae, Apocynaceae, Verbenaceae, Nyctaginaceae, Acanthaceae, Rubiaceae, Oleaceae, Euphorbiaceae, Amaranthaceae, Bignoniaceae, Passifloraceae, Punicaceae, Amaryllidaceae, Cleomaceae &

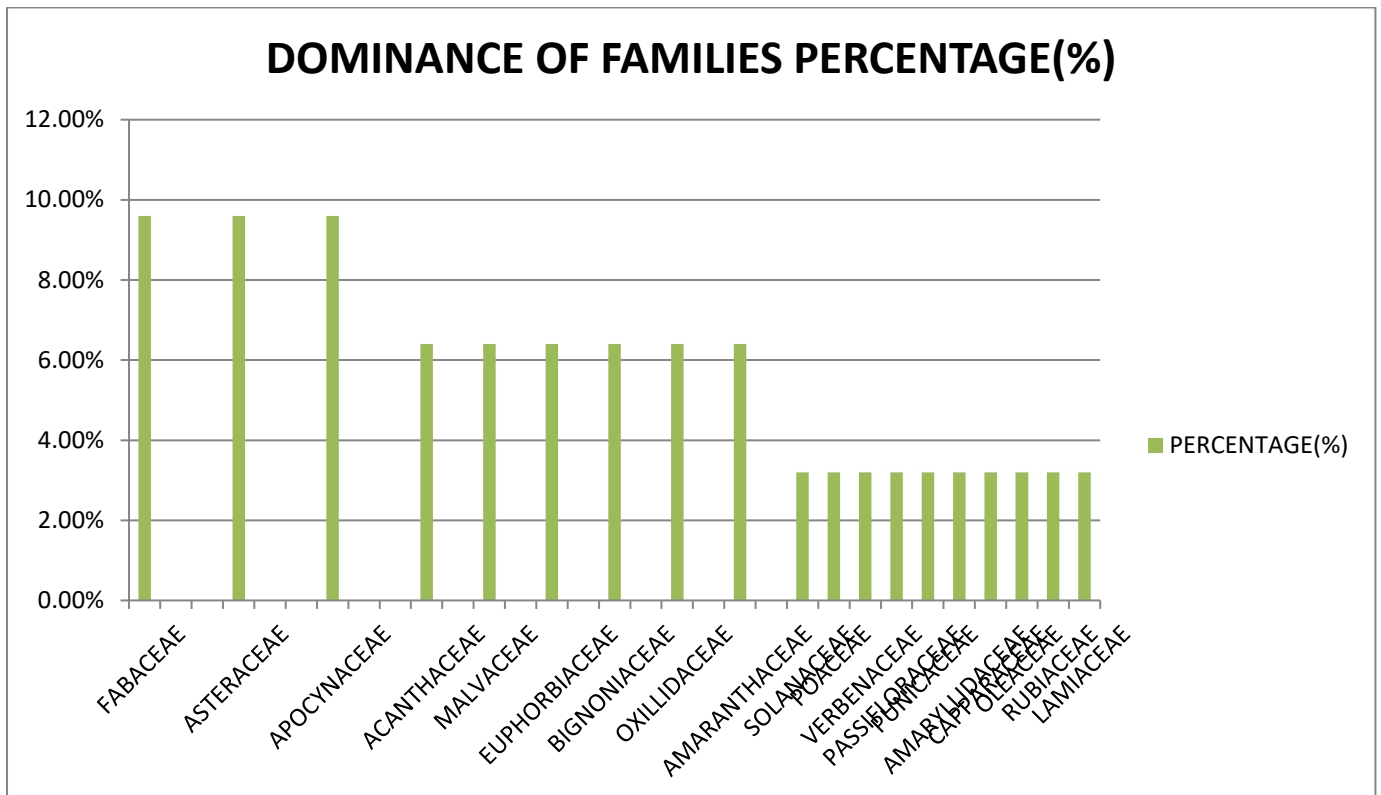
Oxillidaceae, Lamiaceae. These palynologically investigated under light Microscope.

All the pollen grains characteristic features studied like Shape, Aperture, Ornmentation flowering season. The shape of the pollen grains varied from Porate to Oblate and Spheroidal. The plants with Spheroidal shape pollen *Catharanthus roseus*, *Lantana camara*, *Bougainvillea spectabilis*, *Tridax procumbens*,



Pseuderanthamum, Ixora coccinea, Jasminum sambac, Hibiscus rosa-sinensis, Pulmeria alba, Euphorbia heterophylla, Cynodon dactylon, Ghompherna celosioides, Hibiscus syriacus, Tecomaria capensis, Turnera ulmifolia, Punica grantum , Cleome gynandra, Oxalis dilenii, Nerium oleander, Ghompherna globosa, Datura stramonium, Jatropa integrerrima, Cyanthillium cinereum, Delonix regia, Tecoma stans .

The plants with Symmetrical pollen is Parthenium hysterothorus. The plant with Irregular pollen shape is Callaindra. The plants with Cylindric pollen shape Bauhinia racemosa, Crossandra infundibuliformis. The plant with Boat shaped pollen is Hymencallis littoralis.



The above table describes about the Dominance of the families among those collected 31 plants in our field work. The 31 plants are belongs to the different families, like Fabaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaryllidaceae, Verbenaceae, Oleaceae, Rubiaceae, Capparaceae, Passifloraceae, Poaceae, Asteraceae, Apocyanaceae, Punicaceae, Oxillidaceae, Bignoniaceae, Malvaceae, and Euphorbiaceae. If we observe the table among those families Fabaceae, Asteraceae, Apocyanaceae are the Families showed equal Dominance over other families, and the dominant percentage of those families is 9.6%. and the families with medium dominance in those 31 plants were placed in the 2nd place of the table, they are

Acanthaceae, Euphorbiaceae, Malvaceae, Amaranthaceae, Oxillidaceae, and Bignoniaceae. The families showed the dominance percentage about 6.4%. and the remaining families were showed least dominance among 31 plants, they are Solanaceae, Poaceae, Verbenaceae, Amaryllidaceae, Punicaceae, Oleaceae, Rubiaceae, Lamiaceae, Passifloraceae and Capparaceae. These families showed the dominant percentage about 3.2%. As per our observation the plants with 6.4% dominance are in highest number in those collected 31 plants.

#### IV. CONCLUSION

The present study shows that the area which in few floral species. In that Fabaceae, Asteraceae, Apocynaceae are dominant species. In the study area Callaindra, Bauhinia racemosa, Delonix regia, Parthenium hysterophorus, Tridax procumbens, Cyanthillium cinereum, Catharanthus roseus, Pulmeria alba, Nerium Oleander. They release more pollen grains in seasonal. Less dominant families are Solanaceae, Poaceae, Verbenaceae, Nyctaginaceae, Rubiaceae, Oleaceae, Passifloraceae, Punicaceae, Amaryllidaceae, Capparidaceae, Oxillidaceae, Lamiaceae. In study area Datura stramonium, Cynodon dactylon, Bougainvillea spectabilis, Ixora coccinea, Jasminum sambac, Turnera ulmifolia, Punica grantum, Hymencallis littoralis, Cleome gynandra. They are also release pollen grains seasonally. Among 19 families 18 are Dicots, and only 1 is Monocot. Result from our study showed that great variation in shape, aperture, ornamentation. (showed in table 1).

In our result some pollen grains are causing allergies, respiratory problems by Parthenium hysterophorus, Euphorbia heterophylla etc. Therefore their concentration in the air may be the free disposing factors for causing allergy in sensitive individuals. These data may help to study the individuals phases of allergy. these pollen taxa may be help in to know the pollen taxa of Kamareddy dist.

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# Combined Perturb and Observe and Artificial Neural Network Approach for Maximum Power Point Tracking in Photovoltaic System under Uniformly Shaded Conditions

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## ABSTRACT

Maximum Power Point Tracking (MPPT) of PV system is very much essential for the efficient operation of the solar photovoltaic (PV) system. PV system performance mainly depends on solar insolation and temperature conditions. In this paper combination of Perturb and Observe (P&O) and Artificial Neural Network (ANN) MPPT algorithms is proposed to provide reference voltage to DC-DC boost converter in the PV system under uniform shading conditions. In ANN-based techniques, the maximum power points are acquired by designing ANN models for PV modules. Compared to conventional P&O MPPT method, this approach tracks to the Maximum Power Point (MPP) faster with less fluctuations. The training of the ANN is done with Levenberg Marquardt algorithm and the whole technique is being simulated and studied using MATLAB software.

Keywords : MPPT, Photovoltaic, Artificial Neural Network, Back-propagation

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## I. INTRODUCTION

At present worldwide including Indonesia have energy crisis so that the necessary renewable energy as a replacement. One of renewable energy namely solar energy has the greatest potential in Indonesia in the amount of 156.487 MW and utilized for the new 5MW. The freely and abundantly available solar energy can be easily converted into electrical energy using PV cells [1]. Since PV sources exhibit nonlinear I-V characteristics, their power output mainly depends on the nature of the load. So, direct load connections to PV systems result in poor overall efficiency. As solar

panels are still expensive, minimizing the cost of their life cycle has recently become an important consideration. Therefore, a Maximum Power-Point Tracker (MPPT) is required to handle such problems and ensure that the PV system is operating at the Maximum Power Point (MPP). Many different MPPT Techniques have been proposed, with the objective of reducing the hardware and improving the performance of the PV system [2, 3].

The general requirements for maximum power point tracker (MPPT) are simple and low cost, quick tracking under condition change, and low output power fluctuation. It is necessary to solve this problem by

using a more efficient method. Neural Network technology has attracted widespread interest in electrical engineering. Neural network modeling does not require any physical definitions for a PV array. Many number of algorithms available for the MPPT including perturb and observe, incremental conductance, parasitic capacitance, constant voltage, fractional open circuit voltage and fuzzy logic algorithms. These methods have disadvantages like costly, difficult to implement and non-stable.

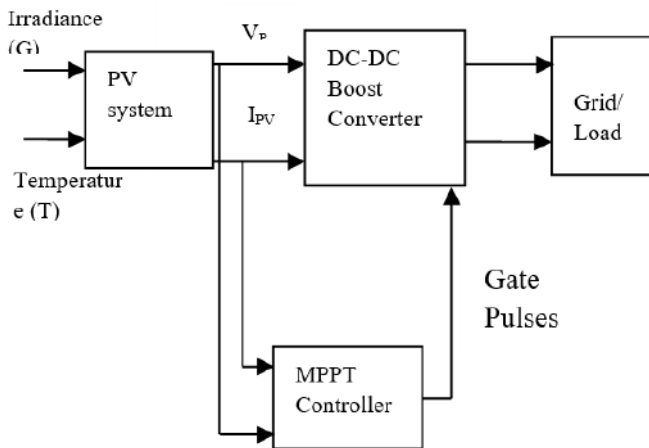


Fig. 1. Block diagram of a PV system.

A drawback of P&O MPPT algorithm is that, during steady state, the operating point oscillates around the MPP giving rise to the wastage of energy. Many improvements of the P&O algorithm have been proposed in order to reduce the number of oscillations around the MPP, but they slow down the speed of response of the algorithm to varying atmospheric conditions and decrease the algorithm efficiency during cloudy days. These problems can be overcome by using ANN. ANN is suitable to handle non-linearity, uncertainties and parameter variations in a controlled environment. Hence many number of ANN algorithms have been developed for this purpose [4, 5, and 6].

The uses of neural network in the industrial electronics have been increased, and have a large perspective in intelligent control area [7]. In this paper an ANN based MPPT is presented and trained with LM (Levenberg-Marquardt) algorithm and the Back propagation

method to extract the optimal voltage of the PV array which also decreases the tracking time to reach the MPP. The simulations are carried out to validate the proposed ANN method.

## II. PV SYSTEM MODEL

The Block diagram of a PV system is shown in Fig. 1. A PV cell can be represented by an equivalent circuit as shown in Fig. 2. A PV array consists of several photovoltaic cells connected in series and parallel. To increase voltage or amperage of a solar system, the solar panels can be placed in series (higher voltage) or parallel (higher amperage) or a combination of both. The characteristics of this PV cell can be obtained using standard equations.

The V-I characteristic equation of a solar cell is given as follows,

$$I = I_{ph} - I_s \left[ \exp\left(\frac{q(V + IR_s)}{kT_c A}\right) - 1 \right] - (V + IR_s) / R_{sh} \tag{1}$$

Where  $I_{ph}$  is a light-generated current or photocurrent,  $I_s$  is the cell saturation current,  $q$  ( $= 1.6 \times 10^{-19}C$ ) is an electron charge,  $k$  ( $= 1.38 \times 10^{-23}J/K$ ) is a Boltzmann's factor,  $T_c$  is the temperature of a solar cell,  $A$  is an idealist factor for a p-n junction,  $R_s$ ,  $R_{SH}$  are the series and shunt resistances respectively. The photocurrent mainly depends on the solar irradiation and the temperature which is given as,

$$I_{ph} = [I_{sc} + k_I(T_c - T_{ref})]\lambda \tag{2}$$

Where  $I_{sc}$  is the cell's short-circuit current at a 25°C and  $1kW/m^2$ ,  $K_I$  is the cell's short circuit current temperature coefficient,  $T_{ref}$  is the reference temperature of a solar cell, and  $\lambda$  is the solar insolation in  $kW/m^2$ . On the other hand, the saturation current varies with temperature, which is described as

$$I_s = I_{rs} (T_c - T_{ref})^3 \exp\left[\frac{qE_G(1/T_{ref} - 1/T_c)}{kA}\right] \tag{3}$$

Where  $I_{rs}$  is the reverse saturation current of a solar cell at a reference temperature and a solar irradiation,

$E_G$  is the band-gap energy of the semiconductor used in the cell. The idealist factor  $A$  is dependent on PV technology.

### III. MPPT ALGORITHMS.

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking is used to improve the efficiency of the solar panel. Several approaches have been proposed for tracking the MPP. Among those methods, the perturb and observe (P&O) and incremental conductance (INC) methods are widely used in spite of its oscillations around MPP and confusion by rapidly changing atmospheric conditions [8].

#### A. Perturb and Observe method

In this method, the controller adjusts the voltage by a small amount from the array and measure power. If the power increases, further adjustments in that direction are tried until power does not increases. This is called the perturb and observe method. P&O is the widely used MPPT method due to its ease of implementation. This method will result in high- level efficiency. The flow chart of this algorithm is depicted in Fig.3.

The advantage of the P&O method is simple structure, easy implementation and less required

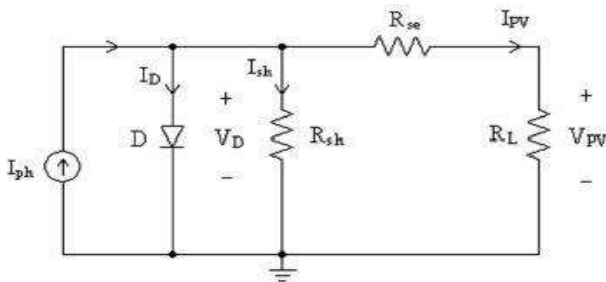


Fig. 2. Electrical equivalent circuit model of a solar PV module

Parameters [9]. The shortcomings of the P&O method can be summarized as follows:

1. The power tracked by the P&O method will oscillate and perturb up and down near the maximum power point. The magnitude of

oscillations is determined by the magnitude of variations of the output voltage.

2. There is a misjudgment phenomenon for the P&O method when weather conditions change rapidly.

#### B. The ANN-Model Based MPPT Algorithm

Neural Network has the potential to provide an improved method of deriving non-linear models which is complementary to conventional techniques. It is trained to derive non-linear PV array model and MPPT using back propagation and Radial basis function.

Back propagation an abbreviation for “backward propagation of errors”, is a common method of training artificial neural networks. It is an example of nonlinear layered feed-forward networks. Back propagation neural networks construct global approximations to nonlinear input-output mapping. The network has three layers, i.e. input, hidden and output layers. The input layer receives the external data, the second layer (hidden layer) contains several hidden neurons which receive data from the input layer and send them to the third layer (output layer), which responds to the system. The weights and biases of the network are adjusted in order to move the network output closer to the targets. All the layers of neural network have a hyper tangent sigmoid transfer function. The Architecture of Back-propagation Neural network for PV array modeling and MPPT tracking having two inputs, three neurons in the hidden layer and one output is shown in Fig.4. [4]. The ‘newff’ function creates a feed-forward back propagation network. It allows a user to specify the number of layers, the number of neurons in the hidden layer and the activation function used [7]. Under uniform shading conditions, the ANN is using the measurement voltage and power of PV is the input of ANN, the output is the reference voltage that the PV obtains the maximum power at.

In the ANN based MPPT method, it has two stages to track the MPP. These two stages are operated alternatively. In the first stage, the trained ANN has guided ( $V_{ref}$ ,  $I_{ref}$ ) to optimal point ( $V_{opt}$ ,  $I_{opt}$ ) which is close to MPP quickly and in the second stage the P&O is used to track the MPP exactly [11]. The Algorithm for the proposed method is described in Fig. 5.

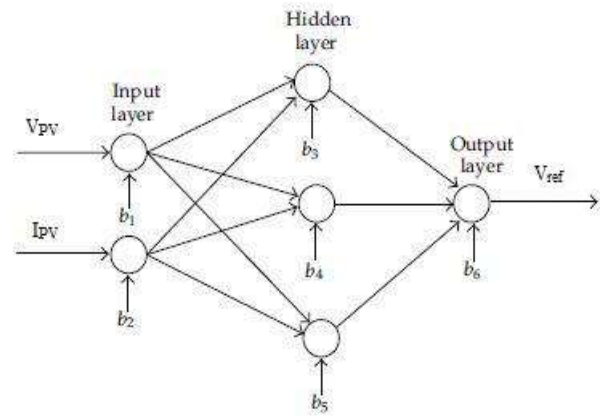
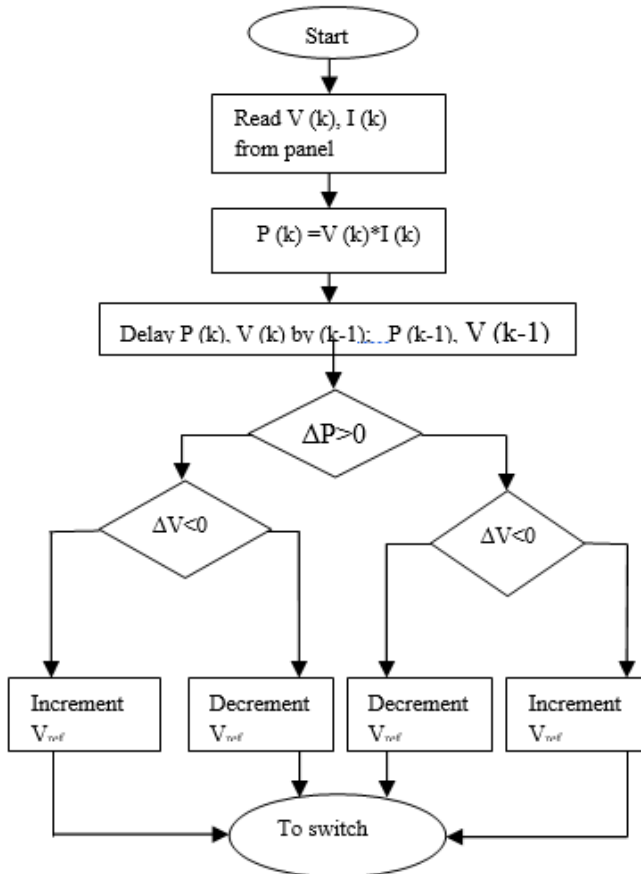


Fig.4. Architecture of Back-propagation neural network.



The training data are determined by using Matlab/Simulink to simulate the PV array. The net is obtained by training with trainlm function – Levenberg – Marquardt algorithm. After training, the network weights are set by the back-propagation learning rule. The weights and biases of the network are adjusted in order to move the network output closer to the targets. The Simulink block of an ANN is shown in Fig. 6.

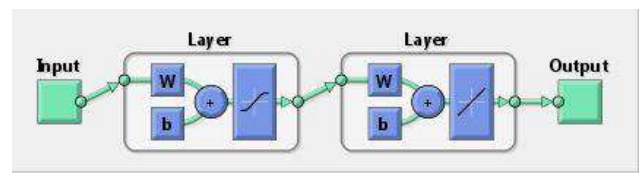


Fig.5. Back-propagation neural network for MPPT

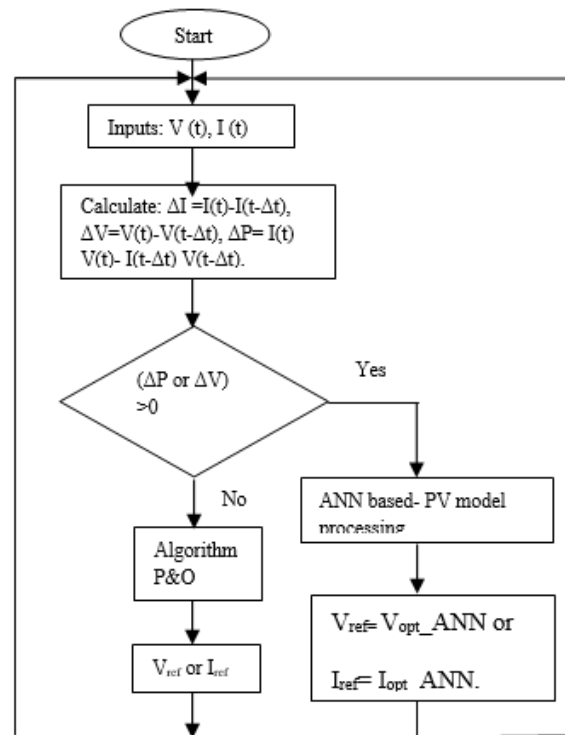


Fig.7. Simulink Block of an ANN

#### IV. SIMULATION RESULTS AND DISCUSSIONS



The Overall Simulink diagram of a PV system is shown in Fig. 8. Simulation studies have been carried out to verify the proposed Artificial Neural Network method and the results are presented. An accurate PV module electrical model is demonstrated in Matlab/Simulink. The PV and IV Graph under constant irradiance and temperature are shown in Fig.9.

Simulation of closed loop boost converter for solar installation is done using Matlab/Simulink and the results are verified. The closed loop system is able to maintain constant voltage. This converter has advantages like minimized hardware and good output voltage regulation [10]. The proposed method tracks to the MPP faster than the conventional P&O algorithm. The proposed method tracks to the MPP in 0.15s but the P&O algorithm tracks to the MPP in 0.42s.

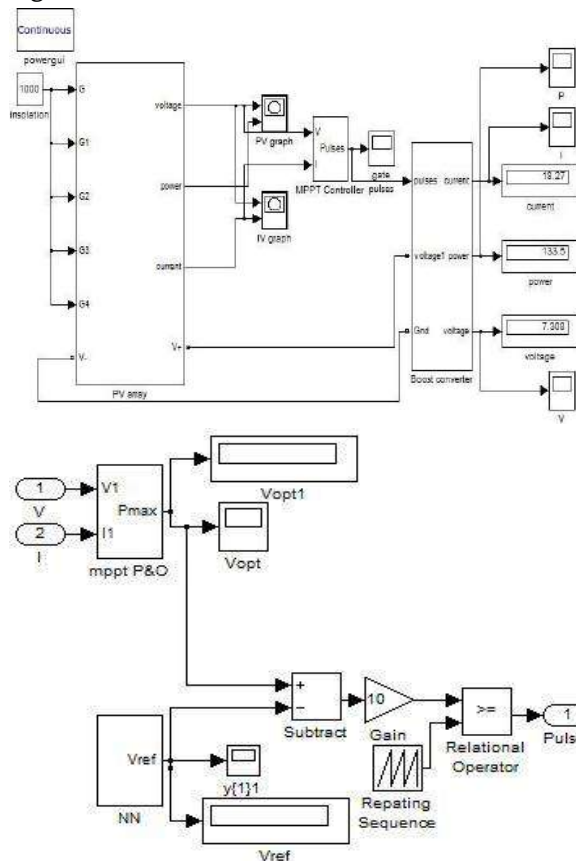
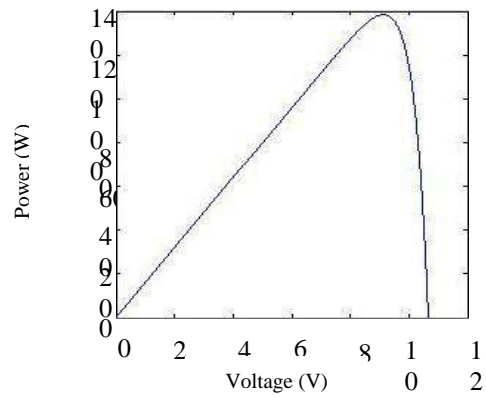
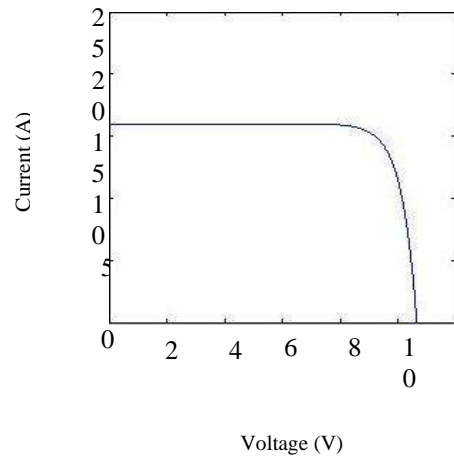


Fig.8. MATLAB/SIMULINK arrangement of entire PV system



(a)



(b)

Fig.9. Characteristics of a PV module under uniform Insolation (a)PV characteristics (b) IV characteristics.

The performance plot of ANN is shown in Fig. 10. Fig. 11 shows the maximum power and optimal voltage outputs of MPPT.

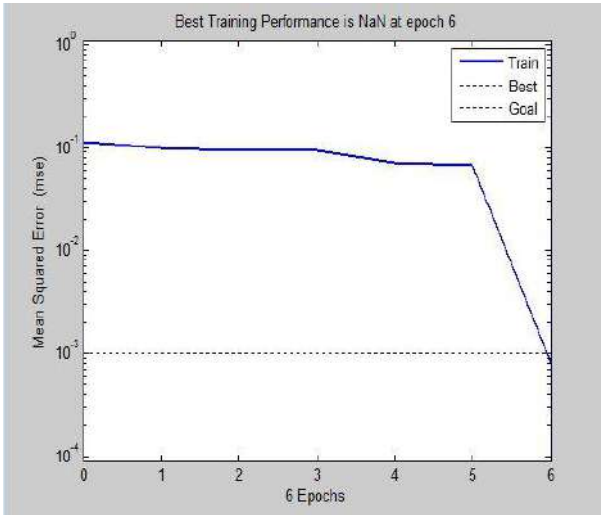
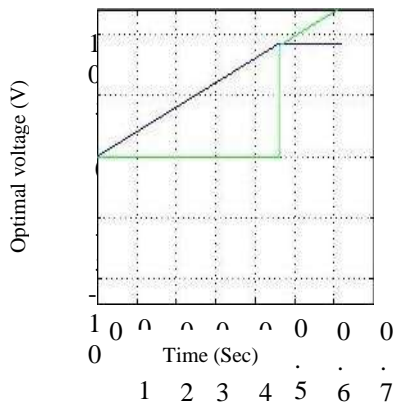


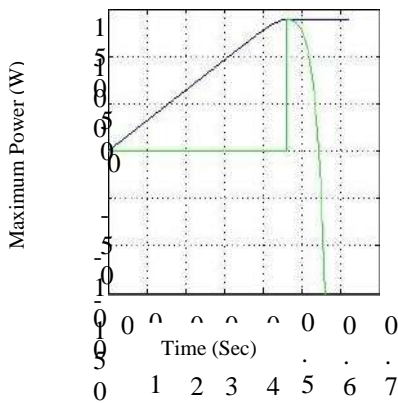
Fig.10. Performance plot of ANN

Table 1. Comparison of Conventional and Proposed Techniques:

S.No	MPPT Technique	Voltage (V)	Current (A)	Power (W)	Time to track MPPT (sec)
1	Conventional P&O	9.254	17.45	125.4	0.42
2	ANN based P&O	9.33	18.27	133.5	0.15

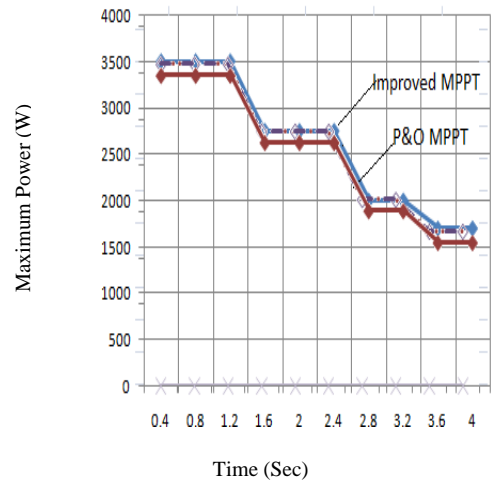


(a)

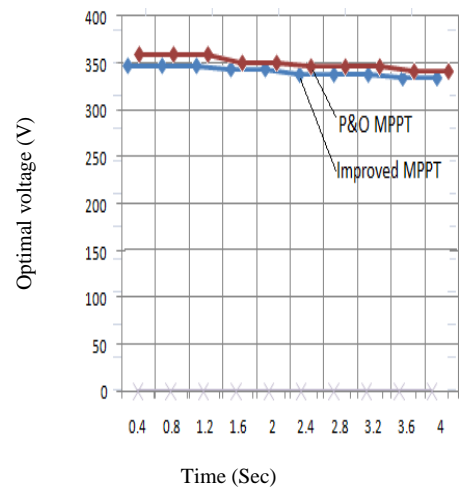


(a)

Fig.11. Outputs of MPPT (a) Optimal Voltage (b) Maximum Power



(a)



Time (Sec)

(b)

Fig.12. Comparison of conventional and improved MPPT Techniques (a) Maximum power comparison  
(b) Optimal voltage comparison

## V. CONCLUSION

This paper presents a Maximum Power Point Tracking (MPPT) controller based on Artificial Neural Network. A Matlab/Simulink model is used for photovoltaic system for uniform shading conditions. The error of P&O output (optimal voltage) is compared with the ANN output (reference voltage) and it is again compared with the repeating sequence to generate the gate pulses which is used to drive the DC-DC Boost converter. Compared to conventional MPPT techniques, the proposed ANN-based MPPT method can converge to target MPP very fast and track it without any oscillations as shown in Fig.12.

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# An Empirical Study of Security Challenges in Cloud Data Storages

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## ABSTRACT

A revolutionary process, cloud computing is transforming the way in which company hardware and software design and purchase are carried out. Because of the ease with which cloud data centers can be accessed, users are opting to transfer their data and application to cloud storages. However, the services and support expected from the cloud service providers to the users or towards the data stored by the users is not sufficient. Ease of access and round the clock availability of the data is not the only thing expected by the CSP. The integrity of the data, privacy of the data, and security of the data should be utmost responsibility of the CSP. According to this report, security rift, information theft, and unreliability of cloud-based data storage are all problems associated with the use of cloud storage. Finally, we are presenting potential cloud-based solutions to the difficulties that have been identified.

Keywords: Cloud Computing, Cloud Data Storage, Policies & Protocols, Security Issues.

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## I. INTRODUCTION

A revolutionary process, cloud computing is transforming the way in which company hardware and software design and purchase are carried out. Cloud service providers offer numerous improvement to public clients, including costless services, resource elasticity, and ease of entree over the internet, among others. Cloud computing is becoming increasingly popular. Cloud computing is already becoming incredibly popular among organisations of all sizes, from small to large, as a means of growing their operations and forging strategic connections with other businesses [1]. In regardless of the reality that cloud computing provides a plethora of benefits, many users are hesitant to store their confidential or sensitive

information in the cloud. This comprises personal health information, emails, and government sensitive papers. Take for example the scenario in which data is housed in a cloud datacenter and the cloud client loses complete control around their data sources.

Edge computing is a novel technology that puts processing and storage resources closer to the data source, reducing reaction times and saving bandwidth. Due to a variety of difficulties, cloud storage technology cannot meet the demands of IoT and mobile applications. These include lack of real-time services, bandwidth limits, expensive operational expenses, and worries about data privacy. These limitations of cloud computing open the door for edge computing, a technology envisioned globally to meet the increasing runtime and real-time requirements of

IoT and smart devices linked to the network, among other gadgets.

Cloud Service Providers (CSPs) have pledged to securing customer data hosted in the cloud using methods like firewalls and virtualization. These solutions would not guarantee full data security due to network flaws and CSPs' total control over cloud applications, hardware, and client data. Prior to hosting, sensitive data may be encrypted to protect data security and privacy. Encryption techniques are sometimes impractical owing to the enormous amount of communication overheads that arise during cloud access patterns. To preserve data confidentiality and anonymity, secure cloud data storage and management are necessary [2]. This research focuses on security flaws, as well as difficulties relating to consumer data confidentiality and anonymity.

The current access control methods, such as identification and cryptographic hash functions, can only cope with a limited number of internal risks. Academics are increasingly focusing on the implementation of information security in benefit smart cities. To summarise, edge of the network networks use a hierarchical system of border infrastructure server farms to manage smart phones and different machine learning duties formerly handled by restricted edge devices. Edge computing networks are gaining popularity.

Edge computing can help construct smart city applications by delivering location-aware, bandwidth-sufficient, real-time, private data, and reduced services. Edge computing has grown rapidly in recent years due to its benefits over cloud technology. Edge computing offers several benefits besides being a viable system software for significant infrastructure networking and other applications. However, by expanding real-world attack surfaces from several angles, its incorporation may increase security and privacy concerns.

While current research focuses on modelling security engineering, it ignores frequent node re-evaluation. Malicious nodes change their behaviour periodically, losing fewer data packets and increasing the network's

dispersed processing share. To successfully fight against internal assaults, smart city networks need a more comprehensive approach to dealing with rogue devices that compromise security and privacy. The authors of this study investigated the current CC mechanisms working across smart city networks. We specified durability, scalability, computing, non-repudiation, compatibility, information derivation, networking life, and quality of service criteria.

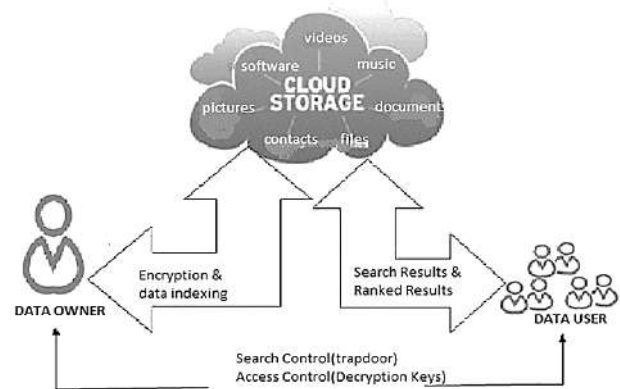
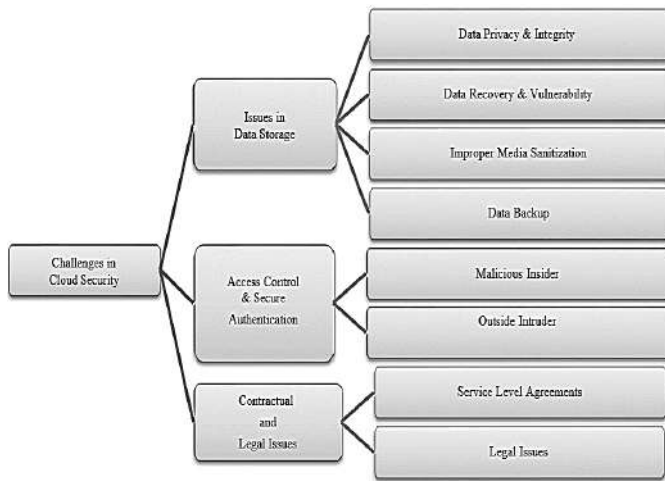


Fig. 1. Environmental factors

## 1 Challenges & Issues in Cloud Data Storage Infrastructure

There is no control over the data that is stored in cloud data centers since cloud computing does not provide that control. With complete control to the data, cloud service providers can execute any nefarious operations such as copying, erasing, or manipulating the data without being detected. Cloud computing provides a certain measure of influence over through the virtual machines because of its distributed nature. There are many more security issues associated with this absence of confidentiality and privacy than it does with the typical cloud infrastructure, as illustrated in figure 1. The sole encryption method does not provide complete control over the data stored, but it does provide a level of protection that is superior to plain data. Aspects of cloud computing that distinguish it from the generic cloud model include virtualization and multi-tenancy, as well as more attack opportunities than the generic

cloud model. The figure 2 contains a number of difficulties, which are described in greater detail below.



**Fig. 2.** Challenges in Cloud Storage Security

### 1.1 Issues in Cloud Storage

There is no control over the data that is stored in cloud data centers since cloud computing does not provide that control. With complete control to the data, cloud service providers can execute any nefarious operations such as copying, erasing, or

#### 1.1.1 Data Integrity and privacy preservation

Regardless of the fact that cloud computing is less costly and uses less resources, it poses significant security risks. Because of the above criteria, cloud computing must secure the confidentiality, integrity, data availability and user privacy in the generic cloud computing model. However, because of the above conditions, the cloud computing model is more exposed to security attacks than other computing models. Because of its ease, cloud users are growing at an exponential rate, and the number of applications hosted in the cloud is increasing rapidly. As a result of these circumstances, cloud clients are exposed to additional security risks. If an attack on a provided by individuals is successful, it will result in a data breach, which will allow unauthorized access to the data of any and all cloud customers. The multi-tenant nature of cloud data was lost as a result of this integrity violation.

Particularly vulnerable are SaaS companies, who may also lose their scientific information and face significant risks in terms of data storage. Additionally, data processing is fraught with danger when data is being converted among various tenants, in addition to these hazards. Because of virtualization, users can share a large number of physical resources among themselves. As a result, cybercriminals of such CSP and/or organisations initiate attacks against the CSP and/or organisations. These circumstances may provide an opportunity for a rogue user to launch attacks against encrypted information of other customers while analyzing this data. Another significant risk occurs when data is transferred from the CSP to a third-party storage facility [5]. The authentication process and key distribution processes in security for cloud computing are not yet fully standardized to meet industry standards. Although typical cryptography methods perform well in a general cloud computing architecture, they do not perform well in the absence of a standard and safe key management system for the cloud. As a consequence, cryptography is useful in mitigating the risks connected with cloud computing.

#### 1.1.2 Data recoverability and vulnerability

As a result of the capacity pooling and elasticity properties of the cloud, customers can take advantage of variable and on-demand resource supply. The resource that has been assigned to a certain user may be transferred to another user at a later time. Malicious users can utilised data recovery techniques to get the data of prior users if they have access to computing and storage resources [13]. Amazon machine picture data were recovered 98 % of the time, according to the authors of [13]'s research. The computer forensics vulnerability has the potential to cause significant risks to confidential user information.

### 1.1.3 Improper media refinement.

The storage media are sanitized for the following reasons: (i) the disc may need to be replaced with another disc; and (ii) the disc may be corrupted. In addition, there is no longer the need to even maintain the disc, and there is no longer the same need to manage the services. Improper refining creates a significant risk to stored information. It's not really permitted to improve in a multi-tenant cloud because the tenant is the previous tenant.

### 1.1.4 Data backup

When there is an inadvertent and/or planned calamity, having a data backup is critical. In order to maintain data availability, the CSP must undertake routine copies of the data stored. The backup data, in reality, should adhere to strict security requirements in order to avoid hostile behaviors including such modification and unauthorized access from occurring.

## 1.2 Access Control and Identity Management

Multifactor authentication and information security are crucial components of securing data and services. It is vital to maintain track of who has used the system to avoid unauthorized access. Identity and access control issues arise in cloud computing since the data owner and the data being stored are on different executive platforms. Businesses use a variety of authentication and authorization strategies in the cloud. Using many authentication and authorization methods over time creates a difficult scenario. When stated before, cloud users' IP addresses change often as services, such as backups, are performed or resumed. Cloud users may engage and leave cloud resources as required, taking advantage of on-demand access policies. All of these issues demand efficiency and efficacy in identity and authenticity management. The cloud's identity management system must be kept current and manageable promptly so users may join and depart cloud resources. On the other hand, XML wrapping

attacks on web sites, for example, are a worry with weak credentials that can be easily reset.

### 1.2.1 Malicious Insiders

An organization's workers, contractors, and/or third-party business partners can all represent a threat to the organization's security. Cyberattack against the cloud environment, namely on the Cloud Service Provider (CSP) side, result in the loss of the validity, authenticity, and protection of the user's information. As a result, network failure or intrusions occur in both of these situations. This attack is quite valuable, and it is generally known to the majority of the organisation [7]. Because of the sophistication of insiders' understanding of the inner architecture of an organization's data storage structure, there is a wide range of attack tactics that they can employ. The majority of organisations are ignoring this attack since it is extremely difficult to defend against and impossible to discover a comprehensive answer to this attack. This attack poses a significant danger in associated with data thefts and unauthorized disclosure, both within the enterprise and in the cloud [8].

### 1.2.2 Outside Intruder

Outsider attacks [3] are defined as attacks that originate from outside the organisation. Information security is amongst the most essential concerns when it comes to cloud computing. Because service providers do not have access to a particular protection system of data centers, they cannot deliver services to customers. However, if they want complete data protection, they must rely on the infrastructure provider. A private networks cloud environment is one in which the network operator can only define the security settings remotely, and we have no way of knowing whether or not such settings have been effectively implemented. In this Procedure, the resulting in a stronger must achieve the following goals: (1) confidentiality, which allows for safe data transfer and access; and (2) auditability, which allows for data auditing. In order to



prevent outside intruders from accessing sensitive data that is kept in the cloud.

### 1.3 Legal Contractual Issues

Following the transition to a cloud computing systems, there are numerous concerns to consider, including regional authorities, subordinate legislation, deserved promotion, contract enforcement, and so on. The above-mentioned difficulties fall under the categories of legality, Service Level Agreements, and network infrastructure location [9].

#### 1.3.1 Service level agreements

When it comes to cloud computing, the Contract Agreement can be considered a protocol because it establishes a number of requirements and agreements between such a subscriber and the cloud computing service provider, which can be considered a protocol in its own right. The SLA should also include the following clauses to protect the parties: If there is a data breach, CSP will take steps to rectify the situation and maintain a minimum level of service [5]. Users ought to have a clear awareness of the privacy of their capabilities, and any specific provisions should be discussed and agreed upon prior to the execution of the service agreement. It is getting increasingly difficult to enforce contracts attributed to the reason that the data provided by CSP are absolutely unverifiable. The agreements must always be discussed in a collaborative manner between the CSP and the end user due to the fact that they are non-negotiable and pre-define. Whether to comply with regulatory standards like as Sarbanes-Oxley and HIPAA [10] becomes an issue of whether to comply or not.

#### 1.3.2 Legal Issue

The regulatory issues occur as a result of the availability of CSP resources in a number of legal authorities that are physically in conflict with one another [11]. If a user is transferred from one geographical location to another, a problem may arise as a result of the different legal jurisdictions. For a

movement, data is split over a number of data centers, each of which is owned by a different CSP and each of which has its own set of rules and security guidelines. This process has the potential to create a severe problem in cloud computing.

## II. Literature Review

In this part, we discussed the research effort approaches while also providing a thorough explanation of the subject matter. Tables are used to present the findings so that the reader may readily comprehend them. There are various sub-chapters that might be used to explain the topic.

### 1.4 Solution for Data Storage Issues

The computer combines this block into a circuit specification [9] that is not exposed in any other blocks since it has no transmitted characteristics. Fair-play promotes two competing entities to make best use of resources and achieve favorable results. Unlike Beaver's underlying FairplayMP protocol, which has a fixed number of touches. New features and major improvements have been introduced to the present methodologies as part of an ongoing collaboration effort to modernize the BMR. Given that the number of rounds used in the procedure is important to the protocol's final efficacy, we should use this method.

It is typical practice for small groups inside larger organisations to distribute documents among themselves to successfully complete tasks while remaining concealed from others. User groups and documentation develop throughout time, therefore users need a document indexing system that enables them to find documents quickly without (1) divulging additional document information, (2) burdening administrators, and (3) requiring users to trust just one authority. [10] captures the notion of privacy, which is defined as the degree to which information escapes from the index in conjunction with anything like the constraints specified in the restricted item. These

techniques also leverage secret divisions and term mergers to set adjustable constraints on information leakage, even in reaction to statistical assaults. These tools are supplied.

This document [11] eliminates the need for a confidential authority. The study offers a solution based on centralised PPI with distributed search compliance access control mechanism. Even after the index is produced, this PPI keeps all information private. This gadget has been tested in the field. Second, system implementers maintain total control over the balancing of privacy and efficiency in their individual domains or document searches when employing PPI applications on their systems. Situations and words invest them with significance. The author presents the first e-PPI attempt for statistically differentiated distributed record search and privacy protection.

Subashini and Kavitha [12] performed a survey on healthcare service delivery model security vulnerabilities. Insecure storage, cookie manipulation, and insecure configuration are some of the data security vulnerabilities that may arise in the SaaS model. Network security problems, session management weaknesses, and dangerous SSL trust setting are validated in the SaaS paradigm.

Varsha et al. [13] reviewed cloud computing security challenges and recognised the Cloud Security Alliance's top seven security weaknesses (CSA). The analysis identifies multi-tenancy as the biggest security risk.

Wei et al. [14] identified two primary cloud computing security classifications: Cloud Storage Security (CSS) and Cloud Computation Security (CCS) (CCS). CSS refers to the security of data stored on unrecoverable cloud services. The CCS value shows the computation accuracy of unreliable cloud servers. This paper proposed a novel core Sec-Cloud structure and thoroughly discussed its functioning. The study detailed three kinds of attacks: Storage cheating attack models, computation cheating attack models, and privacy cheating attack models are all types of storage cheating attacks. A scalability and reliability study has

also been performed to show the recommended protocol's efficacy. The SecCloud protocol solves issues with cloud storage and computing.

Taxonomies of security issues, DDoS assaults in the cloud, and DDoS defence solutions in the cloud were presented by Gupta and colleagues [15]. The article detailed the technique of a DDoS attack as well as countermeasures. The essay also addresses Cloud security risks. Cloud service delivery methods allow for DoS attacks, DNS server assaults, Mac address attacks, impersonation, cross-VM attacks, security breaches, privacy invasions, cross-site request forgery, authorization violations, infrastructure damage, and other security flaws. The essay also compares and contrasts numerous DDoS defence methods.

Multi-tenancy, elasticity, insider and foreigner attacks, inability to manage, data leakage, etc. were all mentioned. Data encryption, data auditing, safe information management information integrity and privacy, SQL-injection attack solution, and flooding attack are examples of security techniques given by Khan et al. To keep your cloud environment secure, employ SAML, Universal Identification, OpenID, and SSL/TLS.

The Cloud Service Provider commences the revocation procedure automatically when the time period associated with each user expires (CSP). This time-based encryption solution allows users to exchange credentials with the CSP in the past and request re-encryption keys in the present. The ABE protocol ensures access control by examining attributes rather than individuals. This strategy ensures data confidentiality and accessibility for certain members of the group, but not for all.

Rather of rebuilding the tree from scratch each time, random selection was employed to reduce computational repetition. A number of significant recommendations for data security and adequate key management have been released by the Computer Security Alliances (CSA) [18]. The credential's scope should be handled by a group or a person. Poor cryptography approaches should have been avoided at

all costs. The finest rules for multifactor authentication and cryptographic algorithms solutions should be followed, and it is preferable to use heuristic detection technology to optimize data security while being stored on a computer system. The customer or businesses, as well as any trusted third parties, should practise sound key management practises. If the auditing protocol is constructed incorrectly, the encryption process may be used to restrict the transmission of data to third party companies even during auditing process. However, encryption in and of itself cannot prevent data from being transmitted to

third parties, but it can restrict it to a bare minimum. However, it necessitates a large number of key management processes as well as significant overhead for key generation when storing data. However, the disclosure of an encryption key results in data leakage, which continues to be an issue in cloud environments. This issue has been addressed by integrating the elliptic curve authentication mechanism with both the randomized disguising procedure [19], which is described in detail below. Table 1 shows an illustration of this concept.

**Table 1.** Cloud data storage issues comparison

Ref	Methodology	Integrity	Confidentiality	Availability	Privacy
[12]	Cloud data security using Bilinear Pairing Encryption Data Integrity checking by Third Party Auditor	✓	✓	✗	✓
[15]	Data Integrity and Privacy Preserving through FADE Threshold secret sharing	✓	✓	✗	✓
[16]	Secure data sharing in cloud through Attribute based encryption	✗	✓	✗	✓
[17]	Resident Data Security and Data Redundancy through Erasure correcting Code	✓	✓	✓	✗

**1.5 Access Control Solutions and Identity Management**

Simple Privacy-Preserving Identity Management for Cloud Environments (SPICE) was proposed by the authors in [20] for use in identification and authentication systems. The SPICE ensures group signature in order to provide unidentifiable identification, access control, accountability, unlink ability, and participatory design authorization, among other functions and features. The SPICE gives the above-mentioned capabilities with nothing more than a single registration, making it extremely convenient. After registering with a reputable third-party, users are issued a unique set of credentials that

can be used for all of the benefits rendered by CSP. The authentication certificate is generated by the user when the credentials are used. Different CSPs require a range of authentication qualities, and the user must generate the appropriate form of identification certificates using the same credentials for each CSP's requirements.

In [21] the author proposes the Role Based Multi-Tenancy Access Control (RB MTAC), which is a type of multi-tenancy access control. The RB MTAC is a combination of a role-based access control scheme and an identity management system. The user must first register with the CSP in order to receive a single certificate that should have been distinct from other credentials. During the

registration process with the CSP portal, the user must select a password. In order to gain entry into the cloud environment, users must first pass through into the identity module, which uniquely identifies the user, and then they are directed to the role assignment module, which determines the relationship to the RB MTAC database and assign appropriate roles to registered users based on the information that has been enrolled.

Several researchers, including Dhungana et al. [22], have proposed a method for public telecommunication protocols as an authentication and authorization

architecture, which is maintained using the Users maintained Accessing (UMA) protocols, which would be discussed in greater depth below. In this situation, CSP acts as a host, while the authorized user acts as the operator (or service provider). Users who seek services are likewise managed by the authorization manager, who is in charge of the service administration and service requesting users. With the support of authorization management, this scheme is able to provide multifactor authentication and network management across a wide range of Cloud service providers. As seen in the accompanying Table 2, there are several options.

**Table 2.** Access Control in Cloud Environment System Comparison

Ref	Methodology	Services	Access Control	Authentic ation	Identity Managem ent	
[23]	Identity Management Framework (IMF), SPICE	Anonymous and Delegable Access Control	✓	✓	✗	<input type="checkbox"/>
[24]	Role Based Access Control	Role Based Access Control	✓	✓	✗	<input type="checkbox"/>
[22]	IMF	Identity Based Access Control	✓	✗	✓	<input type="checkbox"/>
[25]	Decentralized Access Control	Attribute Based Encryption	✗	✓	✓	<input type="checkbox"/>
[26]	HASBE	Cloud Access Control	✓	✓	✗	<input type="checkbox"/>

### III. CONCLUSION

Dynamic data software is stored in the cloud with the least amount of administration labour, and on-demand services are supplied to clients via the internet as a result of the cloud services infrastructure. The opposite is true for customers who, when it re-lates to cloud management, do not have dependable pledges or procedures in place. Because of this, there will be several security concerns associated with data storage, including those relating to privacy, privacy, reliability, and accessibility. We focused on data storage security concerns in cloud computing in this study, and we began by outlining cloud platform models, deployment methods, and a variety of security issues related with data processing in a cloud computing systems. Finally,

in the con-cluding section, we examined different solutions for information storage challenges inside the cloud infrastructure that guarantee privacy and secrecy.

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# Security Threats to Internet of Things : A Survey

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## ABSTRACT

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Internet of things (IoT) is an emerging technology in the present era. The term IoT refers to as an interconnection of several smart nodes through some heterogeneous link for the purpose of data communication. Some particular protocols control the entire communication in IoT. Due to plenitude of devices, it becomes a huge task to check the loyalty status of each node which is going to be a part of IoT environment. These nodes sometimes get involved in some malicious activities which may cause critical threats to this environment. These anonymous activities may include some attack on the working or security of IoT. In this uncongenial circumstance we need a strong security measurement to countermeasure these attacks. Innumerable efforts have been made to improve the security of IoT. This paper is an effort to make a glance of some of these security schemes

**Keywords :** IoT, Cyber Threats, Network Security, Communication

## I. INTRODUCTION

The growing speed of technology led several innovations for the sake of convenience to human beings. IoT is one of these technologies. It comprises almost all the fields of our life. The human interaction to machines is reduced to some extent in this technology. Many nodes or even many smart buildings are in connection with each other to perform communication in a fast and responsive manner. Following figure 1 explains the connectivity architecture of IoT.

The size of this IoT networks grows along with new incoming devices in this environment. To check the security of all these new devices is almost impossible. Therefore, a few times these devices may create some

challenges to this entire environment. Due to its wide range of applications, these critical challenges are need to be troubleshoot. In this way we are in need of strong security check some to secure of IoT system from all internal and external security threats. There may exist some attacks or some other anonymous activities to harm the working or security of IoT. There may also be another desire to shake the privacy of IoT users. We have categorized some of these attacks as follows in figure 2.

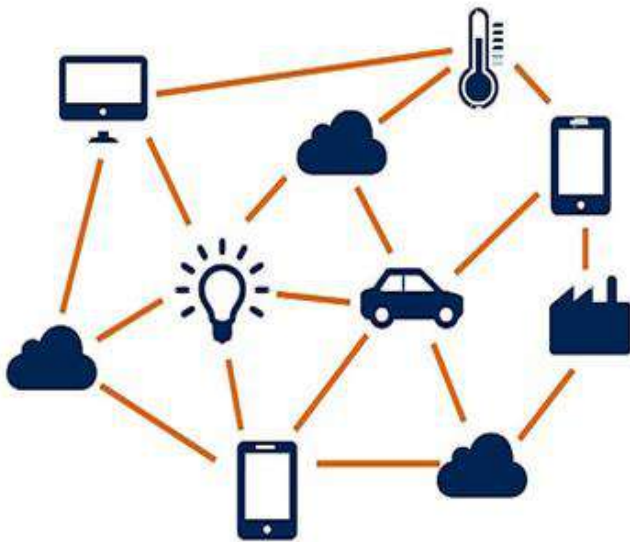


Figure 1. IoT Architecture

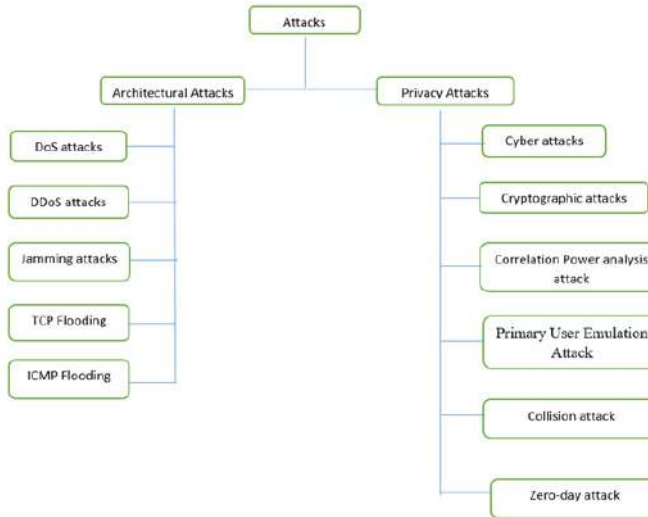


Figure 2: Attacks Category

These attacks categorized into two main categories. Architectural attacks and privacy attacks [1]. The architectural attacks concerns with the working and routing behavior of IoT environment. These may include denial of services attack (DoS), jamming attacks and transmission control flooding (TCP) etc. [2]. The main purpose behind these attacks is to create disturbance in the working of IoT mechanisms. The other type of attacks is attacks is privacy attacks. These attacks are launched to shake the privacy of users. Some of these attacks are directly triggered on the data collection and some of them are concerned with the ways to get illegal access to user’s data. The attacks are sometimes physical or sometimes in cyber form [3].

With the advent of cloud computing, the IoT technology gain faster momentum. All of the data is being stored on the cloud to make it available for everyone. Cloud computing makes over lifer easier however there is a major drawback of this technology. An attacker can gain illegal access to cloud and can manipulates the bulk of user’s data which has been stored on the cloud. Here comes the concept of cryptography in which the data is stored in an encrypted form. This thing hinder the attacker to manipulate the data facts [4]. The spreading quantity of smart nodes enhances the chances of architectural attacks. Ere sometimes occurs a process in which nodes send a bundle of simultaneous requests to the main server. If the quantity of compromised nodes is limited, then this attack is simple called DoS. However if the requests are being sent from more than one node then this attack is known as distributed DoS [5]. Following section contains scientific work related to this domain.

## II. LITERATURE REVIEW

IoT covers almost all the aspects of communicational sciences. This is because of its proper architecture and involvement of several devices in connected with each other through heterogenous communication links. The communication links between these devices may cause some security threats to entire IoT. In other words, it arises a strong need of a proper security model in order to achieve secure and efficient communication. Innumerable efforts has been made to deal with security aspects of IoT. Here we discussed some of scientific contribution related to this space. Authors in [6] presented a honeypots security model to prevent an IoT server against DOS attacks. In IoT. Several devices are integrated with the help of high quality sensors. The main purpose behind this integration is exchange of data and rapid response among these devices. However if some devices continuously send an innumerable amount of data to the server, the functionality of server becomes slow and sometimes server is crashed. To overcome this



problem, honeypots comes with its unique characteristics of seducement and acts as a decoy in the main server in order to mitigate attack on the main server.

Presence of large volume of IoT devices enhances the probability of security threats in IoT. Furthermore the high level of heterogeneity in these devices also plays a vital role to invite attacks on such type of networks. A software defined networks based framework is presented in [7] called softthings. This framework consists on the main master controller which is integrated with IoT devices to reduce the burden on them. This master controller makes the under contention framework capable to detect and diminish the influences of common security threats like TCP flooding, internet control messaging protocol (ICMP) flooding and DDoS attacks.

Cloud computing is an emerging technology in the present era. It makes everything available for everyone at any time. Different servers are integrated with cloud to outsource valuable data on cloud. In some circumstance cloud computing technology works with IoT to magnify the effectiveness of IoT. However, besides the benefits of this combination, this phenomena led a little bit security challenges for IoT. An illegitimate user can gain unauthorized access to these servers and hence privacy of user's can be shacked. In [8], authors presented some cryptographic approaches to encrypt user's data in order to keep it secure in case of any attack.

Another security model based on advanced encryption standard is presented in [9] to secure IoT against correlation power analysis attacks (CPA). In CPA, the attacker intended to get the secret encryption key by analyzing the relation between input and power consumption. For the sake of eliminate the possibilities of this attack, a false key and wave dynamic differential logic (WDDL) assisted advance encryption standard (AES) technique is used.

In [10], authors presented a methodology to detect the presence of any intruder in the mesh of IoT devices. Due to plenitude of IoT devices, it becomes difficult to

indicate the compromised node. However, the proposed idea of authors is capable to identify suspicious events within the network.

Another type of threat on IoT security is discussed in [11]. Suppose an IoT environment, where some secondary user or a third party manipulates the facts by announcing itself as a primary user. The motive behind this scenario would be either desire to get unauthorized access or it may be another desire to perform some malicious activity within the network. Such type of attack is referred as primary user emulation attack (PUEA), Authors proposed two-tier device-based authentication protocol (T2DAP), to provide a solid defense against this attack. Simulations are performed to test the effectiveness of this protocol. The results shows that proposed protocol is minimize the chances of under contention attack to a notable extent however, here it arises the problems of high energy consumption.

In [12], collision attacks and their countermeasure is discussed. The basic architecture of IoT environment is an ideal place for such types of attack to occur. A fog computing based model is used as an antidote for this attack. This model has also some characteristics of software defined networks (SDN) system layer to provide the facility of easily integration of fog nodes. . Both these features get combined to make the system capable to identify the presence of collision attack and malicious user who intending to perform this attack.

In IoT environment, the existence of various heterogeneous links maximize the possibilities of some malware or some other malicious program to get in. These programs give birth to many cyber-attacks in IoT space. Here we need a secure framework which resists the incoming of malicious programs from different nodes. Same type of security scheme is presented in [13], which reduces the malware spreading to a fixed limit like device to device connection. And hence the target bandwidth of malware is lessened within the IoT environment.

In [14], authors proposed an intrusion detection system (IDS) to expose wormhole attack. Wormhole attack

concerns with the routing behavior of network during communication. The occurrence of this attack creates a tunnel in between of two negotiated routers. All the traffic flow diverts toward that particular tunnel because this tunnel exhibits itself as a shortest path of data flow. In this way routing mechanism is badly disturbed and may causes many of serious issues regarding data transmission. The under contention IDS has contains efficient algorithm which can easily monitor routing activities and detect wormhole attack. Another security treat known as zero-day attack has considered in [15]. This attacks refers to the security lope holes in during the software designing for IoT. A distributed diagnosis system based security approach

has been used to legitimate this attack. In this approach, there exist an integration between central service provider and local user cite. If the attack occurs, then after its identification a special data sharing protocol is used which ensures sending of alert messages and also build a trust between network entities and IoT nodes. The presented approach also prove its efficiency in terms of network cost and communication overhead. Deep Learning has also proven its ability in different fields, i.e., allocation problem [16], selection and evaluation [17], threat detection [18-19], and disease detection [20]. Here we explained all of above-mentioned literature review in the following table:

Table 1: Existing Literature

Ref:	Published Year	Attack Name	Attack Description	Countermeasure	Achievements
[6]	2017	DoS attack	A node send a lot of requests to server which disturbs the functionality of server	Honeypots	mitigation of attack
[7]	2022	TCP flooding	An extreme flow of data to distract the working of server	SDN based framework, Softthings	Detection of attack, efficient communication
[8]	2017	Cyber attack	Attacker can gain remotely access to network to perform malicious activities	Cryptographic approaches	Attacks are stooped to a notable extent
[9]	2017	CPA	In correlation power analysis attacks, the attacker tries to obtain the secret encryption key	WDDL based AES	Encryption of data
[10]	2017	Physical Attack	Attacker gain physical access to attack the system	IDS based algorithm	Identification of malicious activities
[11]	2017	PUEA	In Primary User Emulation Attack, the secondary user acts as a primary user	Two-Tier Device-Based Authentication Protocol	Effective authentication process
[12]	2017	CA	Collision attack consists on illegal tries to get system compromised by get combined all the available information.	A fog computing based model	Prevention against collision attack
[13]	2017	Malware attacks	Viruses or malicious activities are injected in the main network through some compromised node.	Malware defensive mechanism	Malware and malicious programs are banned
[14]	2020	Wormhole attack	This attack disturbs the routing behavior of network	Intrusion detection system	Security of IoT
[15]	2018	Zero-Day attack	Attacker tries to attack the system by finding weakness in the software design of system.	A distributed diagnosis system based security approach	Effective security accomplishment

### III. CONCLUSION

There exist a vast range of IoT applications in almost every field our daily life. All this making our life easier day by day. However there also exists some threats to this IoT environment. There may be some internal or external factors which may cause problems to the working or security of IoT. Internal threat are due to wide range of devices which are connected in surrounding of each other. Compromised behavior of any one of them may cause serious risks to IoT. All these challenges comes with a strong need of some security frameworks. In order to secure entire structure and data protection in IoT, plenitude of scientific schemes have been proposed. All of these schemes proves their efficiency in terms of security. However there is still a tradeoff between security and efficiency of IoT.

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# Design and Synthesis of certain Novel Peptides for Dual Selective Activity of Specific Cells

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## ABSTRACT

Cancer and the multi-resistant diseases that plague people today must be controlled to lower mortality rates. With the low susceptibility to resistance, the design and synthesis of peptide assembling was a superior alternative upgrading source for future chemotherapeutic medications. This paradigm first appeared in the pharmaceutical industry. It has been demonstrated that specific peptides exhibit dual functions as antibacterial and anticancer peptides (ACPs). Using a minimalized approach, a 10-residue peptide P1 and Rhodamine tagged peptide P2 were designed and synthesized using solid phase peptide synthesis method (SPPS) for selective activity against microbial and cancer cell lines. Peptide P1 contains RGD sequence has a net charge of +2 and peptide P2 has net charge of -4. The peptide P1 and P2 are characterized by using spectroscopic techniques. Circular dichroism studies showed changes in the secondary structure of peptide 1 and peptide 2 with buffer. Cytotoxicity assay exhibited the viability of normal and cancer cells up to 5 µg concentrations of peptide 1. Thus, Peptide 1 acts on therapeutic properties like antibacterial and anticancer. Both peptide activities are checked against gram-positive and gram-negative bacteria at lower concentration. We can ensure the toxicity level of designed both peptides. Peptide P1 and peptide P2 sequence are non-toxic and recognition of selective activity against cancer cells.

Keywords : Designed Peptide, Antimicrobial Activity, Hydrophobic, Solid-Phase Peptide Synthesis, Cytotoxicity

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## I. INTRODUCTION

Currently, the world is faced with complicated diseases encountered by various viruses, fungi, bacteria and

cancer cells. Therapeutic peptides influenced some factors needed for drug resistance, lack of tumor selectivity and solubility. Recently many cancer therapy has been developed, but anticancer peptide

(ACP) as lesser side effect compare to that of other therapy methods. Antimicrobial peptides<sup>2,3, 43, 44</sup>, (AMPs) are the host defense peptides, (Tossi et al., 2005). with most of them being the cationic (positively charged) and amphiphilic (hydrophilic and hydrophobic)  $\alpha$ -helical peptide molecules—above instructions beneficial synthesis of peptide work. Modify peptide sequences in RGD-like amino acid residue with more biological properties and capabilities. Cationic peptides have most probably played antimicrobial activity. We have discussed AMP, especially positive charge amino acid arginine; more in the sequence. RGD peptide sequence has tumor-homing efficiency in the literature survey. Likewise, peptides<sup>1</sup> containing Arg-Gly-Asp (RGD) 13 motifs have been identified and used to target tumor cells. Another anionic peptide modified sequence iEFA as followed by Fmoc-chemistry protocols<sup>4</sup>, the designed anionic peptide can be expected to bind bacteria that are resistant to cationic peptides<sup>15</sup> and drugs. A minimalist design approach has been adopted to find a short active segment of antimicrobial peptides in the present study. Using MSI-367 as the template peptide, a decapeptide segment was identified. Since the cationic nature of MSI-367 (Ayyalusamy Ramamurthy et al 2010) has been attributed to its activity against bacteria, the lysine amino acids in the sequence were changed to (Perumal & Pandey et al., 2013) glutamic acid. Thus, the designed anionic peptide can be expected to bind bacteria that are resistant to cationic peptides and drugs. Mostly electrostatic interaction between peptide and surface of cell membranes. Modify both synthesis decapeptides as activities checked normal and cancer cells. A current study showed that both iRGD and iEFA peptides depend upon the amino acid sequence's ability to penetrate tumor tissue. We to make design and synthesis curable diseases of the antimicrobial peptide and anticancer drug deliver peptide. The designed peptide was a possible secondary structure like  $\alpha$ -helix,  $\beta$ -sheet,  $\beta$ -turn and random coil. Secondary

structure<sup>11</sup> helpful to antimicrobial activities of the peptide. Those peptide activities against Gram-positive and Gram-negative bacteria and cancer cells. N-terminal modification and Rhodamine attached peptide are potential of the drug deliver agent's chemical, biological properties and selective cancer cells. Efficiency of design peptide needed physicochemical properties, amino acid composition and the addition of chemical groups on the (Chiangjong et al. 2020) ACP sequence influences their conformation, net charge and exposure of the secondary structure, leading to an effect on targeting particularity and ACP-cell interaction, as well as peptide insertion capability, stability and efficacy.

From the above literature review, we design and synthesis of RGD sequence containing peptide P1 which is over expressed in cancer cell<sup>31</sup> shows better anticancer activity compares to that of peptide P2 and Circular dichroism shows both peptide P1 and P2 having secondary structure from unordered structure. It helps to determine the selective activity of specific cells, because cationic peptide P1 is slightly preference to bind with anionic membrane of both cancer cell and bacterial cell.

## II. METHODS AND MATERIAL

### 2.1 Chemicals and Reagents

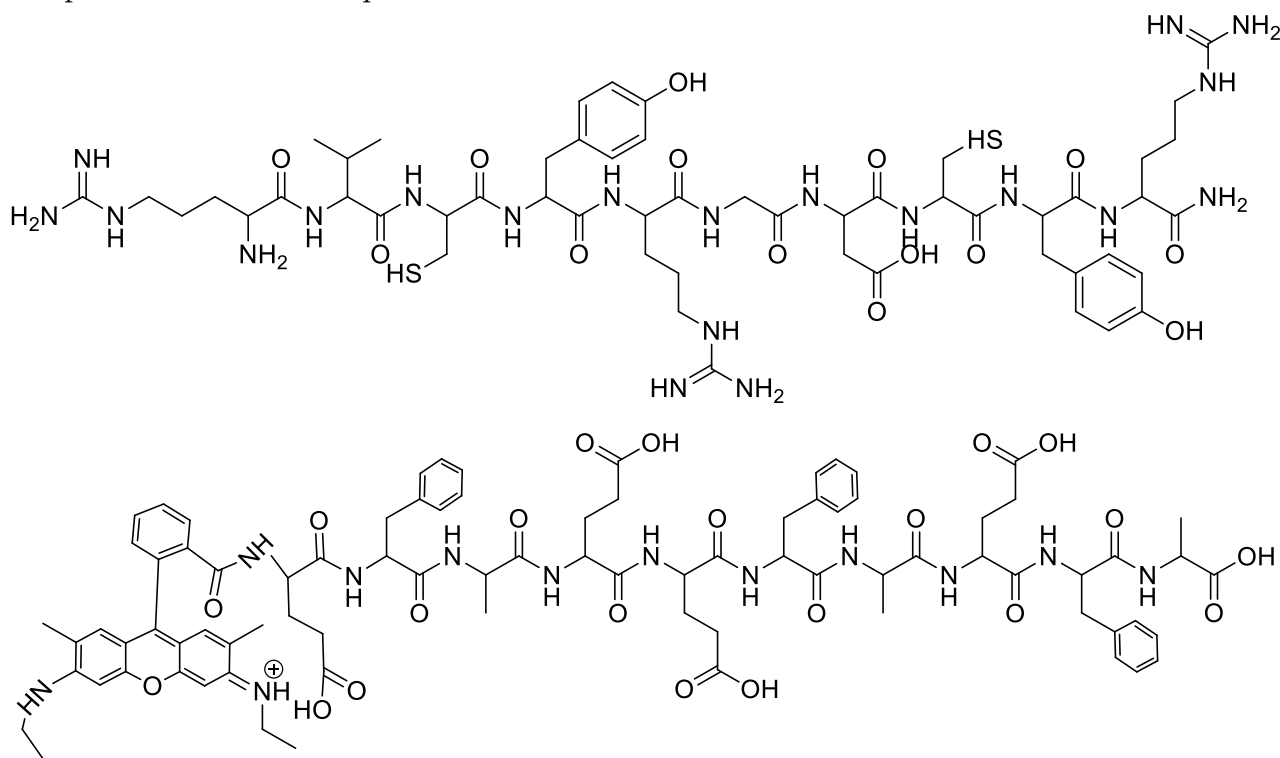
Rink amide-methylbenzhydrylamine hydrochloride (MBHA) resin, 9-fluorenylmethoxy carbonyl (Fmoc) protected amino acids (Arginine, Valine, Cysteine, Tyrosine, Glycine, Aspartic acid, Alanine, Glutamic acid, Phenyl alanine), DIPEA- N, N-Diisopropyl ethyl amine, HOBt-1- Hydroxybenzotriazole, HBTU-2-(1H-benzotriazole-1-yl)-1,1,3,3-tetramethyluronium hexafluoro phosphate, TFA- Trifluoroacetic acid ordered from Sigma Aldrich Chemical Inc, Fluka and TCI chemicals. Thioanisole, m-cresol, indole and mercaptoethanol Rhodamine 6G, were ordered from Alfa Aesar and Sigma Aldrich Chemical Inc. Solvents using acetonitrile, Milli Q water or HPLC Grade water,

ethanol, dichloromethane, dimethylformamide, chloroform, acetic acid, diethyl ether, and methanol were purchased from Rankem chemicals ltd and Spectrochem. Pvt. Ltd. All chemicals and solvents were used peptide synthesis without purification and followed by Fmoc-chemistry protocols. The water-soluble tetrazolium-1 (WST1) reagent was purchased from Roche life Science, USA. Cell culture media, antibiotic-antimycotic solution and foetal bovine serum of United States origin were purchased from Sigma-Aldrich, USA.

## 2.2 Peptide synthesis

Fmoc-chemistry protocol with solid support material of Rink amide MBHA resin<sup>5,6</sup> was used for the peptide synthesis<sup>21,38</sup>. Resin was deprotection with 20% piperidine, then washed and decanted Fmoc group removed from the resin. For synthesizing two peptides, one is peptide P1 (NH<sub>2</sub>-RVCYRGDCYR-CONH<sub>2</sub>), and another one is peptide P2 (Rh-EFAEEFAEFA-CONH<sub>2</sub>). Each amino acid was coupled as HBTU active esters in the presence of one equivalent amount of

HOBt. DIPEA acts as a catalyst to convert the carboxylic acid into an activated ester form. In the coupling process, reagents were treated with resin and shaking for 2 hrs. TFA and scavengers such as Thioanisole, m-cresol, indole, and mercapto ethanol mixture (9.0:0.5:0.5, v/v) at room temperature 2 hrs, lead to the final step of peptide cleavage from resin. The purpose of the cleavage process as permanently removes the Fmoc protective group from the resin. The cleavage mixture was collected by filtration and concentrated using a roto evaporator, and treated with cold diethyl ether to precipitate the crude peptide. The crude peptide was isolated by centrifugation, dried using dry air, and stored at 4°C. Using rotavapor, the TFA in the peptide was removed. Diethyl ether was added to precipitate the peptide, and the peptide was again washed with acetic acid to remove impurities and by-products. (Scheme 1) Molecular weight was determined by the peptide using the ESI-Mass spectrum (+mode and - mode).



**Scheme 1.** Synthesis of N-terminal decapeptide and Rhodamine tagged decapeptide.

### 2.3 Reversed-phase high performance liquid chromatography (RP-HPLC)

RP-HPLC techniques for structural characterization, isolation and purification of peptides. Before starting, the analysis column was thoroughly washed with polar solvents. (Waters 1525 Binary HPLC) equipped with a C-18 reversed-phase column (4.6 × 150 mm) at room temperature. Separation of the peptide-based on hydrophobicity. The concentration of the peptide solution was fixed at 3mg/ml, and 25µl of the peptide solution was injected into the column at 25 µl loop volume capacity for four times to collect the pure peptide for further characterization. The gradient mode of separation of eluted peptide and flow rate is 1.0 ml/min. Gradient program showed here: 5–10 min, isocratic elution [90% eluent A (0.1%TFA in water) and 10% eluent B (0.1% TFA in acetonitrile)]; 10–45 min, linear gradient elution up to 80 to 100% B; 47–52 min, linear gradient elution back to 100% B; and 57–65 min, isocratic elution using 10% B. The flow rate was 1ml/min, and the UV detector wavelength was fixed at 214 nm.

### 2.4 ESI-MASS Spectrum:

The mass spectrum was recorded using LC/MS/MS-PE sciox API-3000 with an ESI source. Molecular weight determined of the peptide sequence using ionization technique involves the addition of a proton or multiple protons.ESI with quadrupole or ion trap analyzers also allows for MS analysis at relatively high LC flow rates (1.0 ml/min) and high mass accuracy ( $\pm 0.01\%$ ), adding a new dimension to the capabilities of LC characterization. In polar organic solvents, the sample concentration is 3mg/ml. The combination of LC and ESI-MS is excellent for routine and reproducible molecular weight determinations on a wide variety of compounds, whether they are positively (i.e., peptides) or negatively (i.e., oligonucleotides) charged

### 2.5 FT-IR spectroscopy:

FT-IR absorption spectral peak characterization was used to determine the peptide structures. Especially the amide group of peptides has identified and recorded the IR spectrum by Perkin Elmer spectrum Two UATR FT-IR spectrometer. The Spectra region is shown in the frequency range of 400 – 4000  $\text{cm}^{-1}$ , under a resolution of 2  $\text{cm}^{-1}$  with a rate of 2 mm  $\text{sec}^{-1}$  in 20 scans. Spectrum peak was analyzed on the peptide's secondary structure, and evidence of the amide I spectra was performed.<sup>11,12</sup>

### 2.6 CD spectroscopy:

CD spectrum was characterized and studied by the secondary structure of the peptide. A Jasco J-715 spectropolarimeter was used to record the circular dichroism spectra. Samples are **P1** and **P2** were recorded to various solvents like water alone, phosphate buffer alone at pH 7.4, Ethanol alone, Ethanol with phosphate buffer and Ethanol with Water using 0.2 mg/ml solution were taken in a quartz cuvette (path length =0.1 cm), and the spectra were recorded at 25°C with a scan rate of 50 nm/min over the range from 197 to 250 nm.

### 2.7 NMR Spectroscopy :

The molecular structure of the peptide compound has been examined using Nuclear magnetic resonance, and this technique has been used to structurally elucidate and characterize amino acid residues in the peptide sequence. A BRUKER-DMX 400 Spectrometer would be used to record the NMR spectrum at a proton resonance frequency of 400 MHz In the peptide compound; the chemical shift value of the various resonance protons is assured. Especially backbone of the NH amide bond in the peptide sequence<sup>13,30</sup> has been identified. NMR had been used to record deuterated solvents like DMSO (d6).

### 2.8 Antimicrobial studies

#### 2.8.1 Antibacterial studies:



Peptides 1 and 2 possess antibacterial activity against gram-positive and gram-negative bacteria. Check the activity of the peptides P1 and P2 using the well diffusion method (Manikandan et al., 2017) at different concentrations of the peptides. With the use of cotton swabs, a fresh overnight (24 hours) bacterial culture ( $1 \times 10^5$  cells/ml) was disseminated evenly on the top of the nutritional agar<sup>41</sup>. Then, using a sterile cork borer, 6 mm holes were punctured. Peptides in various volumes (25-75  $\mu$ l) were aseptically loaded into the holes. For all of the tests, Ampicillin (10 mg/ml) was employed as a positive control sample; following that, the test plates were incubated for one day (24 hours) at 37°C, and the zone of inhibition was measured.

## 2.9 Anticancer studies

### 2.9.1 Cell culture

The MDA-MB-231 cell line was acquired from American type culture collection (ATCC), USA. The cells were maintained in Dulbecco's modified eagle medium (DMEM) supplemented with 10% heat-inactivated foetal bovine serum (FBS) and the antibiotic-antimycotic solution containing streptomycin, amphotericin B and penicillin. Sub-culturing was done by detaching the adhered cells using 0.25% trypsin- ethylene diamine tetra acetic acid (EDTA). Cell culture flasks were maintained under a humidified atmosphere with 5% CO<sub>2</sub> at 37°C.

### 2.9.2 Cell proliferation assay

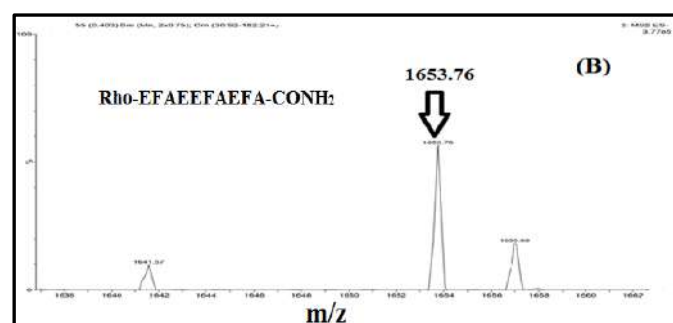
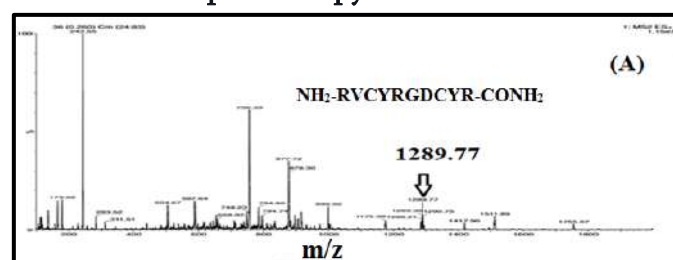
To examine the effect of peptide samples (P-I and P-II) on the proliferation of MDA-MB-231 cells, the water-soluble tetrazolium-1 proliferative assay (WST-1)<sup>45,46</sup> was performed. Briefly, the MDA-MB-231 cells were seeded at a density of  $2 \times 10^4$  cells/wells with 100  $\mu$ l volume in 96-well plate. After 24 h, the cells treated with specified concentrations (1  $\mu$ g and 5  $\mu$ g) of each sample for 24 h. Cells without sample served as control. After treatment, 5  $\mu$ l of WST-1 reagent was added to each well and incubated at 37°C for 1 h. The

absorbance was measured at 450 nm using a multi-mode plate reader (BioTek, USA). The cells were also visualized under a phase-contrast microscope at 10X magnification (Leica, Germany) and the images were captured and analyzed.

## III. RESULTS AND DISCUSSION

Fmoc-chemistry protocol is based on synthesized peptide compounds using the solid-phase synthesis method. The peptide has ten amino acids and peptide P1 is designed and synthesized from Tachyplesin peptide and P2 is obtained from MSI-367 antimicrobial peptide, and modified with Rhodamine at N-terminal region. During peptide synthesis, each amino acid was coupled with Rink amide MBHA resin to form protected amino acids, The entire synthesis process took place in a simple peptide vessel without transfer to any vessels, heating and hazardous chemicals. During isolation and purification of the cleaved crude peptide, various instruments suitable for the characterization study are used to evaluate the peptide's molecular weight and structural details.

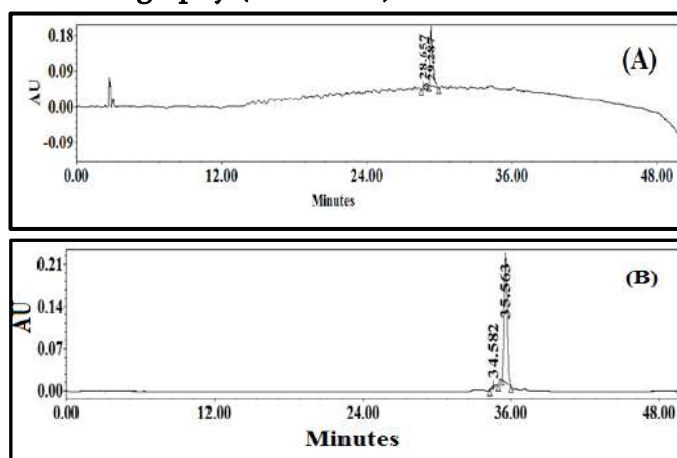
### 3.1 ESI-Mass Spectroscopy



**Figure 1.1(A).** ESI-Mass analysis molecular weight of N-terminal decapeptide **1289.77** and **(B)** Rhodamine tagged decapeptide molecular mass **1653.76**.

**(Figure 1.1 A)**The molecular weight of peptides are confirmed by ESI-MASS spectroscopy. The calculated mass of P1 (1289.57) is matched with the observed molecular weight (1289.77) and also the calculated mass of P2 (1650.32) is matched with the observed molecular weight (1653.76).**(Figure 1.1 B).**

### 3.2 Reversed phase - High performance liquid chromatography (RP-HPLC)



**Figure 1.2(A)** RP-HPLC Purification of peptide (P1) 98.36 % and RT of peptide (P2) 29.287 Minutes and**(B)** RP-HPLC Purification of Rhodamine attached peptide (P2) 98.22 % and RT of peptide (P2) 35.563 Minutes.

The purity of the peptides are analyzed by RP-HPLC, the peptide P1 shows 98.36 % purity & retention time is 29.28 minute and Peptide **P2** shows 98.22% purity & retention time is 35.56 minutes. **Figure 1.2 A** and **B.**

### 3.3 FT-IR Studies

From the FT- IR analysis, the amide I band (between 1600 and 1700  $\text{cm}^{-1}$ ), predominantly associated with the C=O stretching vibration and directly related to the backbone conformation, was the most intense absorbance band. At 1,663  $\text{cm}^{-1}$ , Amide I shows a stretching vibration of C=O associated with backbone conformation. N-H bending and C-N stretching vibration are evident in the Amide II band's IR range between 1470 and 1570  $\text{cm}^{-1}$ , which appears peak at 1510  $\text{cm}^{-1}$ . FT-IR Peak obtained spectra in this amide III band at 1238  $\text{cm}^{-1}$  in the IR range of Amide III bands from 1231 to 1238  $\text{cm}^{-1}$ . The IR spectrum predicts two different structure forms, with amide I peak assigned helix turn and amide II and III denoting an unordered structure of P1. same literature survey following in P2, amide I peak at 1630  $\text{cm}^{-1}$  and amide II peak in IR at 1531  $\text{cm}^{-1}$  and amide III peak at 1210  $\text{cm}^{-1}$  in the IR spectrum. As discussed, secondary structure predicts P2 for  $\beta$ -turn and unordered structure from the FT-IR Fig 1.3.

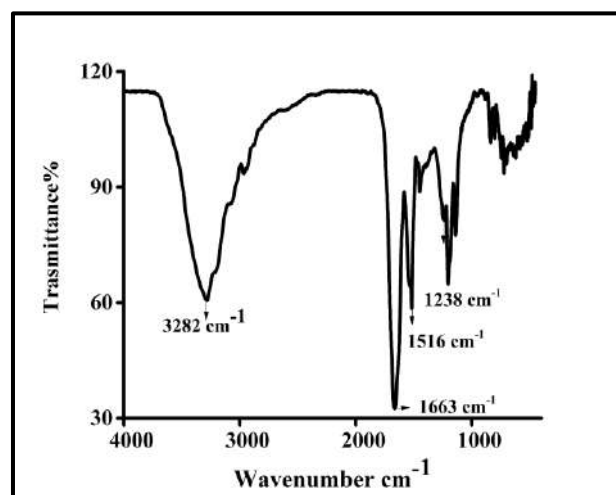


Figure 1.3 (A) FTIR spectrum of P1

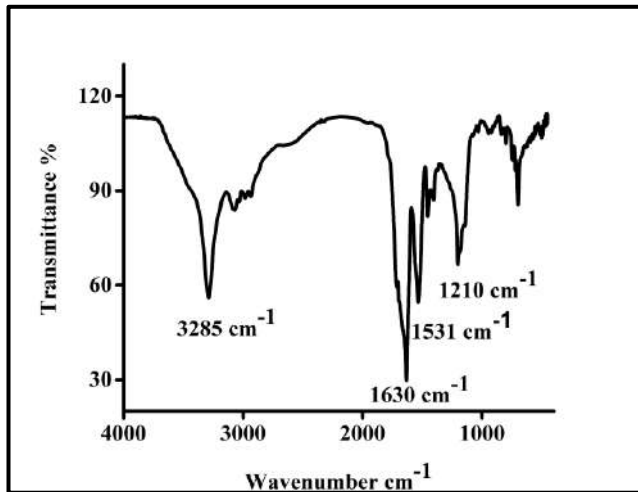
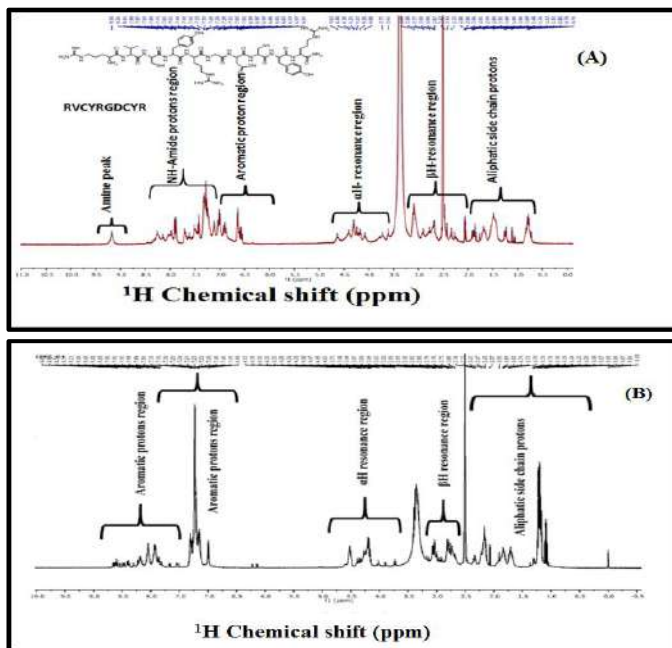


Figure 1.3 (B) FTIR spectrum of P2

### 3.4 $^1\text{H}$ NMR Spectroscopy study

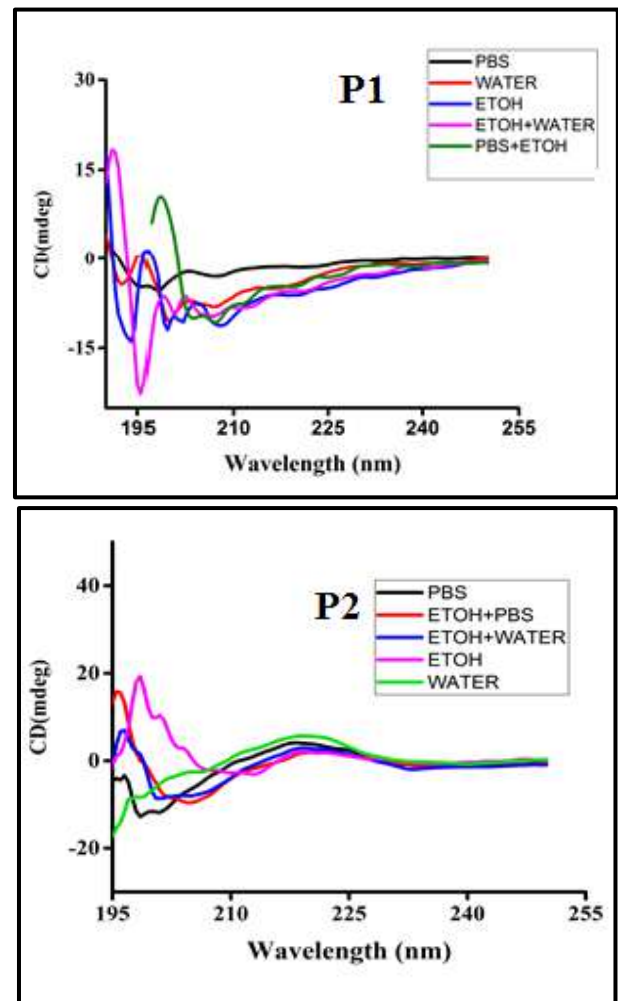
Both peptide P1 and P2 (Figure 1.4) comprise aromatic proton peaks that have been identified utilizing  $^1\text{H}$  NMR, which has been used to record the chemical shift value of the backbone NH bond peak.



**Figure. 1.4A** (P1) and **B** (P2) represented  $^1\text{H}$ -NMR (Bruker Advance 400 MHz, Dms $o$ - $d_6$ ) range shows aromatic proton resonances and amide proton resonances.

### 3.5 CD Spectrum analysis

The CD spectrum peptides are tested by using different solvents and it reveals that, peptide P1 exhibited negative minimum value at  $\sim 222$  nm. As a result, random coil conformation at pH 7.4 absence of any positive CD signal shows the lack of a  $\beta$ -sheet or  $\beta$ -turn conformation. The CD spectra for peptide P2 shows a positive band at  $\sim 219$  nm and a negative minimum at  $\sim 200$  nm were visible in the CD spectra.



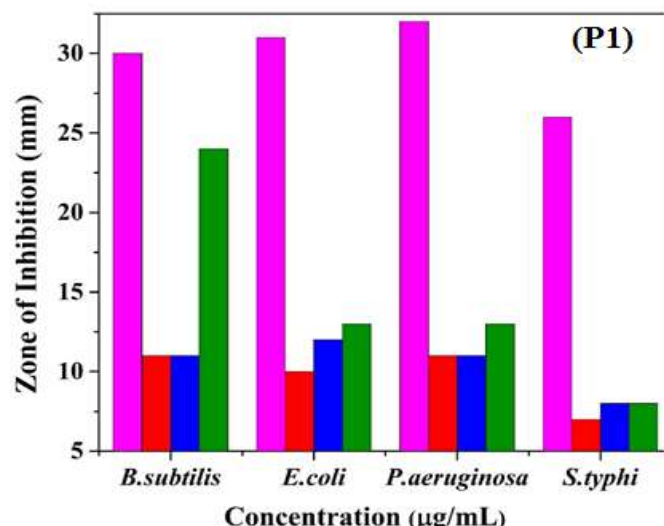
**Figure. 1.5** – CD spectra (195-250nm) of P1 and P2 peptides as well as N-Terminal decapeptide and Rhodamine attached decapeptide.

Given that the peptide's sequence comprises aromatic amino acids, both  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$  transitions are anticipated, The negative minima

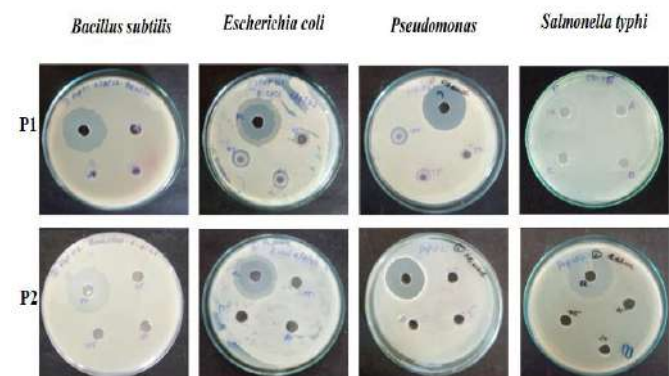
at ~200 nm indicate a considerable quantity of random coil, even though the positive band at ~219 nm is attributed to  $\beta$ -turn conformation (unordered structure) It is commonly known that in aq. buffer, the terminal regions frequently take on an extended or random coil shape. The peptide **P1** thus appears to contain nascent  $\alpha$ -helix turns.

### 3.6 Antibacterial activity

Gram-positive and gram-negative bacteria were used to treat the antibacterial tested, employing the well diffusion method for **P1** and **P2**. Both gram-positive and gram-negative bacteria were more susceptible to peptide **P1**. However, neither bacteria responded to peptide **P2**. As illustrated in **figure 1.7**, further experiment results revealed that both peptides suppressed antibacterial activity at different concentrations, with peptide **P1** being more efficient than **P2** against both gram-positive and gram-negative bacteria.

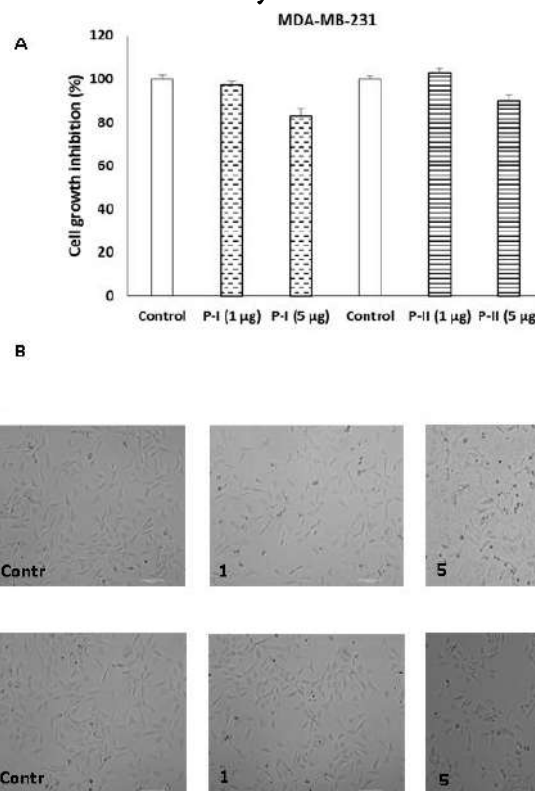


**Figure 1.7.** Concentration of P1



**Figure 1.6.** Peptide 1 and Peptide 2 treated with gram positive and negative bacteria.

### 3.7 Anticancer Activity



**Figure 1.8** Effect of peptides on the growth of human breast cancer (MDA-MB-231) cells

The growth inhibitory efficacy of peptide samples (P1 and P2) in human breast cancer (MDA-MB-231) cells is shown in **figure 1.8**. The results showed that both the samples at 5  $\mu$ g concentration significantly inhibited the growth of MDA-MB-231 cells (**Fig. 1.8 A**). However, P1 exhibited slightly better growth inhibitory effect (17 %) compared to P2 (11 %). The microscopic observation confirms the data obtained in the cell proliferation assay, where reduced cell number with increased dead cells was observed in 5  $\mu$ g peptide treated cells. (**Figure 1.8 B**). The data indicate that the peptide concentration of 5  $\mu$ g and above could be used for cancer therapy applications.

RGD is based on a decapeptide sequence that chooses cancer cells, and gram-positive and negative bacteria must meet particular criteria to access the microorganism and cancer cell membrane. RGD sequence (RVCYRGDCYR), modified for the anticancer property, was derived from tachyplesin. MSI-367 antimicrobial peptide sequence was used to create an EFA decapeptide sequence. Following the formation of the dermcidin antimicrobial peptide sequence base drug, MSI-367 sequence as KFAKKFAKFAKKFAKFAKKFA was examined after being modified EFAEEFAEFA to act as an anticancer peptide. In clinical Gram-negative bacteria, antibiotic resistance is frequent, severely restricting the therapeutic options available. Due to the increased probability of antibacterial characteristics, the RGD sequence (NH<sub>2</sub>-RVCYRGDCYR-CONH<sub>2</sub>) of decapeptide in positive charge of arginine residue is the predominant makeup of this peptide chain. Moreover, it was determined that an EFA-

modified peptide had a higher binding affinity to *E. coli* than to *S. aureus*.

#### IV. CONCLUSION

Cationic and anionic decapeptides were synthesized and modified like RGD and EFA, but net charges various as +2 and -4. peptides confirm the structure elucidation, molecular weight, secondary structure and other characterization also. Secondary structure of peptide primary role in the targeted microbial membrane. ACP therapy influences cancer-related molecular targets, bind anticancer therapeutics and stimulates cancer-related and healthy cell environments in biological systems. Notably, natural and synthetic peptides have been produced as cutting-edge cancer treatment methods. Peptide1 have antibacterial activities compared to no activities for Peptide2. Peptide1 and Peptide2 have various volumes consumed in activities study but significant changes in the antibacterial activities due to electrostatic interaction between peptide and bacteria cell membrane in the data evidence. Especially breast cancer cells against our peptides 5  $\mu$ g and above concentration reduced and increased death cells for the proved in the Cell proliferation assay. Both peptides could be consider used for cancer therapy applications.

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# An Analytical Review on Packet Analysis for Network Forensics and Deep Packet Inspection in Network

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## ABSTRACT

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Packet analysis is a fundamental traceback approach in network forensics. It can play back even the entirety of the network traffic for a specific point in time, provided that the packet details captured are sufficiently detailed. This can be utilised to discover evidence of malicious online behaviour, data breaches, unauthorised website access, malware infection, and attempted intrusions, as well as to reconstruct image files, documents, email attachments, and other types of data that have been transmitted across the network. This article offers a detailed study of the use of packet analysis in network forensics, including deep packet inspection. It also gives a discussion of AI-powered packet analysis algorithms that have enhanced network traffic classification and pattern identification capabilities. In light of the fact that not all information obtained through a network can be used as evidence in a legal proceeding, a comprehensive list of the kinds of digital information that might be allowed has been compiled. We take a look at the capabilities of both physical appliances and software packet analyzers from the point of view of their possible use in forensic investigations of computer networks.

**Keywords :** Packet analysis, Deep packet inspection Network forensics, Packet sniffer Wireshark, Pcap, Digital evidence Network monitoring Intrusion detection

## I. INTRODUCTION

1. Introduction to packet analysis in network forensics  
Because of the ever-growing popularity of online services, security professionals and law enforcement organisations are under increasing pressure to develop innovative strategies for investigating cybercrimes and locating evidence that may be presented in court. Large volumes of data are transferred through

communication networks by online services in a variety of formats, the most common of which is the network packet. Online services transport this data in a variety of ways. According to Stallings and Case (2012), these are groupings of bits that incorporate data as well as control information. More specifically, this term is used to refer to a network layer (OSI Layer 3) protocol data unit. They are the smallest unit of data that may be intercepted and logged regarding network

traffic flow while it is moving across a packet-switched network, and they comprise of control information (the source and destination IP address, error detection codes, and sequencing information) and payload (intended message). A set of bits that contains data along with one or more addresses and other protocol control information is referred to as a frame, and it is a data unit that is found in OSI Layer 2 (the data link layer) (Stallings and Case, 2012). The equivalent is referred to as a segment in OSI Layer 4, which is the transport layer (or datagram).

Network packets can be utilised in forensic investigations and may even produce evidence that is admissible in a court case if they are successfully collected, saved, and processed once they have been obtained from a network. Be aware that throughout this entire piece, we are going to use the term "packet analysis," regardless of whether the actual content is a frame, packet, data gramme, or session, unless it is stated otherwise. This is because the term "packet analysis" encompasses all of these different types of content.

## 2. Capturing and storing network packets

Protocols are defined as "mechanisms to identify and create connections, as well as formatting standards and conventions that are specified for data transfer," and they are what make it possible for network devices to communicate with one another. Using purpose-built software, it is possible to examine the data from a network and separate the traffic into its many components. Packet analyzers are the same thing as protocol analyzers, except that their primary purpose is to analyse packets (packet sniffers, sometimes network analyzers). By utilising a method known as "packet capturing," these software solutions are able to capture and record the network traffic that is moving over a digital network or a portion of a network. After then, the collected packets can be studied by decoding the raw data contained within the packets and

visualised by showing various fields in order to interpret the content of the packets (Chapman, 2016). When a capable wired network interface controller (NIC) or wireless network interface controller (WNIC) is put into promiscuous mode, all of the network traffic that is received can be sent to the central processing unit (CPU), rather than just the frames that the controller is specifically programmed to receive. This is referred to as a full duplex mode. The Berkeley Packet Filter (BPF) is a programme that allows for the filtering of packets, such as receiving only those packets that begin a TCP connection. This programme is available on most Linux distributions. Because BPF only returns the packets that make it through the filter, there is no need for the operating system to copy irrelevant packets to the kernel in order for them to be processed. This results in a significant increase in the speed of the system. Extended BPF (eBPF), which is an improvement on the original BPF, allows for loops since it supports not only forward jumps but also backward hops in addition to the standard forward jumps. Aggregating event statistics can also be accomplished with eBPF through the utilisation of maps, which are global data repositories.

There are a few different ways to "tap into the wire," and the method that should be used to do so is determined by the networking environment in which the device whose traffic to be studied is situated. In the relatively uncommon networks that make use of hubs, a packet sniffer is able to view all of the devices that are connected to the network for the simple reason that traffic that is delivered through a hub is passed through every port that is attached to that hub. The visibility of a packet sniffer is restricted to the port into which it is plugged in a networking environment that uses switched connections. Port mirroring (also known as port spanning), hubbing out, employing a tap, and ARP cache poisoning (also known as ARP spoofing) are the four primary methods that can be used to capture traffic from a target device on switched networks. The answer to this question is dependent on the situation: The first one is only a possibility if we have access to

the command-line or web-based management interface of the switch on which the target computer is located, the switch supports port mirroring, and it has an empty port into which we can plug our sniffer; the second one requires having physical access to the switch the target device is plugged into; the third one calls for a specialised piece of hardware known as a network tap to be connected to the network; and the fourth one necessitates having information about Analyzing network packets, which include valuable information about network activities and which can be used to compile and report network statistics as well as troubleshoot client-server conversations, is helpful in both of these areas. Network packet capture files store a lot of information about online user activity that can be useful in network forensics. Some examples of this information include visited websites and the amount of time spent browsing them,<sup>2</sup> successful and unsuccessful login attempts, credentials, illegal file downloads, intellectual property abuse, and other types of information. Not only do packet files contain a plethora of information, but data may also be obtained from them in a variety of groupings, such as individual frames, client-server talks, packet streams, flows, and sessions. In addition, packet files contain a richness of information. In the field of network forensics, packet analysis can be used to collect evidence for investigations of digital activities; it can also be used to detect malicious network traffic and behaviour, such as attempted intrusions and misuse of the network; it can also be used to identify man-in-the-middle attacks and malware, such as ransomware; and it can be used to identify security vulnerabilities (Alhawi et al., 2018).

The capture format that has become the de facto standard is called libpcap (pcap), and it is a binary format that supports timestamps with a nanosecond-precision.

Pcap files all have the general structure depicted in Fig. 1, despite the fact that this format changes slightly from implementation to implementation.

The maximum length of captured packets, measured in octets, the GMT offset, the timestamp precision, and the maximum length of captured packets are all included in the global header along with the magic number, which is used to identify the file format version and byte order. After this information, there may be zero, one, or more records containing the collected packet data. Each captured packet begins with the timestamp in seconds, the timestamp in microseconds, the number of octets of the packet that have been stored in file, and the actual length of the packet itself.



Figure 1 depicts the overall organisation of pcap files. The data packets only include the most recent N bytes of each individual packet, where N represents the length of the snapshot (typically smaller than 65,535).

Next Generation Capture File Format (pcap) is the format that will replace pcap in the future (pcapng). Instead of merely being able to dump network packets, pcapng is capable of preserving a variety of data kinds with a generic block structure. This is in contrast to its previous limitation. The IETF is responsible for developing the structure of pcapng files, as may be seen in Figure 2.

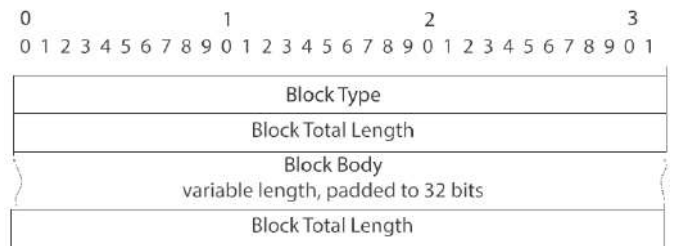
The specifics of the block structure are determined by the block type; the list of block types includes section

header blocks, interface description blocks, simple and enhanced packet blocks, name resolution blocks, interface statistics blocks, systemd journal export blocks, decryption secrets blocks, and custom blocks. Each of these block types has its own set of details regarding the block structure. The creation of further categories is now underway.

IETF RFC 1761.5 is where the format for the snoop capture is defined. Each snoop file is an array of octets that consists of a file header that has a fixed length and one or more packet records that have varying lengths. A 32-bit datalink type, a 32-bit version number, and a 64-bit identification pattern are all included in the header of each and every file.

The RedBack Smartedge pcap format, often known as SE400/800, was developed specifically for NetBSD running on PowerPC with intelligent packet-forwarding linecards. This format expands the pcap format with additional information regarding protocols and circuits. It is built on circuits, and its foundation is circuits.

Additional capture formats include the following: InfoVista 5View capture; the IxCatapult (formerly DCT 2000) trace.out file format; the Cisco Secure IDS iplog format; the Symbian OS btsnoop format; the TamoSoft CommView format; the Endace ERF capture format; the EyeSDN USB S0/E1 ISDN trace format; the HP-UX nettl trace; the K12 text file format; the Microsoft Network Monitor (Net If the timestamp is added by the kernel or the CPU that the capture is offloaded to, or if a packet has been waiting in a ring buffer, then this precision is typically not available in practise because the packet capture implementation that is in place may only support milliseconds. This can occur in a number of scenarios, including when a packet has been waiting in a ring buffer.



Language file format, the NetScaler Trace format, the RADCOM WAN/LAN Analyzer format, the Shomiti/Finisar Surveyor format, the Sniffer Pro format, the Tektronix K12xx.rf5 format, and the Visual Networks UpTime traffic capture format.

### 3. Processing network packets and packet flow

Network packets hold more than just communication data and metadata; files that traversed through a network can be reconstructed from network packet streams (network carving) (Beverly et al., 2011) using purpose-designed network carvers or packet analyzers that support file export from packet capture. This, together with other options to find traces of network data transfer, makes packet analysis a primary traceback technique in network forensics. It can assist in finding traces of nefarious online behavior and breaches affecting an organization, determining the source of network security attacks, and acquiring host-based evidence of malicious actions (Johansen, 2017), although making sense of encrypted network traffic is far more challenging than the analysis of unencrypted traffic (van de Wiel et al., 2018). For example, network traffic classification based on packet analysis and port numbers alone is infeasible for encrypted VoIP applications, such as Skype (Alshammari and Zincir-Heywood, 2015), although even encrypted network traffic can be classified using machine learning (Dong and Jain, 2019).

Packet sniffing is a method of tapping packet flows, i.e., packets as they flow across a communication network (Ansari et al., 2003), and even re-transmitted packets, such as with different TCP properties. This can be utilized for reconstructing data transferred over the

network, and might even be used as an anti-forensic measure.

### 3.1. Deep packet inspection

Deep packet inspection, often known as DPI, is a sort of packet analysis that examines not only the information included in the packet header but also the information contained in the packet payload. DPI can be utilised to identify excessive levels of non-business traffic in enterprises, such as social media use, that require being filtered or blocked; to detect data streams (Yin et al., 2018); video traffic (Huang et al., 2012); encrypted BitTorrent traffic (Carvalho et al., 2009); malicious behaviour (Guo et al., 2017); malicious traffic (Stergiopoulos et al., 2018); intrusions (Parra et al., 2019). In point of fact, deep packet inspection can reveal and record online activities to the extent that it raises privacy concerns regarding mass surveillance by state and government agencies (particularly under legislations that require "wiretap-friendly" online services, such as CALEA in the United States),<sup>6</sup> even if the sheer volume of traffic makes it impractical to record all traces of user activity. This is because deep packet inspection can reveal and record online activities to the extent that it raises privacy concerns regarding mass surveillance by state and government agencies (Stalla-Bourdillon et al., 2014). Deep packet inspection is advantageous for network operators because it enables them to shape traffic and exert control over several forms of traffic, such as email, VoIP, and P2P. DPI services are provided by businesses such as NETSCOUT<sup>7</sup> and Sandvine<sup>8</sup>. These services help prioritise network activity, enforce policies, and assist in the development of new service plans.

### 3.2. Using artificial intelligence in packet analysis

In network forensics, formal knowledge representation is used in the form of ontologies to automate the analysis of network packet sequences. This is done in order to reduce human error (Sikos,

2018). Purpose-built ontologies, such as the Packet-Centric Network Ontology (PACO) (Ben-Asher et al., 2015) and the Packet Analysis Ontology (PAO)<sup>9</sup> (Sikos, 2019), have the ability to capture the semantics of actual network packets and provide terms to formally describe background knowledge in a form that a machine can understand. The datasets that make use of these definitions and codified expert knowledge, in conjunction with reasoning rules, may be utilised to infer new claims and make implicit network information explicit.

In their 2018 study, Shah and Issac used machine learning and developed a plugin in order to reduce the number of false positives that occurred during the detection of hostile traffic using Snort. This plugin decodes packet data, classifies network packets, differentiates between legal and malicious traffic, and reduces the probability of false positive alarms by using support vector machines (SVM), decision trees, a mix of SVM and fuzzy logic, and optimised SVM with firefly.

Deep packet inspection paired with semi-supervised machine learning is an effective method for efficiently categorising flows to recognise audio, video, and interactive data, which paves the way for fine-grained adaptive quality of service traffic engineering (Yu et al., 2018). The classifier is able to adjust to quickly shifting network traffic patterns through the use of periodic retraining with a dynamic flow database. This allows the classifier to adapt.

Deep Packet is the name of the deep learning-based methodology developed by Lotfollahi et al. (2019), which combines the processes of feature extraction and classification. Using two different types of deep neural network structures—stacked autoencoder (SAE) and convolutional neural network (CNN), respectively—it is able to categorise network traffic into classes such as FTP and P2P. Additionally, it is able to identify end-user applications such as Skype and BitTorrent. Not only can the Deep Packet method recognise encrypted traffic, but it can also differentiate between VPN and

non-VPN network traffic. This is a significant advantage.

### 3.2.1. Optimizing and offloading packet processing

The use of implementation integrated circuits (ASICs), field programmable arrays (FPGAs), and graphics processing units are all viable options for achieving hardware acceleration and offloading in the context of network packet processing (GPUs). Offloading of most IPv4 and IPv6 traffic, IPsec VPN encryption, CAPWAP traffic, and multicast traffic are just a few of the types of traffic that the FortiGate's FortiASIC NP6 can handle.

### 3.3. Programming packet processing applications

Specialized hardware, often coded in Assembly or C, is required in order to carry out network packet analysis at speeds in the gigabits per second range, with deep packet inspection in particular requiring this level of processing power (Duncan and Jungck, 2009). Using a parallel packet processing paradigm in conjunction with the purpose-designed programming language packetC is an additional method that may be utilised. This language offers high-level constructs to define coding solutions for applications that include packet processing. It avoids type coercions or promotions to prevent unexpected data truncations or expansions, it supports a strong typing model with restrictive type casting to prevent unexpected side effects, and it simplifies and restricts type declarations in comparison to C. These features are intended to reduce the likelihood of unexpected type conflicts (Jungck et al., 2011).

## 4. Packet data as digital evidence

The capture, analysis, and backtracing of network packets constitute a considerable part of network forensics (Nikkel, 2005). Network packets are sources of network evidence, and together with data from remote network services, form live network evidence

sources. Depending on the online content, network packets have a finite, non-zero acquisition window during which evidential data can be observed or acquired. On the one hand, some argue that using packets as evidence can be problematic in case they are spoofed (Kim et al., 2015). On the other hand, network packets can complement firewall logs and network monitoring software extremely well, and can be considered the ultimate forensic evidence (Hurd, 2018).

Packet capture files can be used to extract potential forensic evidence from network data, such as via the Highly Extensible Network Packet Analysis (HENPA) framework (Broadway et al., 2008). The information extracted from network packets can be used as evidence either directly or indirectly. For example, some information contained in the packets, including the sender and receiver IP addresses, port numbers, etc., along with the transferred data, can be used directly as evidence. Inferred, indirect information derived from multiple packets that can be used as evidence include patterns such as large streams of ICMP packets sent from a particular host to another one in a short period of time, which might indicate a denial-of-service (DoS) attack.

The utilization of packet analysis to its full potential relies on full packet capture,<sup>10</sup> which requires a full telecommunication interception warrant or equivalent (Turnbull and Slay, 2007). If the necessary warrant is obtained and full packet capture is performed (which is often not feasible due to network bandwidth constraints), security engineers can play back all the traffic on a network (Rounsavall, 2017).

Because packet capture files often contain sensitive data, such as personal data of network users, information about the internal structure of an enterprise network, etc., privacy restrictions, policies, and laws make it impossible to share packet capture files. There are approaches and solutions to automatically scramble network packet capture data while preserving binary integrity, such as SafePcap,<sup>14</sup> which complies with the European Union's General

Data Protection Regulation (GDPR)<sup>15</sup> and NIST's NISTIR 8053 "De-Identification of Personal Information."<sup>16</sup> SafePcap performs data modifications in a break-proof manner by recalculating the lengths, checksums, offsets and all other services for all affected packets and protocol layer fields on the fly.

A full packet capture is imperative when investigating what has happened in a network at a particular point in time and who was actually involved in an online activity, because the IP address of a suspect's computer alone cannot serve as the basis of forensic investigations due to the dynamic nature of IP addresses, and because they often cannot be linked directly to an individual (Clarke et al., 2017) and often not even to an exact geographical location (Afanasyev et al., 2011). Nevertheless, following the TCP stream of the simultaneous use of SMTP and a particular IP address can identify the address associated with the From tag of the email header. Furthermore, email headers contain the name of the sender, which may reveal the suspect's real name. Emails sent by the user can be reconstructed, including any attachments. The manufacturer of a suspect's computer can be identified with a high certainty based on the Organizational Unique Identifier (OUI) part of the device's MAC address,<sup>17</sup> although this cannot be used in many cases, particularly in corporate networks. Based on the packet data, it can be determined when the suspect logged in to the network. If the password of the suspect was encoded in Base64, it can be converted to UTF-8 to reveal the actual password that was used to log in. Ultimately, such information can help build a profile of the suspect's identity.

Supporting evidence can be efficiently collected from stored packet information by recreating the original metadata, files, or messages sent or received by a user (Manesh et al., 2011). The analysis of file and software downloads can help identify drive-by downloads leading to malware infections (Ndatinya et al., 2015). Malicious online activities may be identified based on common traits of SQL queries used for attacks on TCP, such as SYN flood attacks, XMAS scans, and SYN/FIN

attacks (Kaushik et al., 2010). What level of forensic evidence can be obtained depends on the tradeoff set between packet file details and network throughput (Ning et al., 2013).

## 5. Network packet analyzers

Generally, each packet analyzer performs four steps to process packets (Yang et al., 2018):

1. Open a packet capture socket: select a network device and open it for live capture, retrieve the network address and subnet mask, convert the packet filter expression into a packet filter binary, and assign the packet filter to the socket
2. Packet capture loop: determine the datalink type and start the packet capture
3. Parse and display packets: set a character pointer to the beginning of the packet buffer and move it to a particular protocol header by the size of the header preceding it in the packet, and map the header to the appropriate header structure (IP, TCP, UDP, ICMP, etc.) by casting the character pointer to a protocol-specific structure pointer
4. Terminate the capturing process: send interrupt signals and close the packet capture socket

Packet analyzers are developed for a wide variety of applications and can be distinguished from one another based on their capacities and features, hardware resource utilisation, processing speed (Goyal and Goyal, 2017), supported protocols, user-friendliness, supported operating systems, supported network types, interface, licence, and type of implementation. There are a variety of packet analyzers available, and many of them enable both live capture and offline analysis. Only those network analyzers that handle hundreds of protocols are capable of doing a thorough inspection of individual packets as well as an analysis of a wide variety of forms of network traffic. Wireless analyzers, often known as WiFi analyzers, are a type of packet analyzer that can

intercept traffic over wire-less networks. Some examples of wireless analyzers are Aircrack-ng,<sup>18</sup> and Kismet.<sup>19</sup> There is a packet sniffer designed specifically for Bluetooth that goes by the name FTS4BT.<sup>20</sup>

Data carving, capture file quality evaluation, anomaly detection, protocol encapsulation, and flexible packet aggregation are some of the features supported by some tools. The list of file types that may be opened by a packet analyzer might differ from one to the next, and some programmes can even decompress gzip files in real time.<sup>21</sup>

The analyzers that come with a graphical user interface (GUI) feature typically have a packet browser that allows users to visualise the content of the packets, as well as a variety of display filters that show only the information that is pertinent to a specific task, as opposed to showing everything that was captured. Some packet analyzers are able to distinguish between different sorts of frames and visually represent this distinction using colour schemes.

The licencing structure of packet analyzers may be broken down into three categories: open source, freeware, and commercial. Types of licences that are commonly connected with Instrumentation for doing packet analysis

Distinguished examples of hardware packet analyzers include the Fluke Lanmeter series (which has since been discontinued), PNtMS (Rahman et al., 2009), the packet analyzer of Thomas et al. (2011), KPAT (Wang et al., 2014), the embedded packet logger of Jandaeng (2016), the Cisco Security Packet Analyzer appliances,<sup>23</sup> SolarFlare's SolarCapture appli- ances,<sup>24</sup> Corvil's hardware.

A few of these appliances are physical in nature (either embedded or dedicated), while others are bare-metal, virtualized, or hybrid in nature.

### 5.1. Packet analyzer software

There are purpose-designed packet analyzers and network tools that are included in the category of packet analyzer software tools. These tools include features for the collection and examination of packets. Intrusion detection software, proxies, vulnerability assessment tools, network scanners, and network monitoring tools are all examples of such types of network tools, all of which are utilised in the field of network forensics (Joshi and Pilli, 2016).

1997 saw the implementation of the Federal Bureau of Investigation's (FBI) configurable packet sniffer as a component of the system known as Carnivore (which was later renamed to DCS1000). It tracked users' activity on the internet, including their email communications. By 2005, it had been completely phased out. The free and open-source packet analyzer known as Ethereal was initially developed by Gerald Combs in 1998. In 2006, the programme was rebranded as Wireshark (Orebaugh et al., 2006). Wireshark has evolved over the years to become one of the most popular graphical packet capture and protocol analysis tools (Shimonski, 2013). It features an extremely user-friendly graphical user interface (GUI) for doing packet analysis (Sanders, 2017). This graphical user interface includes a customised packet browser that shows a maximum of three panes at the same time. These panes include a packet list, as well as the packet information and packet bytes of the packet that is presently chosen (see Fig. 3).

The programme utilises colouring rules to differentiate between inactive and active selected items, marked packets and ignored packets, follow streams (both client and server), and to display valid, invalid, and warning filters. Additionally, the programme is able to display marked packets and ignored packets. It also contains effective display filters that allow the user to zero in on the frames that are pertinent to a certain investigation, for example, by displaying just HTTPS traffic or network communication that is tied to a specific IP address. The capabilities of Wireshark may also be accessed using a command-line programme known as TShark, and Wireshark offers supplementary



tools for the management of packet captures (capinfos, mergecap, editcap). Because of its flexible feature set, Wireshark is used extensively, and both industry professionals and academic researchers are concentrating their attention on it (Mielczarek and Mon, 2015; Das and Tuna, 2017; Alsmadi et al., 2018; Islam et al., 2018; Bhandari et al., 2017).

There are hardware appliances as well as software implementations that may be used for packet analysis; however, software tools are utilised far more frequently than hardware implementations. Logging of individual IP packets on many networks. It has been demonstrated that Snort is effective for doing complicated network behaviour analysis, such as for the purpose of assisting in the detection of advanced persistent threats (APTs). Snort makes use of detection rules for a variety of network traffic types (Cui et al., 2018). In a manner analogous to that of Wireshark, development of Snort is ongoing, and a large number of third-party plugins are available to improve its functionality. One such plugin is VisSRA, which visualises Snort rules and alarms (Hong et al., 2012).

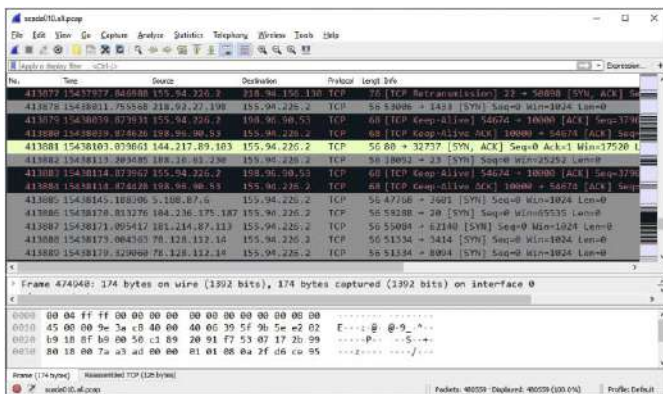


Fig. 3. Wireshark can colorize packets by type and displays them in context.

Eddie Kohler, who was a student at MIT at the time, created ipsum-dump33 in 1999 with the intention of summarising TCP/IP dump files or other packet sources into a self-describing ASCII format that could be consumed by both humans and machines.

Dsniff34 was designed by Song for use on operating systems that are similar to Unix. It is a component of a

larger suite of tools for network auditing and penetration testing. It decodes passwords that were communicated in cleartext across a switched or unswitched Ethernet network, for example, and it parses a variety of application protocols and extracts important information.

EtherApe, a tool for network traffic monitoring and packet sniffing, was created by Toledo in the year 2000 for the Unix operating system. This piece of software, which is both open source and free, can display the traffic on a network using graphs. In these graphs, each node represents a specific host, and the edges of the graphs indicate the connections between hosts. Different protocols may be distinguished from one another thanks to the use of color-coding for the nodes and connections in the network. As can be seen in Figure 4, the quantity of network traffic is graphically represented in a manner that is proportional to the breadth of the graph edges.

Tcpdump37 is a command-line utility that has been available for almost twenty years and is considered to be one of the de facto standard tools for dumping network packets and capturing them for further study. Additionally, it comes with a Windows implementation known as WinDump. 38 Tcpdump is created in tandem with libpcap,39 which is a well-known software library for capturing live network traffic data. This library is also used by packet analyzers and other applications having the capability of packet sniffing, such as Wireshark and Snort. The pcap Application Programming Interface is used by libpcap. The pcap application programming interface is also utilised by the packet sniffers WinPcap40 and Npcap41, as well as ngrep42, a programme that can locate regular expression matches inside the payloads of network packets.

Ettercap43 is a free and open source network security application that was created in 2001 by ALoR and NaGA to combat man-in-the-middle (MITM) attacks on local area networks (LANs). It shows the IP address and the Media Access Control address of any host that is connected to a network. It is able to identify hosts

that have unauthorised IP addresses, and so it is able to detect attackers; but, it will not be able to detect an attacker who spoofs their IP address in order to utilise an allowed IP address (Agrawal and Tapaswi, 2017). Karl von Randow created the Charles Web Debugging Proxy<sup>44</sup> in 2002. It is an HTTP proxy, HTTP monitor, and reverse proxy that visualises all of the HTTP and SSL/HTTPS traffic that occurs between a computer and the Internet. The year after that, Eric Lawrence created Fiddler<sup>45</sup> a free online debugging proxy that can log HTTP and HTTPS traffic. Fiddler was developed by Eric Lawrence. It is possible to filter the data that was taken from the network in order to conceal sessions, emphasise the traffic that is of interest, bookmark breakpoints, and so on.

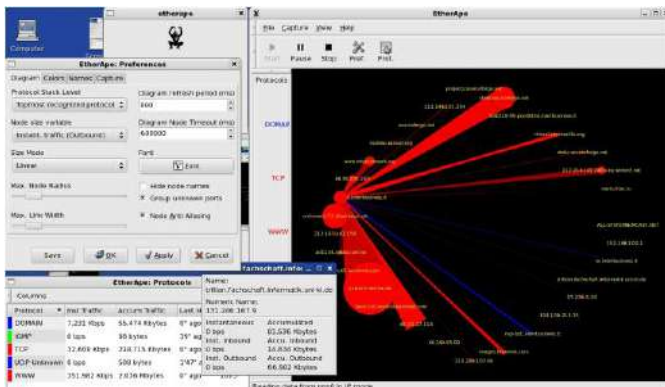


Fig. 4. The EtherApe GUI represents network connections as graphs.<sup>36</sup>

The software includes a widget called the Session Inspector that has the capability to display the contents of a web session that has been recorded. This includes the status of the session, its headers, its caching, its cookies, its URLs, its protocols, the type of compression that was used, its re-directs, and so on.

2009 saw the release of Suricata<sup>46</sup> by the Open Information Security Foundation. Suricata<sup>46</sup> is an intrusion detection and prevention system (IDS/IPS) that is open source-based. Among its many capabilities, it can scan pcap files with IDS rulesets to find traces of suspicious or malicious network activities. In a manner analogous to that of Snort, Suricata is popular enough to have support for a multitude of third-party tools that

may supplement it for the purposes of visualisation and analysis. These tools include Snorby,<sup>47</sup> BASE, Sguil,<sup>48</sup> u2platform (previously Aanval),<sup>49</sup> and CERNE.<sup>50</sup>

During the same year, 2009, Daniel Borkmann created netsniff-ng, which is a free Linux network analyzer. It is a high-performance utility that makes advantage of zero-copy techniques for network packets. As a result, the Linux kernel does not need to transfer packets from kernel area to user space via system calls. The programme is able to collect, analyse, and playback raw 802.11 frames, in addition to supporting the standard pcap file format.

Finding vulnerabilities in online applications has never been easier than it is with WebScarab<sup>52</sup>, an integrated penetration testing tool that is user-friendly. It is confined to programmes that communicate using the HTTP and HTTPS protocols, although it does have the capability to analyse packets.

Tranalyzer<sup>53</sup> is a piece of open-source software that may be used for network troubleshooting in addition to flow- and packet-based traffic analysis. It is developed on top of the libpcap library, and in addition to accepting IPv4 and IPv6 packets, it also takes Layer 2 and encapsulated packets, such as MPLS, L2TP, and GRE, from standard pcap files or live interfaces. Additionally, it accepts IPv4 and IPv6 packets from normal pcap files (Burschka and Dupasquier, 2016).

The logs that are created by tcpdump, snoop, EtherPeek, HP Net Metrix, and WinDump may be analysed with the help of a programme called tcptrace<sup>54</sup>. Yet Another Flowmeter (YAF)<sup>55</sup> is a metre that measures the flow of information over a network. The metadata that YAF generates may be fed into the programme yafMeta2Pcap<sup>56</sup> to generate pcap files specific to a given flow.

The SolarWinds Network Performance Monitor comes with a packet analyzer and also features deep packet inspection, which enables the categorization of network traffic into types based on destination server IP addresses, ports used, and measurement of the total and relative volumes of traffic for each type. Moreover, the packet analyzer<sup>58</sup> comes standard with the

SolarWinds Network Performance Monitor<sup>57</sup>. The Paessler PRTG Network Monitor comes equipped with a large assortment of network monitoring functions, one of which is a packet capture tool known as the Packet Sniffer Sensor. This tool's capabilities for analysing packets are restricted to the examination of data packet headers; however, it does include additional functions, such as displaying how different kinds of network traffic make use of available bandwidth.

An Apache Hadoop-based packet processing tool was introduced by Lee et al. (2011) to address the inefficient processing of large packet capture files that is caused by traditional packet analyzers running on a single host with limited computing and storage resources. This tool can open even petabyte-sized packet capture files thanks to the MapReduce parallel processing paradigm. This application makes use of four innovative and representative calculation modules to calculate overall traffic statistics, periodic flow statistics, periodic simple statistics, and top N statistics respectively.

The packet analyzer developed by Lee et al. (2012) is specifically designed for rapid later access (FLA) and deep packet inspection of network packets by making use of IEC 61850 communication protocols. This analyzer was developed for communications between the server and client of substation automation systems (SASes). Each SAS consists of a station, a bay, and a process level. Considering the large number of packets that need to be processed in IEC 61850 networks, this analyzer was designed for these types of communications. When it comes to evaluating networks of this type, the authors say that their analyzer performs far better than other, more generic packet analyzers.

PcapWT is another programme that can quickly extract packets from massive network traces. It uses the wavelet tree data structure, which enables a rapid search and a good compression ratio. PcapWT's support for multi-threading results in improved performance while reading and writing random file

data to and from solid-state drives (SSDs) (Kim et al., 2015).

The CoralReef software package developed by CAIDA is able to gather and analyse data in real time or from trace files obtained from passive Internet traffic monitors. The ability of CoralReef to classify packet traffic according to the source autonomous systems is one of its defining characteristics (ASes).

The programme known as Xtractr<sup>63</sup> operates in a hybrid cloud environment and allows users to index, search, report on, extract, and collaborate on pcaps.

Cisco NetFlow<sup>64</sup> compiles and organises statistical data on packets as they pass via various routing devices. It is able to determine the flows of packets for both incoming and outgoing IP packets. <sup>65</sup>

The Capsa<sup>66</sup> packet analyzer is an all-inclusive tool that offers support for more than 300 different protocols. It is able to display detailed information on packet decoding in hex, ASCII, and EBCDIC formats. It is able to reconstruct packet streams and make it possible for packet capture and analysis to be carried out automatically at a predetermined time or on a recurring basis. Additionally, packets may be created and replayed using the built-in facilities that are included with Capsa.

The Meterpreter module of Rapid7's Metasploit, which is an assessment tool for vulnerabilities, has the capability to store packets in a ring buffer and export them in standard pcap format for subsequent analysis. It is based on the MicroOLAP Packet Sniffer Software Development Kit. <sup>68</sup>

A packet capture programme for TCP/IP packets, SmartSniff<sup>69</sup> shows collected data as a sequence of client-server dialogues in ASCII mode (for text-based protocols, such as HTTP, SMTP, POP3, and FTP) or as a Hex dump, depending on the kind of protocol being examined (for non-text-based protocols). Raw sockets, the WinPcap capture driver, and the Microsoft Network Monitor driver are the three ways that SmartSniff offers for capturing packets. On earlier operating systems, the Microsoft Network Monitor driver is used.

The packet-based analytics offered by Omnipeek<sup>70</sup> are shown in user-friendly graphical representations and are organised according to flows, which are pairs of conversations. It is able to decode more than a thousand different protocols and offers extensive packet analysis.

Moloch<sup>71</sup> is a standalone piece of open source software that does indexed full packet capture. It uses the common pcap format for both storing packets and exporting them. Moloch has a robust graphical user interface (GUI) that is based on the web. This GUI can present information about sessions and session profiles in a tabular style, and it can graph the top unique values of fields and network connections.

PcapDB<sup>72</sup> is a distributed complete packet capture system that optimises searches for speed and accuracy. It reorganises the packets that have been collected as they are being captured by flow, indexes the packets according to flow, and enables flow-based searches. In most cases, the indices for the collected packets take up less than one percent of the total space used by the data that was captured.

The application known as Stenographer<sup>73</sup> is a complete packet capture programme that can quickly write captured packets to a disc. It does this by providing specific ways to get only those specific packets that are necessary for a certain study, selecting retrieving less than one percent of the packet data that is kept on disc as a result.

Packet Capture<sup>74</sup> is a software for Android that has the power of decrypting SSL data. It is able to show the contents of the packet in either ASCII or Hex.

Tools such as CloudShark<sup>75</sup> and pcapr are available for use by networking teams that wish to share network packets in order to conduct collaborative packet analysis.

## 5.2. Packet builders

Some packet analyzers provide features not only for packet capture and analysis, but also for packet manipulation. However, for modifying packets, there

are purpose-designed packet builders (packet crafters) as well.

Colasoft Packet Builder<sup>77</sup> can be used to create custom packets. It provides templates for Ethernet, ARP, IP, TCP, and UDP packets, and allows the user to change the parameters in a decoder editor, hexadecimal editor, or ASCII editor to create packets.

Hping<sup>78</sup> allows to send custom TCP/IP packets to network hosts while setting the limit for the number of packets after which the sending or receiving should stop, determining the interval between sending packets, and incrementing or decrementing the TTL for outgoing packets.

Scapy<sup>79</sup> is a packet manipulation tool written in Python that enables sending, sniffing, dissecting, and forging network packets, and used in software that probe, scan, or attack networks.

Network Dump Data Displayer and Editor (Netdude)<sup>80</sup> is a framework for the inspection, analysis, and manipulation of pcap/ tcpdump trace files. It can be used to inspect and filter packets at arbitrary locations in trace files, inspect and edit the values of fields in a protocol's packet header, resize individual packets, directly modify packet payload, define arbitrary trace areas for subsequent packet modifications, and copy and move packets between, and delete packets in, trace files.

Fragroute is a command-line packet sniffer that can not only capture packets, but also intercept, modify, and rewrite network traffic, such as by reordering packets or injecting meaningful packets of arbitrary size and length into data streams of TCP/IP sessions (Yang et al., 2018). This can be particularly useful for stepping-stone intrusion detection when analyzing how intruders can manipulate sessions to stay undetected for long periods of time.

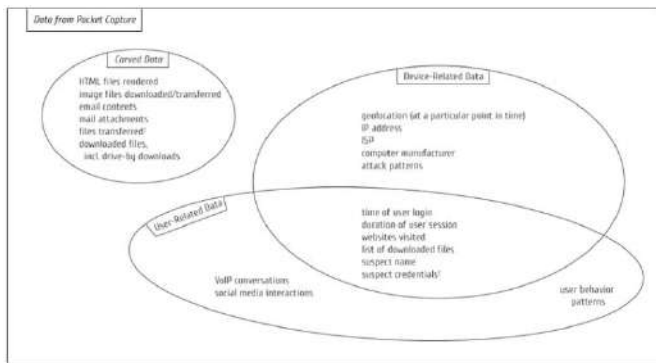


Fig. 5. Primary evidence types derived from network packets for forensic investigations.

### 5.3. Comparisons of packet analyzers for forensic applications

The primary use of packet analyzers in network forensics can be categorized by the data that can be extracted or reconstructed from packet data, and by the level of network activity that can be traced back.

#### 5.3.1. Reconstruction and carving capabilities

Carving can provide both direct and indirect forensic evidence of various nature (see Fig. 5).

Purpose-built carvers, such as tcpflow (Garfinkel, 2013), the Packet Capture Forensic Evidence eXtractor (pcapfex),<sup>81</sup> and File- TSAR,<sup>82</sup> can efficiently extract files from packet capture. NetScout TruView<sup>83</sup> is a high-performance stream-to-disk packet sniffer for tracing abnormal user behavior. It provides advanced filters to find patterns in user behavior, and to identify tampering and compliance and security violations. Its ClearSight Analyzer can play back FTP traffic, messaging, email correspondence, and voice and video calls to quickly extract digital evidence. NetworkMiner<sup>84</sup> acts as a passive network sniffer, which can detect operating systems, sessions, hostnames, open ports, etc. without putting any traffic on the network; as a packet analyzer that parses pcap files; and as a network carver that reassembles transmitted files. Cutter is a tool for the forensic analysis of SCADA network traffic (Senthivel et al.,

2017). It can identify transfers of logic programs and configuration files to/from a PLC in a network packet capture, and extract them for analysis.

#### 5.3.2. Tracing capabilities

When it comes to forensic applications, the amount of context that can be gained from a packet capture is determined by the logical grouping of data that is associated to packets. Many packet analyzers specialise in one or more of the following categories of network information: packet data, packet metadata, flow, session, client-server communication, and payload. Packet analyzers can track one or more levels of network information, such as packet data, packet metadata, flow, and client-server communication (Lovanshi and Bansal, 2019). Although many different types of analyzers are capable of extracting relevant information from packet capture files, certain ones, such as Tranalyzer and TCPflow, are more adept at flow analysis, whereas others, such as Fragroute and NetScout, are better suited for analysing user sessions. This is illustrated in Figure 6.

CoralReef is the greatest option to use when identifying autonomous systems, whereas ngrep is the best option to use when matching patterns or regular expressions in the data payload of packets.

### 6. Research challenges and future directions in packet analysis

The application of machine learning in packet analysis is developing into a sophisticated area of research that aims to solve problems such as the analysis of unknown features and encrypted network data streams (Yin et al., 2018), packet analysis in software-defined networks (Indira et al., 2019), and many more. In point of fact, approaches that are based on machine learning have the potential to address some of the challenges that are associated with packet analysis in relation to big network data (Yoon and DeBiase, 2018). These challenges are affecting an increasing number of packet sniffing implementations.

The examination of data packets transmitted through networks connected to the Internet of Things (IoT) is playing an increasingly significant part in the fight against cybercrime and mass surveillance. For instance, Internet of Things packet analysis may be used to assist in the detection of distributed denial-of-service (DDoS) attacks and the process of botnet formation (Salim et al., 2019). (Kumar and Lim, 2020).

Instead of using files that include packet captures from individual network segments, there is a rising demand for doing packet capturing and analysis in cloud settings due to the expanding number of cloud-based service providers. Cloud storage and cloud computing services are utilised by a variety of industries, including the government and the financial sector, cyber defence and security applications, cloud-managed services, VoIP services, and others. These services involve additional complexities on top of the source and destination IPs, protocols, and port numbers. For instance, this is exactly why Amazon introduced virtual private cloud (VPC) traffic mirroring, which makes it possible to capture and monitor AWS network traffic at scale. This is accomplished by selecting the network interface of a network resource (such as an EC2) and either an elastic network interface or load balancer on another EC2 instance. The traffic that is being delivered to the destination of the mirror is encapsulated using a VXLAN interface on the destination of the mirror. This is the case, for instance, if the network resource in a configuration is an EC2 resource, and the EC2 mirror target runs tcpdump.

Achieving a suitable balance between privacy and packet analysis has been a difficulty for a very long time (Yurcik et al., 2008), and this drives research efforts in the domain of privacy-preserving deep packet inspection. [Citation needed] (Li et al., 2017). Continued growth of the legal challenges and concerns about violating privacy with packet analysis of wireless network traffic (Ohm, 2014) and IoT devices (Vukojević, 2015) calls for additional study into the topic. The accompanying technologies have to be in

accordance with the ever-increasing number of rules and interception laws enacted at the national and international levels.

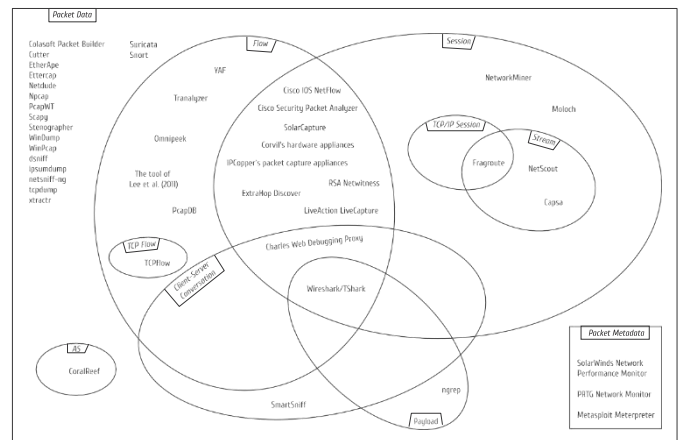


Fig. 6. Packet analyzers by the suitability for analyzing at a particular level of network information context.

## 7. Conclusions

In the field of network forensics, the examination of network packets is an essential step in the process of gathering the data required to achieve a comprehensive comprehension of the activities of online users that took place at a specific instant in time and to provide evidence that can be presented in court. Even though some people might be sceptical about the trustworthiness of the information that can be retrieved or reconstructed from packet data, network packets complement other information, such as corporate firewall logs or CCTV footage, and in many cases, they form the one and only information source about what has happened during an online activity and who was involved in it. Because using packet analysis in network forensics is different from using packet analysis in other application areas, such as intrusion detection, both the potential and limitations of packets in providing forensic evidence have been discussed. The potential of packets has been explained, but the limitations have been highlighted. There are hardware and software implementations available for packet sniffing; however, the capabilities of these tools differ substantially in terms of characteristics, supported

protocols, interface, and licencing. Packet sniffing may be performed using either of these implementations. This study gave comparisons of state-of-the-art packet analyzers from a variety of perspectives, including both pros and cons.

The reader is able to acquire a solid understanding of the processes in packet analysis as well as the tools designed for packet analysis thanks to the exhaustive review that is presented in this paper. In addition, the reader is able to gain an understanding of the specific requirements of network forensics. This may be put to use in the development of original algorithms, as well as cutting-edge tools and procedures, for the purpose of packet analysis in forensic applications.

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# Digital Image Encryption and Decryption based on RSA Algorithm

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## ABSTRACT

Digital images are crucial in many areas, including online communication, multimedia systems, medical imaging, and military communications. Color images are being stored and transmitted over the internet and wireless networks in large amounts and thus it is necessary to protect them from any unauthorized user access. Cryptography is the art of codifying messages, so that the messages become unreadable, this way it plays a vital role in the field of security of data. There are several Cryptographic Algorithms to encrypt and decrypt Images. This paper aims to Encrypt and Decrypt Images based on RSA Algorithm providing Authentication and using Image Hash functions for additional Security and Integrity of images. This project also makes sure the Image retains its quality and is not corrupted even after decryption.

**Keywords** : Cryptosystems, Encryption, Decryption, RSA Algorithm, Image Quality Techniques, Authentication

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## I. INTRODUCTION

RSA Algorithm is most popular and proven asymmetric key cryptographic algorithm. A number various algorithms were proposed for public-key cryptography. Some of these were initially promising but later turned out to be breakable.

At MIT, Ron Rivest, Adi Shamir, and Len Adleman created one of the first effective solutions to the problem in 1977. It was initially published in 1978. Since then, the Rivest-Shamir-Adleman (RSA) scheme has dominated as the most extensively used and adopted general-purpose method of public-key encryption.

The plaintext and ciphertext of the RSA cipher are integers with a range of 0 to  $n-1$  for some  $n$ . An average size of  $n$  is 1024 bits, or 319 decimal places, or  $n \approx 2^{1024}$ . The RSA algorithm unlike few Symmetric algorithms are not based on permutation and combinations, but is rather dependent on mathematics that is to find and multiply large prime numbers with each other. It is based on very large prime numbers. With these large prime numbers one can generate a pair of keys (a Public Key and a Private Key).

So we can say that RSA allows you to be at ease with messages before you send them. And the approach moreover helps you to certify your notes, so recipients will know that their messages are not adjusted or

altered even as in transit. The computers that are made by LG, Toshiba and Samsung are the devices that are embedded with an RSA-Enabled Chip.

Images are widely used over Internet which is a medium of increasing growth of multimedia transfers. So it is very important to secure these images from cryptanalysis and cryptanalysts and ensure that the transfer of these images are complete from one place to another over internet and is not altered or corrupted by hackers.

To secure the Images or Data the first step is Encryption where the data is converted into unreadable or non-understandable form. Later when the transmission of the data is complete it retains back the original form by using the algorithm techniques. This process is Decryption, where the unreadable form is converted back to original data. Additional protection can be provided to this process by providing User Authentication and using Image hash functions. In case of Image encryption and decryption, we also need to make sure once the Image is retrieved back, the quality of the image is not compromised. There are a few parameters to check the Image Quality, few of these include methods like PSNR, SSIM and MSE. In this project we have used SSIM and MSE to check the image quality.

## II. CRYPTOGRAPHY TECHNIQUES OR CRYPTOSYSTEM

To ensure security and integrity of data several cryptographic techniques are used. Basically, there are two Cryptographic systems, depending on the keys used. They are: Symmetric Key Cryptography (same key) and Asymmetric Key Cryptography (different keys).

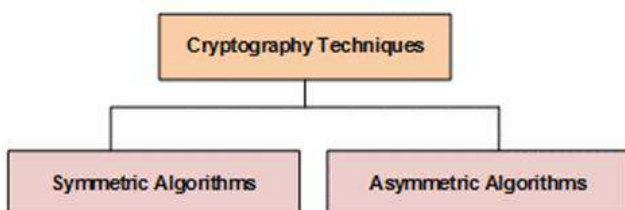


Figure-1. Cryptographic Techniques

### A. Components of Cryptosystem

These are the essential components of cryptosystems.

1. **Plaintext:** The algorithm's input for a message or piece of data where the data is in understandable form.
2. **Ciphertext:** This is the encrypted message produced as an output which is in unreadable format. It depends on the key and the plaintext.
3. **Encryption Algorithm:** The encryption algorithm changes the plaintext (readable communication) in a myriad of areas and outputs ciphertext as a result.
4. **Decryption Algorithm:** It produces the plaintext as an output which takes the secret key and the ciphertext as inputs. It generally performs the reverse process of Encryption.
5. **Public and Private key:** Asymmetric and Symmetric Cryptosystems both use public key (knowing to all) and private key (known just to the user) and these are the pair of keys where one key is used for encryption and the other for decryption.

### B. Types of Cryptosystems

#### Symmetric Key Cryptosystem

It is a process that uses only one key that is secret key to decrypt and encrypt a message to protect it from cryptanalysts.

Ex: DES, AES and 3-DES.

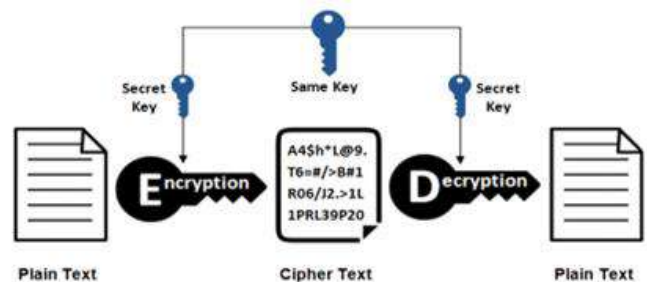


Figure-2. Symmetric Key Cryptosystem

#### Asymmetric Key Cryptosystem

Another name for this system is Public Key Cryptosystem. Here, the encryption and decryption keys used by the sender and receiver are distinct.

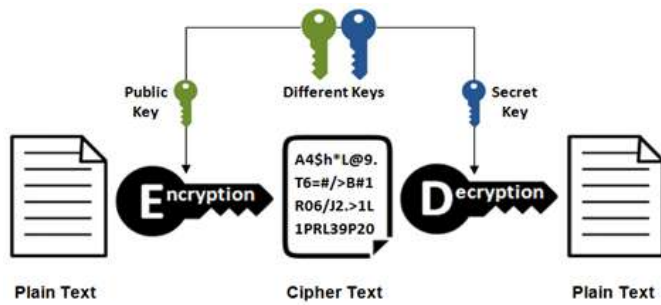


Figure-3. Asymmetric Key Cryptosystem

Ex: Diffie-Hellman, RSA, DSA and ECC

### III. OBJECTIVES

The main Objectives of this project:

- Simulation of RSA algorithm to ascertain encryption and decryption.
- To develop an optimized algorithm using the 2 prime numbers to generate encryption and decryption keys to enhance data security goals such as confidentiality, authenticity, secrecy and integrity.
- Comparison of the approach/results with existing ones.
- Compares the quality of original image with the Decrypted image

### IV. METHOD OF IMPLEMENTATION

Input Image: The image which has to be encrypted.

Key Generation: It is the first step in RSA algorithm. The generation of a pair of keys is necessary before using the public key cryptosystem. These tasks are included in this:

1. To determine 2 prime numbers,  $p$  and  $q$ .
2. Select either  $d$  or  $e$  and then calculate the other.

#### A. RSA Algorithm

Exponential Expressions are used by RSA. Typically, plaintext is encrypted in blocks, with each block having a binary value  $< n$ , or a block size  $\leq \log_2(n) + 1$ ;  $2^i < n \leq 2^{i+1}$ , where  $i$  is the block size in bits. The RSA-768 Challenge, which has a key length of 768 bits or 232 in decimal digits, is the most recent challenge to be overcome in the attack on RSA. Therefore, 1024 to

2048 key bits or more should be considered appropriate. The sender and the recipient are both aware of the value of  $n$ . Only the receiver is aware of the  $d$  value; the sender is aware of the  $e$  value.

#### Working of RSA Algorithm

- Consider 2 huge prime numbers from image pixels  $p, q$  such that  $p \neq q$ .
- Calculate  $n = p \times q$ ,  $\phi(n) = (p-1)(q-1)$
- Select  $e$  such that  $\gcd(e, \phi(n)) \equiv 1$ .
- Calculate  $d$  using Extended Euclidean algorithm ( $d \equiv e^{-1} \pmod{\phi(n)}$ )
- Public key =  $\{e, n\}$
- Private key =  $\{d, n\}$
- Encryption  
 $C = M^e \pmod{n}$  where  $C = \text{Ciphertext}$  and  $M = \text{Plaintext}$ .
- Decryption  
 $M = C^d \pmod{n}$

#### B. Authentication:

It recognises user's identity and it confirms who they say they are. Usually in authentication process the computer or the user needs to prove their identity to the clients or servers which involves username and password or other methods like fingerprint, facial scan, voice biometrics and captcha text.

#### C. Image Hash Functions:

It is a process of assigning a unique hash value to the image with the help of an algorithm. To verify the accuracy of the photos, Image Hash is used in place of cryptographic hash methods like SHA-256 and MD5 Algorithms.

#### D. Autocorrelation:

The autocorrelation function is used to find patterns in data. Every original image will have certain patterns in the autocorrelation plot. For good algorithm the encryption correlation plot should appear random with no identifiable patterns. This reduces the statistical analysis attacks on the cipher image.

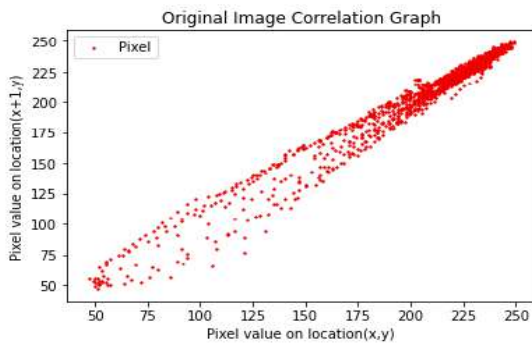


The pixels are selected randomly in horizontal, diagonal and vertical directions in both the plain and encrypted images and calculate the correlation degree

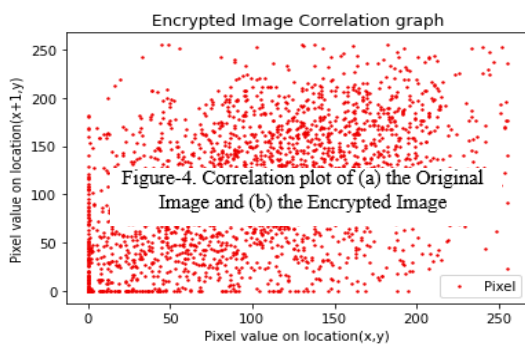
$$r_{xy} = \frac{E((x - E(x))(y - E(y)))}{\sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - E(x))^2} \sqrt{\frac{1}{N} \sum_{i=1}^N (y_i - E(y))^2}}$$

with the expression,

where x and y are neighbouring pixels in different directions and  $E(x) = \frac{1}{N} \sum_{i=1}^N x_i$ .



(a)

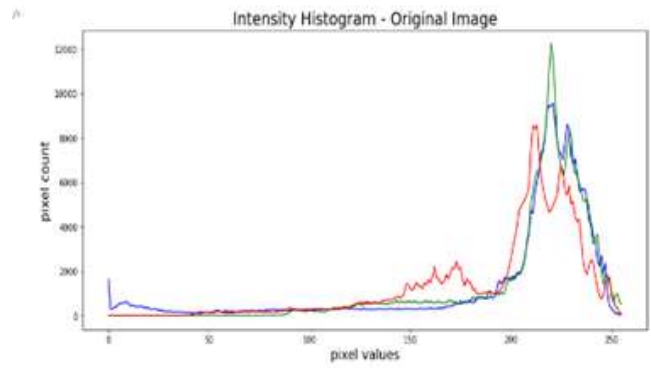


(b)

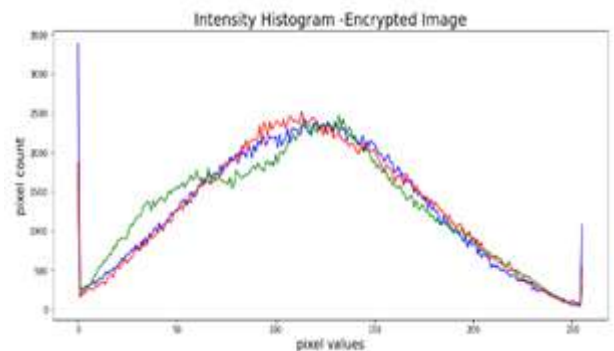
## V. IMAGE QUALITY TECHNIQUES

### A. Histogram Analysis

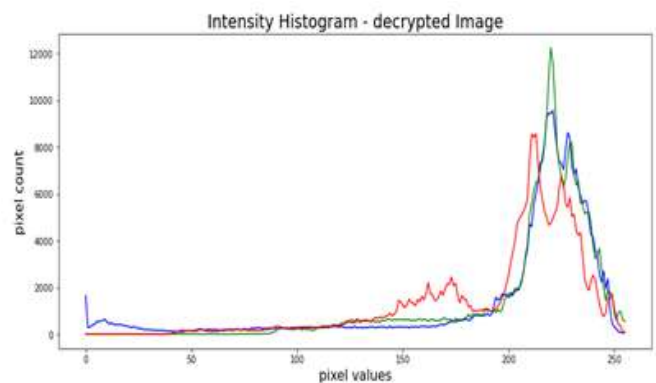
It is an effective way of comparing two images and thus illustrating the image quality. The Histogram plots of Original Image and the Encrypted Image should always be different while the histogram plots of the original and decrypted images should be the same.



(a)



(b)



(c)

Figure-5. Histogram plot of (a) Original Image, (b) Encrypted Image and (c) Decrypted Image.

### B. Structural Similarity Index Measure (SSIM)

It is used for measuring the similarities between two images. The initial distortion or Uncompressed of free image predicts the Image Quality. Generally, the value

$$SSIM(x, y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x + \sigma_y + c_2)}$$

varies between 0-1. 1 implies perfect match with the original image.

### C. Mean Squared Error (MSE)

The statistical models like images and data uses MSE to measure the amount of error in it. It is the sum of squared difference between the two images. The two images must have the same dimensions. The MSE equals zero when the model has no error.

$$MSE = \frac{1}{n} \frac{1}{m} \sum_{i=1}^n \sum_{j=1}^m (Y(i, j) - \hat{Y}(i, j))^2$$

## VI. RESULTS

Here it is shown that Images of almost all sizes can be encrypted and decrypted. The results are as shown below.



(a)



(b)



(c)

Figure-6. (a)Original Image, (b) The Encrypted Image and (c) The Decrypted Image

The SSIM and MSE values for the respective images are as shown below.

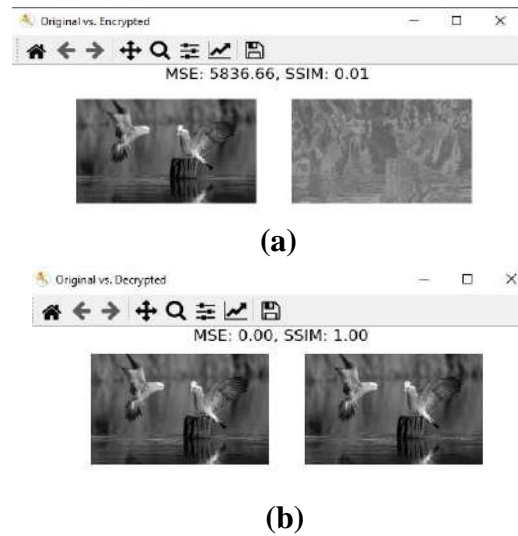


Figure-7. (a) SSIM and MSE values of Original Image Vs Encrypted Image (b) Original Image Vs Decrypted Image.

## VII. DISCUSSIONS

Simulation of RSA algorithm on images and respective Encrypted and Decrypted Images are being displayed.

Authentication is provided for the Encryption and Decryption process with their respective user credentials for additional protection of the data.

The Scattered Pattern of Autocorrelation graph shows that the Algorithm is a good algorithm for Encryption of Images.

Comparison of the approach/results with the existing ones.

Compares the quality of the Original Image with the Decrypted Image.

## VIII. CONCLUSION

In our project we have shown the implementation of the RSA Algorithm obtaining the final results in the form of Image Encryption and Decryption. This project is also provided with Authentication and Image Hash functions for integrity. We have also used SSIM and MSE for Image Quality evaluation.

### IX. FUTURESCOPE

- Further other algorithms can be used together and compared.
- Encryption for Audio or video can also be implemented further.
- Steganography can also be used to enhance encryption.

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# Big Data Backup Deduplication: A Survey

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## ABSTRACT

The massive explosion in the field of data such as images, video, audio, and text has caused significant problems in data storage and retrieval. Companies and organizations spend a lot of money to store and manage data. Therefore, there is an urgent need for efficient technologies to deal with this massive amount of data. One of the essential techniques to eliminate redundant data is data deduplication and data reduction. The best technique used for this purpose is data deduplication. Data deduplication decreases bandwidth, hard disc drive utilization, and backup costs by removing redundant data. This paper focuses on studying the literature of several research papers related to data deduplication for various techniques that several researchers have proposed. It summarized multiple concepts and techniques related to deduplication and methods used to improve storage. The data deduplication processes were examined in detail, including data chunking, hashing, indexing, and writing. Also, this study discussed the most critical problems faced by the data deduplication algorithm.

**Keywords:** Data Deduplication, Data Reduction, Redundant Data, Data Chunking, Hashing.

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## I. INTRODUCTION

The expansion of data that accompanied the information revolution is massive, and many organizations and people are already facing real problems in dealing with this vast volume of data and how to secure and store this data [1]. The International Data Corporation (IDC) defines global information as data produced, captured, or transcribed via globally distributed digital resources. Global data will expand from 33 zettabytes (ZB) in 2018 to about 175 zettabytes (ZB) by 2025, as shown by IDC forecasts [1]. Many large companies like Google, IBM, Microsoft, Intel, and Motorola found, through a study conducted on the existing global data, that almost three-quarters of the

current digital data are duplicate data [2]. Therefore, there is an urgent need for organizations, IT companies, and industries to store a massive amount of their data securely and to be able to work on it and retrieve it quickly. Since this data is vast, one of the most challenging tasks in big data is the process of backup and maintenance, as these operations are costly and considered among the challenges in this field [3]. Therefore, there is a significant challenge in storing and managing such vast amounts of digital data [4]. As a result, the deduplication technique, which prevents storing duplicate data on hard disks, is among the most excellent solutions to these challenges [5]. Data deduplication technology has become the dominant

technology that reduces the space required for backup data and primary file systems [6].

The data deduplication system has four major stages: chunking, fingerprinting, indexing, and data writing. The early phase considered a bottleneck in removing redundant data is chunking, in which vast amounts of incoming data are divided into small parts or chunks [7]. Chunk-level deduplication may be accomplished in two ways: fixed-size chunking (FSC) and variable size chunking (VSC) [8]. In FSC, the entire file contents divide into chunks of equal size. The FSC has low efficiency of deduplication and suffers from the boundary shifting problem, whereas VSC eliminates the issue of boundary shifting and divides the file into chunks; it does not have to be of equal sizes. The VSC method requires more computation and time but provides a more significant percentage of deduplication [9]. Fingerprinting is the second stage of the data deduplication system; each chunk is allocated a unique value. Hash functions such as Secure Hashing Algorithm SHA-1 or Message-Digest Algorithm MD5 are widely used in this stage of the data deduplication system, which generates a digest for each chunk called a fingerprint. The third stage is indexing when the previously stored fingerprint values are compared with the fingerprint values of the new chunks to obtain the duplicate chunks. Indexing relies on chunking fingerprints to find duplicate chunks that can be identified and then remove them. If indeed the fingerprints of the two chunks match, they are considered identical. Writing is the fourth stage of data deduplication, storing a unique copy of the data on the hard disk. The unique chunks that do not have identical fingerprints are considered non-duplicate and stored in a hash table [10].

This paper examines different classifications to remove duplicate data, including granularity-based (file-level deduplication or chunk-level deduplication), time-based (before or after data is stored on disk), and based storage location deduplication, side-based deduplication, and Implementation based duplicate data. It also provides a review of the development of

data deduplication technology, the pros and cons of each algorithm, the technical methods used, and identifies the problems and challenges facing storage systems based on data deduplication technique. Several recent studies and survey contributions in the field of deduplication have provided new algorithms and methods for improving deduplication. In addition, some studies focus on a specific aspect of deduplication, such as chunking or indexing systems and cloud storage.

The remaining sections of the survey were set up as follows. The key benefits and downsides of data deduplication are outlined in Section 2. Some of the recent studies that investigated various deduplication methods are included in Section 3. Section 4 goes into great depth about several deduplication methods. Section 5 goes into great detail on the primary steps in data deduplication. Finally, the summary of the survey is presented in Section 6.

## II. DEDUPLICATION

The data deduplication technique is one of the most important techniques used to remove redundancy data [1]. This technique helps companies provision much money by reducing the cost of bandwidth and storage. It is helpful in cloud services because it reduces the need for additional storage devices [2]. Data deduplication is a technique to resolve storage problems. Four main steps are included in removing data duplication: data chunking, fingerprinting, indexing, and writing [3]. "Fig. 1" illustrates the general view of the four main stages of data deduplication There are various advantages of Data Deduplication, such as:

1. Improved efficiency of the network.
2. The space required for storage is Low.
3. The cost of storage is reduced.
4. Storage efficiency is increased.

Reduced upload bandwidth [4]. On the other side, there are several disadvantages to the deduplication technique, which are listed as follows [5]:

1. The duplicate data removal method requires some additional resources
2. Hash function inconsistencies can cause data to lose accuracy and consistency.
3. Security and Privacy.
4. Reducing data duplicates affect storage system availability.

### III. Related Work

Table I shows several papers that dealt with deduplication in recent years and reviews the most critical techniques used and the results obtained. In addition, shows the data sets that each researcher relied on to obtain the results and the limitations of each paper.

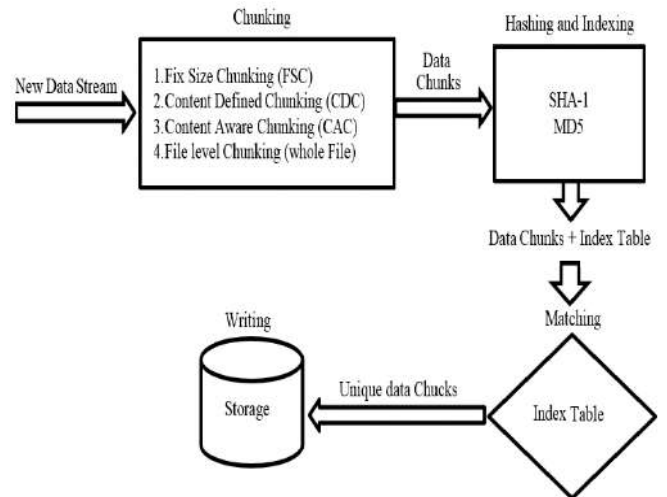


Figure. 1. General view of data deduplication stages [6].

TABLE I. The list of techniques, datasets, achievements, and limitations of recently released publications on data deduplication.

Paper	Technique Used	Dataset	Achievement	Limitation
2021 [12]	<ul style="list-style-type: none"> <li>• Effective mathematical bounded linear hashing</li> <li>• The hierarchal fingerprint lookup strategy</li> </ul>	<ul style="list-style-type: none"> <li>• Linux Kernel 10.9 GB</li> <li>• SQLite 6.44 GB</li> <li>• Oracle RMAN Backup 18.7 GB</li> </ul>	<ul style="list-style-type: none"> <li>• Decreases the hashing time</li> <li>• Reduces hash index table by 50%.</li> <li>• Minimize hash comparison time by up to 78%.</li> </ul>	<ul style="list-style-type: none"> <li>• The size of a hash index table grows greatly</li> <li>• Using a fixed number of hashes (five hashes)</li> </ul>
2021 [13]	<ul style="list-style-type: none"> <li>• Matching based on forwarding/end feature vectors</li> <li>• Uses dynamic adjustment of mask bits</li> </ul>	<ul style="list-style-type: none"> <li>• Glibc, GCC, and MySQL 56 GB</li> <li>• Redis 111GB</li> <li>• SYN 108GB</li> </ul>	<ul style="list-style-type: none"> <li>• Achieve a 222.3% deduplication ratio compared to Rapid CDC.</li> <li>• Chunking speed was 11.4x faster than Rapid CDC.</li> <li>• Productivity is higher by 111.4% than Rapid CDC</li> </ul>	<ul style="list-style-type: none"> <li>• New fingerprints improve processing speed.</li> <li>• The deduplication ratio is slightly improved.</li> </ul>
2021 [14]	<ul style="list-style-type: none"> <li>• A collection of repeating patterns is utilized to detect breakpoints.</li> <li>• Three-level lightweight hash function.</li> </ul>	<ul style="list-style-type: none"> <li>• (Linux 3.9, Linux 4.14.157, and Linux 5.8.12) 2.32 GB</li> </ul>	<ul style="list-style-type: none"> <li>• Faster than BSW by 15 times</li> <li>• Ten times quicker than TTTD</li> <li>• Five times faster than MD5 and SHA1</li> </ul>	<ul style="list-style-type: none"> <li>• It does not use a dynamic set of divisors.</li> </ul>
2020 [15]	<ul style="list-style-type: none"> <li>• Use of five main techniques</li> <li>• Quick-rolling hashing based on gears</li> <li>• Simplify and enhance the Gear's hashing rule</li> <li>• Skip sub-minimum cut-off points</li> </ul>	<ul style="list-style-type: none"> <li>• TAR 56 GB</li> <li>• LNX 178 GB</li> <li>• WEB 237 GB</li> <li>• VMA 138 GB</li> <li>• VMB 1.9 TB</li> <li>• RDB 1.1 TB</li> <li>• SYN 2.1 TB</li> </ul>	<ul style="list-style-type: none"> <li>• Chunking speed is 3 to 12 faster than CDC approaches.</li> <li>• Improve system throughput</li> </ul>	<ul style="list-style-type: none"> <li>• The same redundant data removal rate as the CDC.</li> </ul>

Paper	Technique Used	Dataset	Achievement	Limitation
2020 [16]	<ul style="list-style-type: none"> <li>Bytes Pair Frequency-based Chunking (BFBC) algorithm</li> <li>The proposed triple hash function</li> </ul>	<ul style="list-style-type: none"> <li>Linux Kernel 5.93 GB</li> <li>SQLite 6.44 GB</li> </ul>	<ul style="list-style-type: none"> <li>DER is better than other CDC algorithms</li> <li>Three times faster than TTTD.</li> <li>Ten times faster than the BSW algorithm.</li> <li>Hashing is 5 times faster than SHA1 and MD5</li> </ul>	<ul style="list-style-type: none"> <li>Efficiency is affected by content data set similarity.</li> <li>Potential hashing collision increases with a large dataset.</li> <li>Computational overhead increases when the size of the hash table increases.</li> </ul>
2018 [17]	<ul style="list-style-type: none"> <li>New fingerprint function</li> <li>A multi-level approach to hashing and matching</li> <li>New indexing method for storing metadata.</li> </ul>	<ul style="list-style-type: none"> <li>Versions of Emacs and 3DLDF (GNU 580 MB, GNU 1.27 GB)</li> </ul>	<ul style="list-style-type: none"> <li>Improves the TTTD algorithm.</li> <li>Reduce system resource usage</li> </ul>	<ul style="list-style-type: none"> <li>Efficiency is affected by content data set similarity.</li> <li>Potential hashing collision increases with a large dataset.</li> </ul>
2017 [18]	<ul style="list-style-type: none"> <li>An asymmetric local range's maximum value</li> </ul>	<ul style="list-style-type: none"> <li>Bench: 108 GB</li> <li>Open-source: 169.5GB</li> <li>VMDK: 1.9TB</li> </ul>	<ul style="list-style-type: none"> <li>2.3X increase in throughput.</li> <li>Increases system speed by 50%.</li> <li>Overcoming the problem of the boundaries-shifting</li> </ul>	<ul style="list-style-type: none"> <li>Deduplication strategies cannot be used directly on security systems.</li> </ul>
2016 [19]	<ul style="list-style-type: none"> <li>Bucket-based and Map Reduce under HDFS</li> <li>Fixed-size chunks</li> <li>MD5 algorithm module to generate hash</li> <li>MapReduce model is applied</li> </ul>	<ul style="list-style-type: none"> <li>Zip Code Tabulation Area (ZCTA) 2.6 GB and 1.7 GB</li> </ul>	<ul style="list-style-type: none"> <li>Distinctive buckets used for hash storage</li> <li>Reduce hashing time and chunk lookup.</li> <li>High deduplication ratio.</li> <li>Significantly reduces data volume.</li> </ul>	<ul style="list-style-type: none"> <li>Uses fixed-size chunking to reduce duplicate data removal</li> <li>Boundary problem</li> <li>It uses md5 algorithm</li> </ul>

#### IV. Types of Deduplication Technique

There are different ways to remove duplicate data saved in the data store. However, most companies use deduplication approaches to solve and reduce the

deduplication problem [7]. "Fig. 2" shows the different approaches used to remove duplicate data [2]:

- Based on Granularity
- Based on Time deduplication.
- Side-based deduplication.
- Implementation-based deduplication.

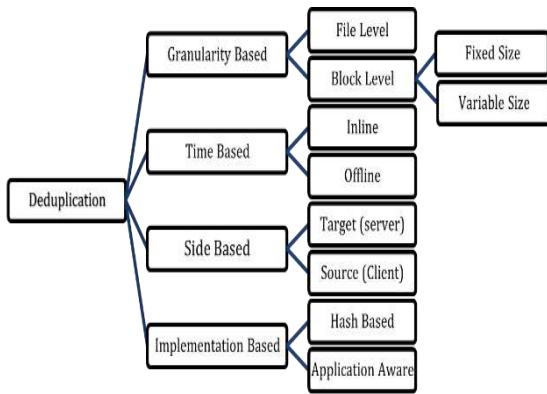


Figure. 2. Types of deduplication approaches

### A. Based on Granularity

Depending on the first criterion, there are two classifications of deduplication, as follows [8]:

1) **File-level deduplication:** When using file-level deduplication, the entire file is handled as a single chunk rather than divided into many chunks [9]. In this technique, one hash value is constructed for the whole file, and the hash value for the new file is compared to the hash values of the stored files to find and eliminate duplicate files [10]. This method is not concerned with the internal contents of the file. For example, when two files are saved with the same internal content but different names, they are considered separate files. This approach is quick, easy, and requires little processing power. Single-instance storage is another name for this approach [8]. "Fig. 3" shows the deduplication technique with file-level deduplication.

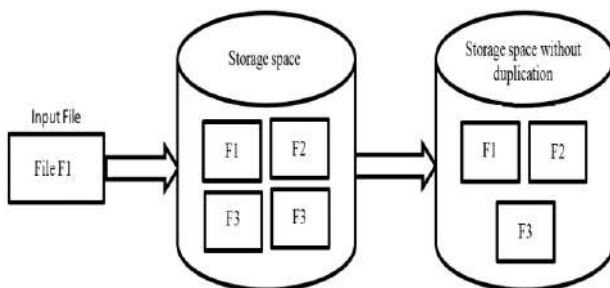


Figure. 3. File-level deduplication[11].

2) **Chunk-level deduplication:** In this approach, the file is divided into several small blocks, and each is

called a chunk. In data deduplication, the search for duplicate chunks is within the file, and each chunk's unique copy is stored. Files can be divided into two ways to de-duplicated chunks [23]. Files can be divided into chunks of fixed length, i.e., the chunks with the same size, or into chunks of variable length, i.e., chunks with variable size [25]. Data deduplication using chunks level is far more efficient than deduplication of file-level [26]. The Content-Defined Chunking CDC algorithm breaks the data stream into chunks of varying sizes based on the content of the data stream, and when the local content does not change, the chunk limits do not change [27].

a) **Fixed-Size Chunk De-duplication:** The file is broken into fixed-size chunks, and identical chunks are identified using a standard hash algorithm [28]. The size of chunks can range from 8 to 64 KB [29]. The main drawback of this method is that any modification, even if minimal, in the chunk leads to rewriting the collection of other successive chunks on the drive. For example, if a single byte is entered at the beginning of this data stream, it causes all boundaries of the current chunk defined using FSC to be changed, resulting in less redundant selection and thus less deduplication. In other words, it suffers from what is called a boundary-shifting problem. Nevertheless, this approach is prevalent with a meagre remove data redundancy ratio. Figure (4) shows the deduplication technique with Fixed-size chunk deduplication.

b) **Variable-size chunk deduplication:** This partition type depends on the file's internal content for dividing the file into chunks [30]. The file is broken into chunks of varying sizes using a method known as Content-Defined Chunking CDC [23]. The boundaries defined in this algorithm are variable in size, which depends on multiple indicators that can change if the content of a file is changed or deleted [31]. The change in the size of the boundaries adopted by this algorithm makes it more resistant to deleting or entering new data [30]. However, this algorithm needs more system resources, such as the CPU, to perform a full file scan



and determine the boundaries of each chunk [23]. "Fig. 4" shows the deduplication technique with variable-size chunk data deduplication.

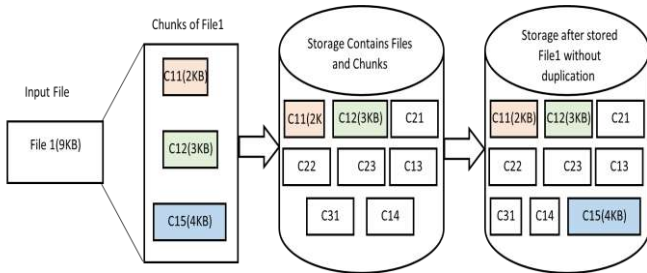


Figure 4. Variable-size chunk deduplication[11]

3) Granularity based Advantages and Disadvantages: Granularity classification categorizes redundant data according to its Granularity, which describes the influence of this on different storage techniques, the techniques employed in such systems, and the impact of those varied ways on deduplication efficiency, performance, and resource consumption. The main drawback of categorizing data by Granularity is that typical hash storage systems are limited in their ability to reduce data redundancy.

**B. Based on Time deduplication**

In this approach, there are two methods [23].

1) Inline deduplication: Inline deduplication eliminates redundant data during or before it is written to the hard disk, reducing the storage space [23]. This method is flexible and powerful since it processes the data once [8]. Inline deduplication can be done on the client-side or when data is sent from the data source/client to the target/server [10]. However, the inline deduplication approach can only use a fixed-length chunk because it checks the incoming raw chunks and does not know other chunks [17]. The main drawback of this technique is that network efficiency significantly impacts it. However, this method's required storage capacity is less while the computation time is high [32]. "Fig. 5" shows the deduplication technique with Inline Deduplication of Data.

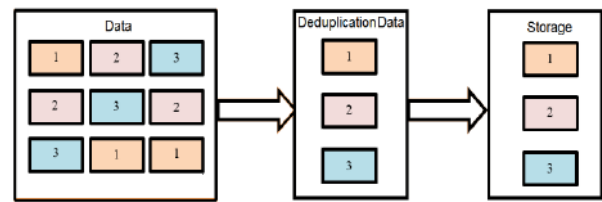


Figure 5 Inline Deduplication of Data [24].

2) Post-process deduplication: Data is initially written to the storage device, and duplicate data is found and removed [23]. Both file and sub-file levels may benefit from post-process deduplication [17]. This technique's performance is superior to the inline approach [33] because it involves fewer calculations. The major drawback of this approach is that it requires an additional disk cache, which means that it is more expensive than the inline method [32]. "Fig. 6" shows the Post-process Deduplication of Data.

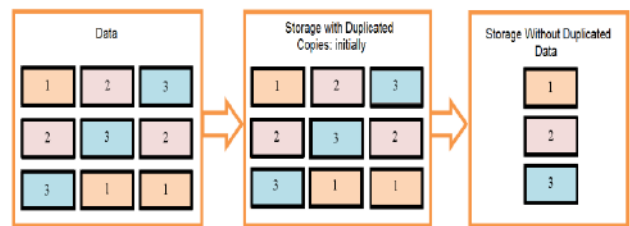


Figure 6. Post-process Deduplication of Data [24].

3) Time Classification Advantages and Disadvantages: In time classification, all deduplication systems depend on when the process occurs, if the process is during the storage process or after the storage process. Inline deduplication occurs during data flow, whereas post-process deduplication occurs after data has been written to disk. Inline deduplication has a slow storage performance, whereas post-process deduplication has a fast storage performance because the hash calculation is deferred. The storage requirement and network traffic are less in inline deduplication and more comparative in post-process deduplication. The storage throughput of inline deduplication is lower than that of post-process deduplication. Inline does not require temporary storage space, while post-process deduplication is required.

### C. Based on Side

In this approach, there are two methods source / client deduplication and target deduplication as shown in "Fig. 8" [32].

1) Source / Client deduplication: This approach removes duplicate data at the source before sending it [33]. Removing the data takes place on the client/source side before transferring the data to the backup device [32]. One of the essential features of this type of data removal is that it does not require a high bandwidth compared to the Target deduplication. As a result, source/client deduplication has two main advantages: it uses less bandwidth to transmit data and stores unique data [32]. The problem with this method is that it de-duplicates data using the entire client's resources [24]. However, this method's disadvantage is that it overloads the client CPU up to 15% by performing the Deduplication processes. Besides, if large amounts of data need to be processed, then the processing time will be increased, leading to slowing down the servers on the source side [20]. "Fig. 7" (a) shows source/client data deduplication.

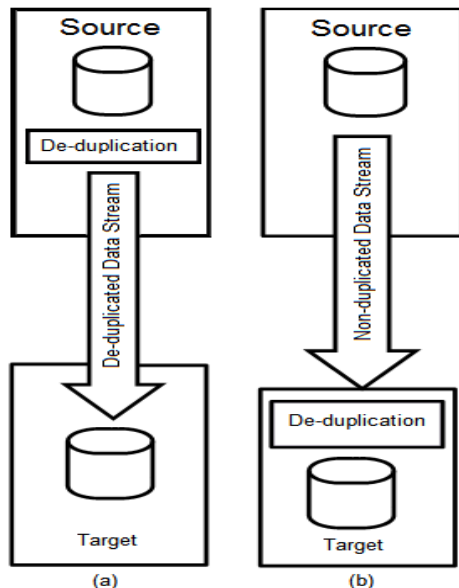


Figure. 7. (a) Source/client data deduplication and (b) target data deduplication [20].

2) Target deduplication: The duplication process occurs at the backup server-side, as all comparable data is completely transferred to the backup server [24]. Target data deduplication is fast and easy to perform the deduplication process on the server side because it contains all the data in its full replica [9]. However, this method has the disadvantage of requiring more bandwidth to transmit data due to the possibility of duplicate data [24]. Figure (8) (b) illustrates target data deduplication.

3) Advantages and disadvantages of side classification: Source deduplication requires bandwidth less than target-based deduplication. The resources that are needed by source-based more than they need for target-based deduplication. The processing overhead at the client for source-based is more than target based. Therefore, the source-based approach is slower than target based.

### D. Based on Implementation

In this approach, there are two methods in this principle [32].

1) Hash-based deduplication: Hash-based deduplication is applied to find out if two documents or two chunks are the same [32]. In the beginning, the content of the data is hashed. Next, the created signatures of the chunks are compared to see if these two chunks are redundant or not [24]. If the generated signatures are the same, the two entities are discarded as being too similar. If not, it is saved on the hard drive. Finally, it can calculate the value of a data hash using any of the known hashing algorithms, including but not limited to MD5, SHA-1, SHA-256, and SHA-512 [32].

2) Content or application-aware deduplication: When using the content-aware deduplication method, data is treated as an object in the deduplication application [24]. The process of comparing is performed on the level of objects. After detecting identical parts, it saves only the bytes modified in the two parts [8]. It removes redundant data at the byte

level [24]. The content-aware technique looks for similar fragments or bytes, and only bytes that have changed or are unique are saved [32]. For example, if a backup stream is taking place on a file and it is known where the file boundaries are, knowing the boundaries can be helpful in data deduplication [34].

3) Advantages and disadvantages of implementation classification: This classification requires overcoming the shortcomings of previous classifications by implementing content-based deduplication or application-aware systems to examine and differentiate different systems based on efficiency and speed. Content-aware-based deduplication is

faster than content-based deduplication because it only processes and compares data in the same type of objects and does not compare with all. In comparison, the latter is more efficient than the former. The comparison of different data deduplication techniques is shown in Table II.

### V. Deduplication Stages

The main stages included in data deduplication can be summarized in four stages: data chunking, fingerprinting, indexing and writing. This research deals with these stages and the techniques used in each stage in detail [18].

Table II Various data deduplication techniques are compared and contrasted.

Deduplication Method	Throughput	Storage	Efficiency	Deduplication Ratio	Bandwidth	Cost
File Level	high	Average	less	a little	a little	a little
Block Level	a little	high	high	high	Average	Average
Source Based	Average	Average	Average	Average	a little	a little
Target- Based	Average	high	Average	Average	high	high
Inline	a little	a little	Average	a little	a little	a little
Post-Process	Average	a little	high	high	high	high

#### A. Chunking Algorithms

Dividing files or data streams into multiple chunks of fixed or variable length is known as data chunking [12]. A set of different chunking algorithms deals with the process of dividing files into chunks. These algorithms will be analysed and discussed in this section, and their most important advantages and disadvantages are present as follows:

1) Rabin Fingerprint Algorithm: The Rabin fingerprint [35] based on the CDC algorithm was used to eliminate redundant data in deduplication systems and network traffic [36]. The Rabin method establishes minimum and maximum bounds on the size of the chunks to prevent the algorithm's output from being

very short or highly lengthy. Tiny chunks contain more fingerprints, need more space to store and process, and are therefore not cost-effective, while too long chunks lead to a decrease in deduplication efficiency [37]. Rabin's algorithm [38] suffers from two main problems; the first is to calculate the fingerprints of all the pieces, which takes a long time [37], and the second is the significant variance in the size of the chunk, which reduces the efficiency of removing duplicate data. "Fig. 8" illustrates the general view of the Rabin fingerprint algorithm [19].

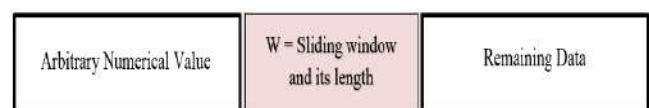


Figure 8. Operation of Rabin fingerprint algorithm [19].

2) Two Divisors (TD) Algorithm: The TD [39] algorithm is based on using a secondary divisor to determine the breakpoints for dividing large chunks. It has a good chance of getting the duplicated chunks as it is used to overcome the boundary shift problem caused by the BFS algorithm [39]. The TD algorithm starts with checking the stream file, searching for the breakpoint, and creating a fingerprint for each chunk [34]. Then, it checks that the fingerprint of both divisors matches. It will be a breakpoint if the first divider finds a match in the fingerprint before the threshold value. If the first divisor fails to reach these breakpoints during a specific threshold value, the second divisor is used. It uses the secondary divider to try to find a breakpoint [39].

3) TTTD (Two Thresholds, Two Divisors) Algorithm: The TTTD algorithm [39] consists of combining two algorithms, the TD algorithm and the SCM (Small Chunk Merge) algorithm [40]. The TTTD algorithm improves the efficiency of the Rabin algorithm in removing duplicate data. The TTTD algorithm provided an additional backup divisor to reduce the difference in the chunk size, which has a high probability of finding the breakpoints[27]. The TTT algorithm uses four parameters in the process of discovering the breakpoints, which are:  $T_{min}$  (Minimum Threshold),  $T_{max}$  (Maximum Threshold),  $D$  (Primary Divisor), and  $D$  (Primary Divisor). The minimum and maximum threshold values should be set to control for variance in the chunk size so that the second divisor is half of the base divisor [40]. The TTTD algorithm has been improved [41] by adding a new switch condition to improve the time required for execution without affecting the deduplication ratio. If the breakpoint is not reached before 1600 bytes, the values of each major divisor  $D$  and second divisor  $D$  Dash have been reduced by half [42]. The TTTD algorithm improves [43] processing time by about 6% and reduces chunk size by about 5% [14].

4) MAXP: MAXP [39] is a CDC algorithm that solves the Rabin algorithm's chunk size variance

problem by attempting to find local extreme values in a symmetric fixed-size window. MAXP is also recommended for eliminating network redundancy [34]. The MAXP shifts a fixed-size symmetric window over the byte stream on a byte-by-byte basis and checks whether the byte value in the center of the current window is the maximum value. The extreme points are used as a cut point to divide the input stream. The MAXP method [44] uses the strategy of locating local extreme values by rechecking some of the previously compared bytes, which significantly reduces the chunking throughput [4].

5) Bimodal: The bimodal approach combines chunks of varied average sizes and is an improved version of the CDC algorithm[26]. The bimodal algorithm performs a specific split of the size of the expected chunk in a dynamic manner. It works to split the data stream into large chunks, and for non-duplicated chunks, it divides them into smaller chunks. This algorithm is based on two methods to eliminate redundancy in large chunks [45]. The first method works by dividing the data stream into large chunks, and after identifying the areas of the new chunk's content, the data near the boundaries of the changing area chunks are divided into small chunks. The second method uses a flexible algorithm to combine the small chunks from the first method into a large one to solve the boundary shift problem [20].

6) MCDC (Multimodal Content Defined Chunking): The MCDC algorithm [46] is presented to maximize the efficiency of Bimodal Content-Defined Chunking. The MCDC finds the optimal size of chunks by changing the data size of chunks and the ability to compress data in these chunks. This algorithm works in two stages: First, the data is divided into fixed-size chunks, and then the Compression ratio (CR) is found separately for each chunk [42]. Dividing the data into fixed chunks led to the boundary shift problem. In the second stage, the MCDC algorithm has solved this problem by dividing the data stream into variable chunk sizes using Uni-modal chunking and calculating the compression ratio for each of them [42]. The

dividing using variable-size chunks and based on the comparison fingerprint technology reduced the number of chunks and lowered overall system cost while maintaining effective deduplication [45].

7) Leap-Based: Leap-based CDC algorithm [47] add a new control function to see if the window is qualified or not. It is used to improve the algorithms that use the CDC algorithm to remove duplicate data. This algorithm uses a pseudo-random method instead of the methods used in many CDC algorithms. "The Transformation derived from the locality-sensitive hashing and the theorem that the sum or the difference of normal distribution is still a normal distribution" [47]. The leap based has two parameters, M and Pw, and these parameters determine the performance and chunk size of the leap-based CDC, where M is the number of satisfactory windows and Pw is the window interpolation probability. The lead-based CDC algorithm uses two parameters to determine performance [45].

8) AE Algorithm: AE Asymmetric Extremum Algorithm [27] significantly improved the performance and efficiency of existing chunking algorithms. Instead of employing a fixed-size window like the MAXP Algorithm, AE solves the boundary shift issue using an asymmetric variable window[44]. It works to find the maximum local extreme value in the window, does not need backtracking, and needs only one comparison [48]. Therefore, the AE algorithm is high-speed, and the variance in the chunk size is minimal compared to other chunking existing CDC [44] algorithms. It does not impose any restrictions on the size of the chunk size [34]. "Fig. 9"

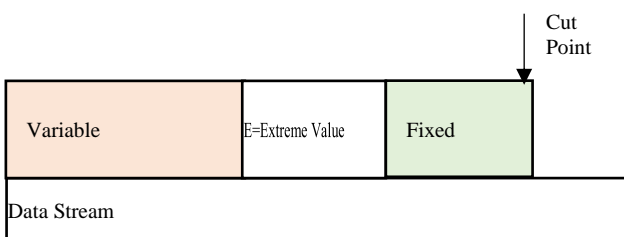


Figure. 9. Operation of Asymmetric Extremum Algorithm [19].

illustrates the AE Asymmetric Extremum Algorithm [19].

9) Rapid Asymmetric Maximum Algorithm (RAM): The RAM algorithm is a hash-free chunking approach based on AE that declares chunk cut-points using bytes values. It reads data as a byte stream without putting a window at the end of every chunk. Due to the usage of two windows, one fixed and the other variable, RAM employs the same algorithm as AE [19]. However, the RAM method places the fixed-sized window at the start of the chunk, followed by the variable-sized window and the byte with the highest value [12]. The RAM algorithm takes less computation time because it searches for a byte greater or equal to the current maximum value. Unlike the AE algorithm, which searches for data equal to or less than a current value. Since there is a lower probability that a byte is higher than the current value, the RAM algorithm is less overhead than the AE algorithm [49], so RAM's throughput is better than the algorithm AE [48]. "Fig. 10" illustrates the general view of the Rapid Asymmetric Maximum Algorithm (RAM [19].

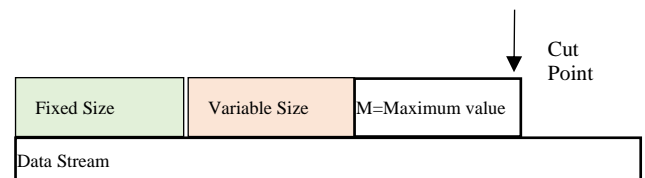


Figure. 10. operation of Rapid Asymmetric Maximum Algorithm (RAM) [19]

10) Minimal Incremental Interval (MII): The MII algorithm[48] was introduced based on incremental data synchronization. Since data is saved on the physical disk, the length of the chunk is considered one of the essential factors in the performance of earlier algorithms such as (AE and RAM). Because it is based on an incremental backup method, chunking is used to pick just the new data, which is not kept on the physical disk. The MII algorithm does not depend on chunk length because it is an incremental synchronization chunking algorithm that has the potential to manage byte shifting problems. MII

compares the byte that was read recently to the byte already existing. The MII can provide better ways to solve the byte shift problem, but the efficiency of this algorithm, in general, is not good, and the performance was poor in the variation of the size of the chunk [48].

11) Parity Check of Interval (PCI): The PCI algorithm solves the MII algorithm problem. It circumvents the boundary shift problem and can locate precisely where the data changes in incremental synchronization. PCI algorithm reads files as a stream of data and consists of a window of length ( $w$ ) where the window's header is set as the first byte of the file. This method reduces the bandwidth needed to send data across the network, but the speed of dividing data into chunks is lower than the AE and RAM methods [50].

12) Quick CDC: The (Rabin CDC) algorithm takes a long time, and the ratio of deduplication data is low because it depends on byte-by-byte computation. The Quick CDC method employs three techniques to increase cutting speed, deduplication rate, and CDC throughput [12]. In the first technique, the Quick CDC algorithm can jump straight to their chunk boundaries in the case of duplicate chunks that appear several times. The second technique, for the unique chunk, the Quick CDC method overrides the minimum chunk length. Third, The Quick CDC distributes the chunk length into a small area since it can dynamically adjust the mask bits so that chunks are always more significant than the minimum chunk length. As a result, the Quick CDC algorithm improved the chunking speed, and the deduplication ratio was slightly improved [12]. Table III show the Advantage and Disadvantage of different Chunking Methods.

## B. Hashing and Fingerprint

The data is broken up into blocks or chunks, and a unique hash value is created for each chunk. A sequence of hash values results from this [51]. The main task of the hash function is to create a unique fingerprint for each file or chunk, and this process aims to convert an extensive data set of variable length into

a data set smaller in size and of fixed length [52]. The chunk between the beginning of the file and the breakpoint location, or between the old breakpoint and the new breakpoint position, is passed to the hash function (MD5, SHA-1) for hash value comparison when comparing chunks [34]. Multi-threading expedites the fingerprint process by using multi-core CPUs' capabilities [53].

1) The MD5 Hashing Algorithm: MD5 contains a series of numbers, and it was built based on the md4 algorithm, which is faster than MD5. The MD5 is more secure than the MD4 algorithm. The main objective of the algorithm is to protect the data's integrity and identify any changes made to the data. The results for the MD5 algorithm are always of a fixed size with a hash value of 128 bytes [54]. It produces a string consisting of four 32-bit blocks each. The MD5 method, which includes four processing cycles, is applied to the messages to be encrypted. In a digital signature, encryption, data identification, and data protection applications, the MD5 algorithm is commonly employed [11].

2) The SHA-1 Hashing Algorithm: The National Institute of Standards and Technology (NIST) developed the (SHA-1) algorithm as a security mechanism based on the results of the (SHA) algorithm. The MD4 method is the basis for the hash algorithm, SHA-1 [55]. The (SHA-1) algorithm always outputs 160 bits, regardless of the size of the message. The algorithm (SHA-1) uses complex methods to transform data and logical functions [56]. For processing units, this arithmetic process is decomposed into the 32-bit words of 512-bit size, with four loop operators and 20 cycles for each circuit, for 80 cycles [11]. SHA-1 is more potent in encryption when compared to MD5, but it takes more time for data encryption. Algorithm (SHA-1) contains 80 iterations, while algorithm (MD5) contains 64 iterations, so it is slower than (MD5). One of the essential applications of the (SHA-1) and (MD5) algorithm is deduplication, where the chunk hash computation expresses the bottle in deduplication [11].

Table III Advantages and Disadvantages of The Chunking Methods

Method	Advantage	Disadvantage
Rabin Fingerprint Algorithm	Eliminate redundant data deduplication systems. Reduce network traffic.	The chunking output is low. It takes a long time. Significant variance in variance size. Data removal efficiency is low
TD Two Divisors Algorithm	Reduces chunk size. Good chance to find duplicated chunks.	Duplicate chunk. Detection problem.
TTTTD	Improves the efficiency of the deduplication ratio.	The chunking output is low.
MAXP	Computational overhead is generally reduced. Reduces the contrast between chunks	Throughput of chunking is low.
Bimodal	More duplicate data is eliminated.	Suffers from shifting boundaries
MCD	Boundary shift with the best chunk size.	Boundary shift problem.
Leap-Based	Improvement to deduplication performance.	Additional overheads in the calculation.
AE Asymmetric Extremum Algorithm	gains high performance. Very fast. Smaller chunk variance.	Less resistance on byte shifting. It takes more time to process chunks.
RAM Rapid Asymmetric Maximum Algorithm	Reduce computational expenses. The productivity of chunking is high. High chunking speed. The cost of chunking is low.	Boundary shift problem.
PCI Parity Check of Interval	It has a greater ability to resist byte shifting.	The variance in size was very poor. The algorithm's efficiency is insufficient.
MII Minimal Incremental Interval	Manage byte shifting problem.	Adjusting the chunk size is difficult. The efficiency of the method is low.
Quick CDC	Enhance chunking speed and enhance the throughput of CDC.	The deduplication ratio is slightly improved.

3) The Mathematical Bounded Linear Hashing Algorithm: The linear hash method comprises mathematical boundaries formed by multiplying distinct random values by a predefined quantity of non-repeatable zero bytes. It's enough to produce distinct unique signatures to identify the plaintext contents of the chunks by using different number sequences to obtain different short hash values. The hash functions of massive data are described by mathematical signatures, which have algebraic features and a low collision probability [6]. Furthermore, compared to typical security hash functions, the arithmetic operations utilized to produce hash code are fundamental, resulting in a relatively minimal processing cost. This approach's computational cost is minimal compared to classic

hash algorithms like MD5 and SHA-1. A 16-bit mathematical function is used to produce each hash. Using several hash functions to represent the data content can help decrease collisions and enhance the lookup stage [32].

### C. Indexing and Matching

The hashing and indexing process consists of a temporary lookup table to store the name of the chunks and their hash values[20]. The new hash is compared to the previously stored hash values in indexing to identify duplicate data chunks. Two or more chunks are considered duplicates if their fingerprints match since the duplicates are removed, and only the unique chunks are stored [34]. Every

hash value at location (i) is compared with all hashes from location (i + 1) to the end of the sequence. A new reference is created when the hash values are equal. The sequence of hash values is extended by duplicate identification tags and backward references at the end of this stage [51]. In deduplication matching steps. If the hash values are the same, the procedure compares the two chunks byte by byte; if they are the same, the system removes the new chunk and adds a logical reference to the location of the old one. This operation takes much time and overhead the system [14]. One of the important challenges facing deduplication is the possibility of expanding the fingerprint indexing table. If the size of the fingerprint table is more than the whole amount of RAM, the hard disk index search becomes a bottleneck [57].

#### D. Writing on Disk

Each unique chunk is added to the system and requires a corresponding (hash, location) entry to be inserted into the system's fingerprint index. Even for modest data sets, the fingerprint index size can exceed the system's RAM size. Let's consider a chunk store with 20TB of unique data: if the fingerprint index only stores each chunk's SHA-1 hash (20B), an average chunk size of 4KB would result in a 100GB index! In general, caching is the technique we use to improve our performance whenever our data structures exceed the bounds of our memory [37]. The standard caching techniques rely on good locality to be effective (spatial and/or temporal locality) [58]. Unfortunately, seen that SHA-1 fingerprints are independently and uniformly distributed, and as a result, fingerprint index queries have no locality of reference. The fingerprint index performs poorly when normal caching methods are naively used, and each lookup still necessitates a costly disk search. The Data

Domain deduplication solution addresses this issue, known as the disk index bottleneck problem [58].

## VI. CONCLUSION

Many companies and organizations use different techniques to remove redundant data to get rid of redundant data. In this study, many redundant data reduction approaches are discussed, like the many types of data deduplication techniques categorized according to granularity-based, time-based, side-based deduplication, and Implementation has been studied and clarified. The most important characteristics related to these types are discussed. The challenges and solutions to issues related to data duplication are covered. In this survey, the most important advantages and disadvantages of using these types on a large scale are also reviewed and discussed. The research included an overview of the methods for splitting data into fixed and variable chunks and provided tips on maximizing the efficiency and productivity of data deduplication. Various hashing approaches have been examined, and their primary methodologies have been varied. The most important types of hashing methods studied are MD5, SHA-1, and mathematical model-based hashing. The study also looked at the indexes used to find duplicate data chunks and save unique ones. In addition, comparisons were made between the different methods and algorithms according to the criteria of time, efficiency, and the percentage of de-duplicating data.

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# A Systematic Review of Deep Learning Based Online Exam Proctoring Systems for Abnormal Student Behaviour Detection

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## ABSTRACT

In the last years, educational technology has advanced tremendously. Increasing numbers of schools and universities are embracing online learning to serve their students better. As a result of the COVID-19 epidemic, students now have more flexibility in their study schedules and may work at their speed to better themselves. AI-based proctoring solutions have also grabbed the industry by storm. Online proctoring systems (OPS) generally employ online technologies to ensure that the examination is conducted in a secure environment. A survey of current proctoring systems based on artificial intelligence, machine learning, and deep learning is presented in this work. There were 41 publications listed from 2016 to 2022 after a comprehensive search on Web of Science, Scopus, and IEEE archives. We focused on three key study questions: current approaches for AI-based proctoring systems, techniques/algorithms to be employed, datasets used, and cheating detection methods suggested in such systems. Analysis of AI-based proctoring systems demonstrates a lack of training in using technologies, methodologies, and more. To our knowledge, Machine Learning or Deep Learning-based proctoring systems have not been subjected to such a study. From a technology standpoint, our research focuses on detecting cheating in AI-based proctoring systems. New recently launched technologies are included in this review, where these technologies potentially substantially influence online education and the online proctoring system.

**Keywords:** Deep Learning, Machine Learning, Artificial Intelligence, Online Exams, Online proctoring, Online learning.

## I. INTRODUCTION

It is becoming more common to see the impact of Information technology on people's lives as they become more integrated into society. Several crucial situations, including natural disasters, conflict, and pandemics, have demonstrated encouraging outcomes

for e-learning [1]. The development of online education has been fast. Students are increasingly turning to online credential programs like Massive Open Online Courses (MOOCs). Universities are also moving to the internet in order to provide their students with more resources. In addition, a growing number of individuals are now publishing their own

courses. As a consequence, students have more opportunities to learn and develop their skills [2]. Several technical breakthroughs allow for the use of sophisticated image processing and machine learning methods for the actual achievement of educational tasks via E-learning [1]. According to a recent study, course evaluation has been a significant focus of online learning research since 2009. Since there is no direct interaction between students and teachers, course evaluation is complicated in online learning [3]. During the epidemic, almost all educational institutions have been obliged to switch to online education [4]. There has been an increase in colleges offering online lessons and exams for all courses. The COVID-19 Pandemic also impacted college admission tests and the employment procedure, which is based on a written test [5]. For college students, the abrupt transition to online education has varying results. Graduate students are not expected to take their studies as seriously as high school students [5]. Machine Learning (ML) principles like feature selection, classification, etc., are used to offer a specific approach/technique for online tests [1]. For online tests, such as MOOCs and those completed during the recruiting process, using an AI-based proctoring system will soon be the standard, and it is a need. In order to earn a high-quality online certificate, one must endure a rigorous assessment procedure. Similar to how tests are proctored in schools and universities, online exams must be overseen. All students need to be monitored by an AI-based system since there are more methods and possibilities for students to cheat when tests are given online [5]. A precise match between instructors and students for physical examinations would not work in this situation [6], [7]. Students' laptops and PCs already have cameras and microphones that these technologies may employ to keep tabs on them and guarantee academic honesty. Many things must be taken into account while building a system. There must be no problems with the AI-based system running on any system, and it must

not be an obtrusive system at all [5]. As protection against exam tampering, students would take their tests through a private web browser, and webcam and microphone monitoring would also be used to monitor their behavior. The Artificial Intelligence Based System would monitor all actions and report any efforts at cheating [5].

The system would flag attempts to cheat, and appropriate action is taken. The test might be halted, or a report could be generated for the institution's evaluation. In order to maintain track of the student's actions, a human proctor might benefit from the use of the software. A human proctor would be alerted if a student is suspected, and their questionable behavior would be noted for subsequent examination. One person may concentrate on students who are most likely to cheat by using this method. In addition, it adds a layer of protection to the surveillance system. False positives may be decreased as well as the number of people needed to supervise the test if done in this manner [5].

In online exams, the verification and identification of anomalous conduct by the examinee are critical characteristics. Static and continuous verification are the two methods available. Only once throughout the online test does the examinee undergo static verification. Examinees are authenticated at regular intervals throughout an online test using continuous verification [1]. The university's preferences and the resources of the majority of students influence the choice of such systems. A human proctor method may not function if the students take the tests from a place with a poor internet connection or power outages, as any faults with the student's live video will signal them. Since the test may be administered as long as the computer is operating, a digital secure browser-based solution is preferable. [8],[5], and [9].

Preventing cheating via the identification of aberrant activity is crucial for ensuring the integrity of online assessments. The ideas of examinee verification and anomalous behavior identification are closely

connected. For instance, biometric identifiers often verify and detect anomalous examinee behavior [1]. When unwanted access to various system components is ensured, the security of online examinations is crucial. The studies examine several facets of online test security. Organizations such as the EU have issued recommendations to control the access to and storage such user-generated data. It is a given that data security must be addressed, given the use of biometric authentication for the test in newer systems. Not just during the test but also for the sensitive information that is kept and communicated throughout the examination procedure [10], [11], and [1]. The paper has the following objectives: This article examines the many methods, strategies, and algorithms used in Online Proctoring System-based AI and machine learning methodologies. In addition, it discusses the datasets suggested or employed for such a system, as well as the cheating detection algorithms used in every publication. In this almost 41-paper literature study, we have covered every aspect of this topic.

Existing research is mainly concerned with developing and enhancing Online Proctoring systems. There are no comprehensive assessments of the work done on machine learning-based proctoring systems from existing reviews. We have used this chance to determine the research conducted when designing MLPS (Machine Learning-Based Proctoring System). In terms of convenience, online exam cheating is superior to traditional offline exam cheating. For online assessment, detecting and preventing online cheating is vital. As a result, Massive Open Online Courses summative assessment faces one of its most serious challenges yet. Academic dishonesty and cheating are major issues in online education, according to recent research. In order to protect online exams, proctoring methods such as identity verification, keystroke recognition, and video proctoring have been used [12]. Other tactics include controlling the Browser, restricting test duration, randomizing questions and answers, etc. However, it

seems that cheating in distance learning is rather prevalent [13]. While dealing with cheating is one of the most pressing issues in online education [3].

The discussion of AI-based proctoring systems will take place in the following section. Online Proctoring Systems are discussed in Section 2. There are research topics and search criteria in Section 3. Section 4 and Section 5 summarize and explain our survey findings, respectively.

## II. AN OVERVIEW OF ONLINE PROCTORING

Research on online proctoring in learning is not new. Even prior to the Pandemic, several colleges and organizations used proctoring systems for online classes. Competitive and adaptive examinations, such as the GRE, GMAT, and CAT, are proctored exclusively. Online proctoring employs virtual monitoring techniques (such as tab switching, timestamps, background noise, etc.) to evaluate students taking tests. Exams of this kind are often administered online and in a distant location, allowing students from any area to participate. [14].

For the online proctoring system, the examiner/proctor uses a web camera to record the student taking the test and a secure server to save the video, which the examiner can then see. The examiner or proctor may investigate any questionable action. Pupils cannot open new tabs in their web browsers due to the second feature, Locking. Computer or browser lockdown are other names for this technique [15]. According to [16], the following characteristics of proctoring are listed in Table(I). Three kinds of proctoring systems are recognized by [16]. Fig. 1. depicts the several proctoring system types. The online proctoring method has seen several technical developments. The [16] provides an exhaustive review of proctoring tools. The assessment and investigation of the proctoring system were undertaken. The document provides suggestions for educational

institutions regarding implementing the proctoring system based where some examples of these methods listed here. Where in [17] an intelligent online proctoring system is proposed, the aforementioned proctoring method utilizes audio and visual characteristics. However, there is no assessment of their study in the publication. Using tab locking and question bank randomization [18] developed a method to identify and prevent cheating. [19] creates the online test proctoring system e-Parakh, which is only accessible through mobile devices.[20] focuses on numerous cybersecurity problems in the online proctoring system. In addition to challenge-response

and biometrics (such as facial and voice recognition), the study explores blockchain technology and other multi-factor authentication and authorization technologies. When talking about operational controls, it is common to utilize. Lockdown browsers (webcam fraud detection), endpoint security (VPN and virtual machine), screen-sharing and keyboard listening programs, technical controls to counteract spatial (physical) limits, and compliance with the law (GDPR) are some examples of these security methods.[15] Investigates the impact of proctoring on a student's performance.

Table I : Online Proctoring System

No.	Characteristics	Summary	Techniques
1	Authenticity	The verification of the identities of applicants and proctors, who are built into the proctoring software, is included in the authentication process.	Face recognition and two-factor authentication are employed for entity authentication in the proctoring system.
2	Examining tolerance	This restriction on the use of extra resources, such as browser tabs, face recognition during live proctoring, etc., is one that is enforced by the software that is used to proctor examinations.	This is achieved by log monitoring and analysis, Face recognition, Object Detection, and other techniques.
3	Remote authorizing and control	There is an ability to take over a proctoring system (such as starting/stopping an exam for one student remotely) using this feature.	In most cases, this is accomplished by granting administrative privileges and using a multi-tiered security paradigm.
4	Report generation	It involves preparing the student's test report and activity record.	This is often accomplished using tools such as Python and PHP.

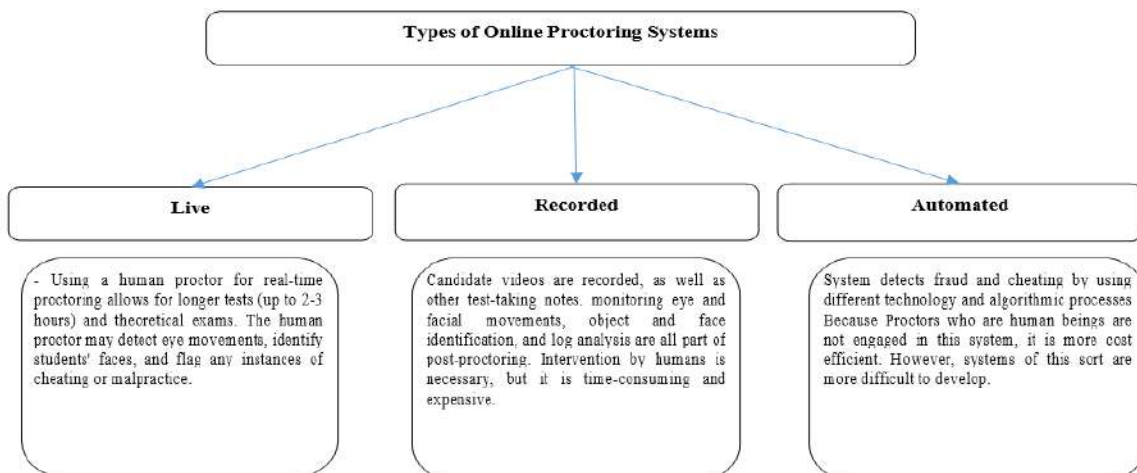


Fig. 1. Online Proctoring Systems: Types and Features



### III. RESEARCH QUESTIONS, SEARCH CRITERIA, AND INCLUSION/EXCLUSION CRITERIA

We searched and compiled a selection of the most relevant publications for the literature review in this article. Publications (the majority were Springer, IEEE, Elsevier), Indexed papers (Scopus, Web of Science, including ESCI, SCI, SSCI, and SCIE), and conference numbers were used to identify and choose these works (mainly containing a good number of citations). A total of 137 documents were obtained from the databases, and

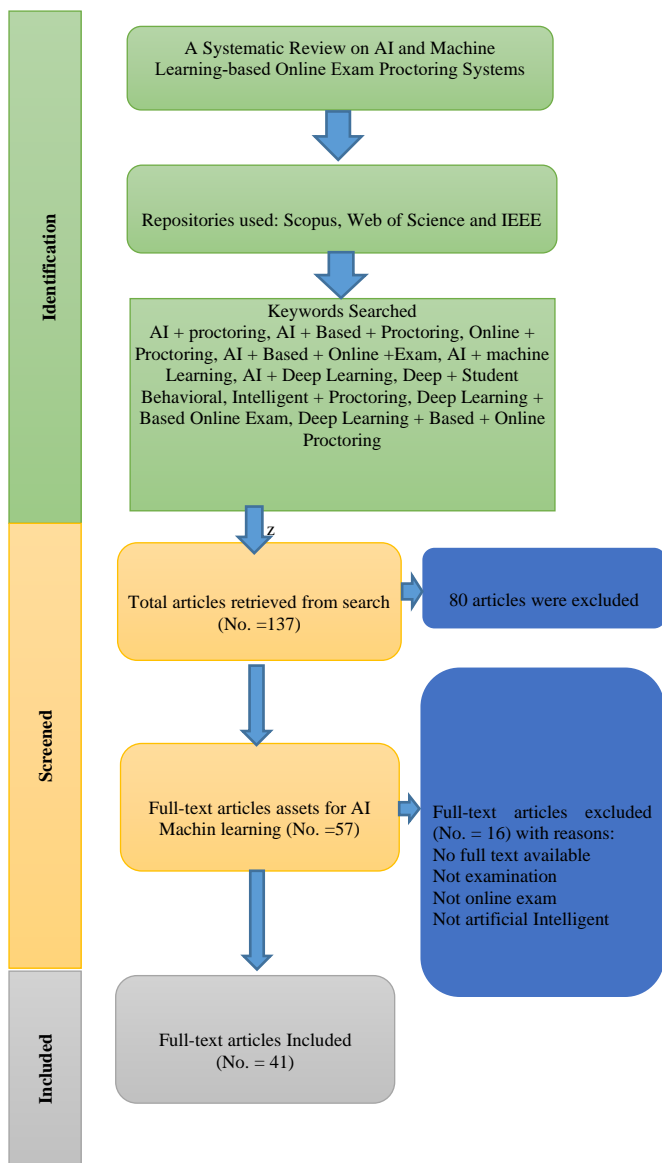


Fig. 2. exhaustive research search process.

80 were omitted since they were irrelevant to our research. In the literature review, the publications based on legal, psychological, and non-AI-based online proctoring systems were eliminated, resulting in 41 publications. These 41 publications are scattered over six years (from 2016 to 2022). This was done to assist us in detecting the newly implemented technologies and improvements in AI-based proctoring systems. Fig. 2. displays our exhaustive research search process.

The articles include issues such as software design, methodologies, techniques, algorithms, datasets presented or used for such a system, and the cheat detection techniques applied in these studies. We are examining prior research on this topic. This paper provides an overview of the current state of AI and machine learning research in online examination proctoring. The following are the research questions:

- RQ1: What are the suggested approaches?
- RQ2: What datasets are suggested or utilized?
- RQ3: How can cheating in online exams be detected?

### IV. ARTIFICIAL INTELLIGENCE-BASED PROCTORING

#### A. What are the suggested approaches (RQ1)?

Webcam, microphone, and other hardware are often used in online proctoring systems. Before the test begins, proctors must confirm that there are no unlawful items in the exam room. It is a requirement that students submit their ID cards as proof of identification [21]. The online proctoring system based on artificial intelligence is shown as follows:

AI-ProctorU, the AI module of the same-named non-AI-based proctoring system, is not very safe and may be tricked. Hence the firm suggests a hybrid approach to ensure high security. This hybrid method combines automatic proctoring with live proctors who are highly trained and can act if they detect cheating [17]. Proctor is an additional well-known online proctoring solution that authenticates students and continuously follows and monitors them using face recognition, behavior

video streaming, audio, and photographic techniques. It also supports many learning management systems (LMS), which allow for limitless picture grabs, screenshots, and video captures when installed on a user's PC.

[20] TeSLA, an EU-funded project, is another example of a proctoring system. TeSLA intends to create strategies for the biometric verification of test-takers. This includes face recognition, voice recognition, keystroke analysis, and fingerprint analysis to confirm that no impersonation is occurring and that the genuine test-taker is providing the answers [11]. Lockdown browsers and self-authentication schemes are used by the PSI Bridge platform, which ensures compliance while protecting student privacy and reducing security concerns. It is a very safe platform that does not need access to the student's computer to check the test's integrity. In a cloud-based Software as a Service, the exam session is recorded and kept on an LMS server (SaaS); in addition, the proctor has access to exam records and infractions that have been highlighted for review. Using a 360-degree monitoring system, ProctorExam enhances spatial controls. Webcam, screen sharing, and a camera on a smartphone are all used to watch the test surroundings. Taker's Facial recognition technology is also included in the system to detect instances of cheating [20].

In addition, online examination services have presented a spectacular multi-factor authentication system that is both secure and user-friendly. Face recognition, OTP verification, and fingerprint authentication are part of the three-part system. For the user to begin using the system, they must first register. User identification consists of a unique ID issued by the institution, an imprint of the right forefinger, and an OTP-verified phone number. A user's credentials are checked before they can log in to a system. There are three modules included in this login module. The user may only take the exam after passing all of these courses. During the inspection, the system does a fingerprint match regularly to check the

user's validity; if this fails, the new fingerprint is compared to the database to determine who is aiding and abetting the crime. After that, a report containing information on the malicious users is forwarded to the Controlling Authority [22].

In [17], a webcam-based monitoring system maintains track of the candidate's behaviors, facial movements, and the device's use and audio information. To record voice and video, they have used webcam hardware and active window capture. An intelligent rule-based inference system may use this information to determine whether or not any malpractices have occurred. Face detection and feature extraction from the examinee's face is utilized to estimate the examinee's head posture. Based on yaw angle fluctuations, audio, and active window capture, misbehavior is recognized.

[23] Propose a unique computer vision-based video content analysis system for the automated generation of video summaries of online examinations to aid remote proctors in post-exam evaluations. Using head posture estimates and a semantically relevant two-state hidden Markov model, the approach predicts typical and deviant student behavior patterns. Video summaries are generated from sequences of anomalous activity that have been observed. Another suggested multimedia analytics system [24] does online test proctoring automatically. The system hardware consists of a webcam, a wearable camera, and a microphone to monitor the testing area's visual and aural surroundings. The system consists of six fundamental components that constantly estimate the important behavioral cues: user verification, text detection, voice detection, active window detection, gaze estimation, and phone detection.

A multimodal biometric architecture is proposed by [25] to combat the threat by continuously authenticating users. The proposed multimodal framework combines facial, mouse, and keystroke dynamics biometric technologies. No predetermined

activities are required from the test taker to gather and process any of the three modalities. ExamShield, a new platform for complete test monitoring, includes the architecture we presented as one of its significant features. The significance of time delay and head posture in detecting cheating in a lab-based online assessment session was examined in another research. There is a statistical correlation between the position of a student's head regarding the computer screen and the likelihood of cheating on a test [26].

Using a structural model that combines B/S and C/S, JSP technology, and SSH frames, [27] presents a method for implementing an Intelligent Examination subsystem in an Internet Plus environment. Student examination terminal enables automated capture and keeping of test candidate's facial image for automatic verification of its identity, automatic collecting of examination papers' information, automatic uploading of answers, and automatic feedback on wrong responses. Others suggest obtaining information about the examinee's head position and oral condition through a webcam and identifying examiners' abnormal conduct during online examinations. The system has been tested online, making monitoring the test simple [28]. [29] Implement continuous authentication on an online test system so that exam actions may be observed remotely. The system comprises two modules: the authentication module and the supervision module. Integrating the two modules allows for creating an examination system that can authenticate test participants and monitor exam circumstances. In another research, classification and identification of the impact were suggested using gesture modeling head positions as a gesture during an online test; the study identifies the student disengagement effect. The use of the divide-and-conquer method on object recognition utilizing Haar Cascade feature extraction and HMM classification resulted in an accurate categorization of disengaged behavior during an online evaluation. The experimental findings demonstrate that head-poses

may be utilized to identify effects concerning inspection behavior [30].

In [31], describe a method that enables instructors to snap a picture and obtain a visual response after our deep learning program analyzes handwriting patterns, evaluates exam answers, and identifies identities and IDs. Consequently, the system provides instructors with a more efficient computational tool for creating and grading examinations in various forms. An online test management system shown in [32] allows for automated and ongoing monitoring. Face-recognition technology ensures that students are whom they say they are. In order to improve the proposed system's performance, various criteria have been created to identify any fraudulent activity by the applicant.

[32] Suggested a way to improve the resilience of posture and illumination fluctuations by employing machine learning online lecture sessions as training data. E-Parakh is an application that enables both supervised and unsupervised remote monitoring of the examination via a variety of techniques, such as live video and audio streaming of not only the candidate but also the candidate's surrounding environment, liveliness check of the candidate, facial comparison of the candidate's photograph [33].

By capturing the whole video and audio, this program allows the evaluator to cross-check the candidate's activities at any moment throughout the assessment and after the examination. [34] In order to keep tabs on the test taker's actions and halt any unethical activity, a camera-based tracking system is being considered. Haar Cascade Classifier and deep learning will be used to monitor (detect), tag, and identify the student's face. Certain restrictions will be applied to stop these activities (e.g., Multiple face detection). A cheating detection pipeline for online interviews and tests is presented by [35]; for the system to work, all that is needed is a video of the applicant taken during the test. Afterward, a cheating detection pipeline is used to identify another person, electronic device use,

and the absence status of a candidate. Face detection, face recognition, object detection, and face tracking algorithms make up the system's backbone. There will be no need to add additional steps to face recognition training because of the incremental training method [36].

They have tried four different face detectors, including Haar-cascade, LBP, MTCNN, and Yolo-face, as well as a Facenet model for face identification to achieve high accuracy. While a deep learning face detector outperforms the others, incremental training of facet models leads to a reduced dataset size by 1% and quicker training times of 7 percent for the Yolo-face face detector and 64 percent for MTCNN compared to batch training. [37] Detects widespread student wrongdoing using a range of machine learning algorithms, freeing up administrative resources. In order to ensure that the test participants are whom they claim to be, the model validates and authenticates them. Students' honesty is verified by recognizing the video and audio that the model analyzes. The system's constant examination of the inputs ensures academic integrity in eLearning by verifying the candidate's honesty. This includes user identification, audio processing, gaze detection, the number of people detected, and the detection of items and phones. Using a temporal sliding window and integrating continuous estimate components, they generate higher-level features to identify whether the test taker is cheating at any time throughout the exam.

[38] E-cheating intelligence agents have been used to identify online cheating behaviors, which are built of two key modules: an internet protocol (IP) detector and a behavioral detector. The intelligence agent keeps a close eye on the kids and can spot any unethical activity before it occurs. Respondus's OPS is well-suited for use in conjunction with an LMS. Both the Lockdown Browser and the Monitor are included. Allows one browser tab to stay open simultaneously while all other tabs are closed. The Monitor uses a camera to keep tabs on pupils' activities in conjunction

with the Browser. Analyzing the camera data allows us to spot patterns that may point to cheating [20]. The paper [40] suggests an innovative technique based on process mining to assess students' computer-based performance. Process mining and similarity analysis are the two critical steps of the proposed method. Students' final grades are determined by an automated process that takes six phases. Additionally, the similarity analysis allows for cheat detection and prevention at the final stage. A real-world implementation of the suggested technique is shown in a course on Enterprise Resource Planning (ERP).

[39] The knowledge base, question encoder, question generating module, and question analysis module are the key conceptual components of the proposed system, which focuses on administering written examinations on online education platforms. An ontology for the format ontology is built on text fragments representing sections of the course. These text fragments are also used in the question generation module to generate fact-based questions and in the question analysis module to create dependency trees for response assessment. In addition, [40] suggests a unique way of creating test papers based on a forecast of exam results. As a result, they use genetic algorithms and dynamic programming to improve the quality of the questions they create continuously. They used Deep Knowledge Tracing for the prediction job. The weight, difficulty, and distribution of test results were considered in the method.

Several artificial intelligence-based tools are available to assist students in transitioning smoothly from online lectures to online exams. For example, Tests software may collect students' behavioral traits during online lectures and then provide them with proctoring services for improved supervision during online exams. [20]. The following Table II provides a breakdown of the various approaches used in the various studies.

Table II: Online Proctoring System

No	Category	References	Total
1	Artificial Intelligent (Machine & Deep Learning)	[23], [24], [25], [26], [27], [28], [31], [41], [32],[33],[34],[35], [36], [38],[39]	15
2	Artificial Intelligent (No Machine Learning)	[17], [20], [11], [22], [26], [29], [30],[42],[43],[40]	10

Several techniques/algorithms have been presented in the chosen publications to attain a certain target for enhancing online tests. Table 3 provides an overview of the top techniques/algorithms suggested in the chosen studies. Researchers demonstrated CNN-based machine learning and deep learning algorithms for examinee verification. [32], cheating prevention [28], [34], and online examination-based ways to strengthen verification / aberrant behavior features (i.e. [32], [28], [34] and automated assessment [31]).

In the same vein, academics have developed a variety of methods and algorithms for recognizing faces and estimating and detecting head poses, as seen in Table 3's numbers #2 and #3. Furthermore, several NLP-based approaches are suggested in # 4 and 5 of Table 3, respectively. In independent research [26], online test cheating is predicted using a normal logistic regression model with no significant variance. Therefore, such simple approaches are omitted from Table 3. In several of the research, relevant information on the suggested approach or algorithm is lacking. [29] designed a two-

component authentication and monitoring method for online examinations. However, the authors did not give meaningful information on the methodologies and algorithms used to create the system. Consequently, such research is excluded from Table III.

Table III: Online Proctoring System

No.	Techniques / Algorithms	References
1	Convolution neural network CNN	[23], [24], [25], [26], [27], [28], [31], [41], [32],[33],[34],[35],[36], [38],[39].
2	Face Recognition, Face Detection	[41], [24], [44], [25], [41], [35],[32],[27], [36],[45],[44].
3	Head Pose Estimation and Detection	[23],[17],[30],[46],[26].
4	Natural Language Processing NLP	[47],[43].
5	Voice Recognition	[24].

**B. What datasets are suggested or utilized (RQ2)?**

For the accurate validation of a proposed approach, datasets are vital. Authenticating the consequences of a proposal requires hence the use of dependable datasets. As shown in Table 4, we were able to identify 13 datasets that were either utilized or suggested in the AI-based research that were chosen for validation. Only DS #1 was freshly produced in [24], but the other six publicly accessible datasets, which are presented in # 1 to 7 of Table 4, are all considered benchmark datasets. These datasets were used in [38], [48], [28], [40] and [25]. On the other hand, the availability

information for the remaining six datasets (# 8 to #13 of Table 4) was not provided; these datasets are denoted by (NO) in the table. This is because the link to download the dataset was not present.

[33] Developed a dataset for the online test on Verification & Abnormal Behavior. However, the contents of the produced dataset were not well described, and there was no mention of its availability. In the same way, writers [23] However, the availability information was missing from the sample of six videos with 25311 frames. According to another research [35], a dataset had been created, but crucial information such as the total number of records was not provided. According to Table 4, ten datasets were used for the Verification & Abnormal Behavior feature, two datasets were used for the Question Bank Generation & Evaluation feature, one dataset was recommended for the Security feature, and two datasets included audio. Three of these datasets use a textual format. Moreover, as shown in Table IV, six datasets are based on video format. It is essential to note that other chosen research did a variety of experiments, surveys, and test scenarios for the validation of the idea without using a specific dataset. For instance, Rajala [48] confirmed the suggested method with the involvement of 478 students who took the test four times.

Table IV: datasets suggested or utilized

Dataset No.	Type	Count of Documents	Aim	is publicly	Rel. References
DS_1	Audio & Video	(72) (movies and audio)	Abnormality & Verification	YES	[24]
DS_2	pictures	(21997)	Abnormality & Verification	YES	[28]
DS_3	pictures	(6) datasets group	Generating and Evaluating	YES	[48]

			Question Banks		
DS_4	pictures	(16128)	Abnormality & Verification	YES	[25]
DS_5	Text	(7) CSV files	Security	YES	[49]
DS_6	Text	(3) CSV files	Generating and Evaluating Question Banks	YES	[40]
DS_7	Text	(94) CSV file	Abnormality & Verification	YES	[38]
DS_8	Video	(6) movies	Abnormality & Verification	NO	[23]
DS_9	Video	(30) movies	Abnormality & Verification	NO	[17]
DS_10	video	(43) movies	Abnormality & Verification	NO	[35]
DS_11	pictures	(1295) images	Abnormality & Verification	NO	[36]
DS_12	Audio & Video	(2) movies or audio for Group	Abnormality & Verification	NO	[33]
DS_13	Video	(39) movies	Abnormality & Verification	NO	[17]

**C. How cheating in online exams be detected (RQ3)?**

Detecting cheating during an online test is vital to ensuring academic integrity. Continuous authentication and online proctoring are the two primary methods for detecting cheating. Online proctoring keeps an eye on test-takers to catch any misconduct, while continuous verification mechanisms confirm their identity. Each of these strategies will be discussed in more detail in the following sections.

Impersonation is one of the most common methods of cheating. In order to prevent illegal candidates from taking the test, it is necessary to verify students before they register for the exam. It is also vital to continually confirm the test identity taker's during the exam. Biometric or behavioral metric modalities are the most common in continuous authentication systems, which may be divided into unimodal and multimodal methods. Unimodal authentication is the automated detection and identification of candidates based on a single feature. For example, a person's face, fingerprints, hand geometry, and iris might be static (physiological) or dynamic (behavioral) characteristics, such as their voice and handwriting [50].

As a unimodal authentication method, [51] developed a non-AI facial recognition system that randomly takes pictures of the test taker. By matching the acquired photographs to the image from the exam registration procedure, the face recognition module ensures the test taker's identification at all times. In [29], an Android-based online test application is built that captures images of the examinee at random intervals. A web-based application enables the administrator or supervisor of the examination to check participant photos. In addition, [41] uses the idea of utilizing a camera to collect faces, then using an automated learning algorithm to translate them into digital data, and finally comparing the resulting data to a database was offered. [45] Face recognition algorithms were proposed as a possible anti-ghostwriter solution, or they alter their look to fool the examiner into believing that a ghostwriter is a natural person.

In [52], an eye tracker is used to verify the examinees at all times. So that various screen regions may be examined for the presence or absence of eyeballs, eye tracking data is converted into pixel coordinates. This makes it more difficult for someone to impersonate you by using many biometric or behavioral attributes simultaneously. According to [52], a fingerprint and eye-tracking authentication system was presented. Using the eye tribal tracker, researchers can verify that

the people taking the tests are the people they claim to be. For security reasons, a test-taker must be re-authenticated every time he or she is no longer present in front of the screen. Using an artificial facial recognition algorithm, [41] suggested a continuous online authentication system to authenticate the user's identity and identify inappropriate actions continually during the online assessment process.

[25] Proposed a system that continually verifies examinees utilizing three complementing biometric technologies: face, keyboard, and mouse dynamics. In this method, test-takers are verified continually in the background during the exam, and alerts are generated and forwarded to the teacher through the proctoring panel. In [50], classification of various sorts of high-stakes tests, cheating methods, and which forms of cheating are more pertinent for which types of examinations are provided. It also analyzes which risks biometric authentication is most successful against and which dangers it is least effective against.

To maintain academic integrity, online proctoring is crucial. In automated online proctoring, the proctoring technology flags or detects cheating actions automatically. Recent technological advancements have enabled remote proctoring of online examinations. Kryterio, ProctorU, and Real-Time Video Monitoring, for instance, enable users to be supervised via a webcam by a human proctor during examinations [53]. In [54], considerable online proctoring help is given. The data demonstrate a large gap between both the exam scores of those that are not proctored and those that were proctored utilizing the ProctorU tool. Some systems may take random screenshots of applicants' laptops during an examination [55]. Therefore, if an examinee uses a prohibited resource on their computer, it will be shown to the proctor. [56] Implemented webcam-based video proctoring at Miami University. The findings indicate that students are less likely to cheat on online exams when supervised using a camera. Diverse automated proctoring technologies are offered

to monitor students during examinations and identify inappropriate activity. Following is a discussion of numerous automated approaches.

[26] Proposed a semi-automatic method of proctoring that uses two criteria to identify suspicious behavior: the time it takes to answer questions and how different people hold their heads when answering them. To determine whether an individual student has cheated, a human proctor might utilize further evidence. [34] suggested a technique that uses deep learning and the Haar Cascade Classifier to recognize the candidate's face. There will be an immediate termination of the test and communication to the administrator if the examinee's head disappears from view or if more than one person is identified. The suggested method in [28] employs a camera to monitor applicants' head position and mouth condition to identify aberrant behavior. Using the concept of rule-based reasoning, the system may identify suspicious conduct during an online test, such as turning the head or conversing.

[17] built a multimodal online proctoring system. The system records the applicants' voices and videos and their active windows. Variations in yaw angle, the existence of audio, or window changes noticed in any period may be indicative of cheating. As a result, a rule-based inference mechanism analyzes the video, sound, and system use data to look for any indications of improper behavior. Using facial and voice identification, body motion track, and computer activity monitoring, ProctorTrack is a full automation online test proctoring solution that may detect any suspicious conduct throughout the exam. [57]. Using a camera, wear cam, and microphone, [24] has built a system that can identify a broad range of cheating actions during an online test. A wearable camera enables the monitoring of the student's observations. It helps identify any banned phone or text message in the testing room. In addition, the system may identify various types of cheating, such as reading from books, notes, etc., by using the worn cam. In addition, the system can predict the test-head taker's look by

merging data from the camera and wear cam. Receiving verbal aid from another player in the same room or remotely through the phone is also considered cheating. The system can use the microphone and voice detection to identify this kind of cheating; the suggested multimedia system is capable of performing automated online test proctoring. [58] developed an automated test activity detection system that uses security cameras to monitor the body movements of students and a deep learning method to classify their activities into six categories. The activity categories include typical behavior, looking back, gazing forward, making motions to other individuals, glancing to the left or right, and other questionable behavior. [59] PageFocus is a JavaScript program that may be placed on the test page and executed in the background. A defocusing event is logged whenever the examinee navigates away from the test page. The script records the occurrence and frequency of defocus and refocus occurrences on the test page. To combat internet protocol (IP) cheating, an intelligent agent with an IP detector and a behavior detector was proposed [38]. The first module might keep track of each student's IP address and send an alarm whenever a device or location changes. The second module monitors the pace at which users respond to questions to look for signs of abnormality. It is also possible to determine whether two participants are at the exact location by comparing their IP addresses [60]. Each work's method of cheating detection is summarized in the table V.

Table V: summarized cheating detection Methods

No.	Research Purpose	Cheating detection	References
1	Examining cheating strategies and developing an e-exam administration platform	yes	[52]
2	Automated video proctoring, which may save human work and increase digital evaluation,	yes	[55]



	is being presented as early findings.		
3	Comparing the results of online proctored tests with those of onsite proctored tests.	yes	[9]
4	Face-recognition technology might be used to authenticate users.	yes	[51]
5	An online test proctoring and automatic cheating detection system was developed.	yes	[17]
6	Exam cheating may now be detected using an image and audio analytics technology.	yes	[24]
7	Several strategies for preventing students from cheating on electronic examinations were discussed.	yes	[61]
8	Created a computerized examination supervisor that can classify how pupils move their bodies throughout the test.	yes	[58]
9	Detection of dishonesty by recording of webcam activity automatically.	yes	[34]
10	Identifying the behaviour of test takers in order to identify cheating, with a particular emphasis on time delay and head posture.	yes	[26]
11	A method of continuous authentication for an online learning application based on Android was created.	yes	[29]
12	It was possible to create a program called "page focus" that can identify whether the exam window is being opened by an unauthorized party.	yes	[59]
13	A cheating detection system based on two modules, the IP detector model and the behavior detector model, was created.	yes	[38]

14	Online test cheating is examined, notably via continuous authentication and online proctoring, in this study.	yes	[62]
15	Suggested a system which uses facial, keyboard, and mouse dynamics to continually verify test takers.	yes	[25]
16	For online assessments, a massive open online proctoring architecture has been proposed that incorporates both automated and collaborative ways to identify cheating.	yes	[2]
17	High-stakes tests, cheating methods, and which sorts of cheating are more important for which assessments were outlined in the presentation.	yes	[50]
18	High-stakes tests, cheating methods, and which sorts of cheating are more important for which assessments were outlined in the presentation.	yes	[28]
19	Developed a three-tiered architecture for spotting test takers who are posing as other people.	yes	[45]
20	For remote proctoring, we're specializing on video summary of anomalous behavior.	yes	[23]

## V. CONCLUSION AND DISCUSSIONS

This article includes a systematic literature review to discover and examine 41 research (published between January 2016 and December 2022) on AI-based online tests. This leads to presenting two substantial AI-based methods and five suggested methodologies and algorithms. In addition, 13 datasets and 20 significant cheating detection approaches are given. The COVID-19 Pandemic has increased demand for online testing,

which is the next wave of acceptance following online learning. There are no reliable online proctoring systems, but they are altering the way people think about online testing from home, a concept that was formerly considered absurd.

New forms and technologies of cheating arise in tandem with the advancement of detection and prevention strategies. No system can prevent all forms of cheating in online tests. Hence newer approaches are needed. A system that integrates biometrics with a high degree of accuracies, such as user authentication, surveillance of movement, sound, or keystrokes, should be sought by institutions. Other elements that should be included are the ability to shut down the system or Browser, cloud-based technology that eliminates the need for local upgrades, and an easy user interface. Another point of view on a universal AI-based system is the extent to which it is ubiquitous and how much people trust it. The most pressing issue is how to create AI-based proctoring systems that can be trusted. No articles that compared the trustworthiness of proctoring systems based on human or artificial intelligence to those based on existing classroom-based systems [63]. In conclusion, it is challenging to determine if the advantages of these Online Proctoring systems exceed their hazards. The most plausible conclusion we can draw at this time is that the ethical justification of these technologies and their different capacities needs us to carefully ensure, to the best of our ability, that a balance is achieved between concerns and potential advantages. This research may be expanded in numerous ways in the future. For instance, one strategy is to do a comprehensive examination of online test cheating prevention tactics, strategies, and algorithms.

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# Convolution Neural Network Machine Learning Algorithm Prediction Model for Intrusion Detection

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## ABSTRACT

Software Defined Networking (SDN) is evolving as a brand-new approach to the growth and innovation of the Internet. Since SDN can offer controllable, dynamic, and affordable networking, it is anticipated to be the Internet's ideal future. A rare chance to achieve network security in a more effective and flexible way is presented by the introduction of SDN. Because it has centralised control, SDN has the advantage of better network security provisioning as compared to traditional networks. However, in order to increase SDN security, it is necessary to address a number of additional network security challenges brought about by the SDN architecture's flexibility. The centralised controller, the control-data interface, and the control-application interfaces are the SDN's original structural weaknesses. Intruders may take advantage of these weaknesses to conduct several types of attacks.

A crucial component of network architecture known as the Network Intrusion Detection System (NIDS) is utilised to identify network intrusions and secure the entire network. Using Deep Learning (DL) methods, we suggest an SDN-based NIDS (DeepIDS) in this thesis to look for anomalies in the SDN architecture. First, using various flow features, we assess the capability of DL for flow-based anomaly identification.

We demonstrate through studies that the DL technique has the capacity to detect flow-based anomalies in the SDN context. We also suggest a Gated Recurrent Unit Recurrent Neural Network to boost DeepIDS's detection rate. Our experimental findings demonstrate that the suggested model considerably increases the detection rate without degrading network performance. The effectiveness of our system in terms of precision, throughput, latency, and resource utilisation demonstrates that DeepIDS does not negatively impact the OpenFlow controller's performance, making it a workable strategy.

Finally, we present an unsupervised method to address the issue of an unlabelled and unbalanced dataset. This method results in a significant reduction in processing time while producing a high detection rate. Through thorough experimental evaluations, we determine that our suggested strategy we conclude

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that our proposed approach exhibits a strong potential for intrusion detection in the SDN environments.

Keywords : IDS , DL , ML , IDS, SDN, CNN.

## I. INTRODUCTION

### Motivation

Software Defined Networking (SDN) is a developing architecture that is dynamic, manageable, cost-effective, and adaptable, thus making it ideal for the high- bandwidth, dynamic nature of today's applications and networks. SDNs are currently being deployed in many network environments, from home and enterprise networks to data centers (e.g., IBM, Cisco, Google WAN B4 [9], Huawei carrier network [10]). As can be seen in Figure 1.1, the SDN market has grown to more than a \$9.5 billion market in 2019 and is predicted to continue to grow to \$13.8 billion by 2021. The capabilities of SDN (e.g., logically centralized controller, and the use of convolutional neural network.

and global network overview) help to solve several security issues in a traditional network and bring the ability to control network traffic at a fine-grained level. However, the SDN architecture itself also introduces some new attack threats and security vulnerabilities. Kreutz et al. [11] introduced seven threat vectors in SDN. Several attacks can be conducted in the SDN architecture. For instance, Distributed Denial of Service (DDoS) attacks can overwhelm an SDN controller and a communication channel with artificial service calls. A Man-in-the-Middle attack can break links between the controller and the switches and claim control of the network.

Because of the wide variety of types of SDN deployments, SDN security is a serious concern and has recently been extensively researched - see [12] and [13] for more detail.

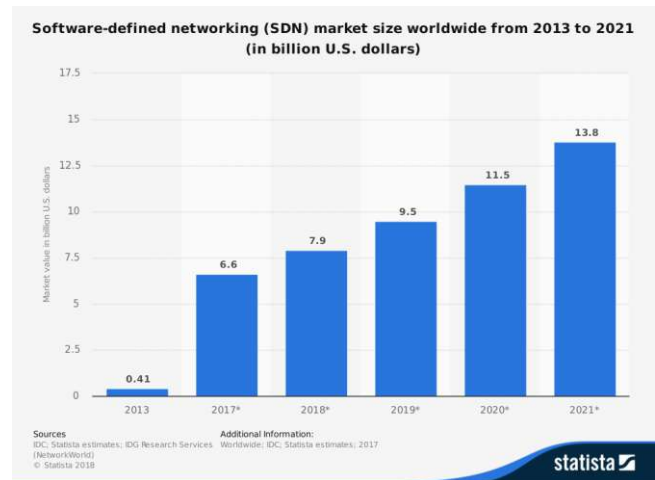


Figure 1.1: The SDN Market Size Prediction [1]

Therefore, there is a need to develop an efficient network intrusion

### Challenges

In general, there are a few challenges for flow-based intrusion detection in the SDN architecture as follows: Network traffic is dynamic, diverse and constantly changing. In addition, network attacks keep evolving and become more intelligent and aggressive. The dynamic nature of network traffic makes intrusion detection extremely challenging.

Traditional NIDSs use a large number of hand-crafted features to improve intrusion detection accuracy. However, an SDN provides us with a limited number of raw flow features. Therefore, it is a challenge to improve intrusion detection accuracy with these limited raw flow features.

NIDS is supposed to provide real-time intrusion detection and mitigation. Therefore, computational



complexity and network overheads also need to be seriously considered.

For ML/DL intrusion detection approaches, the network data is significantly important. These datasets are used for training and testing systems for intrusion detection. The availability of labelled network datasets is a big problem. The SDN architecture is still a new technology, so network datasets for it are either quite rare and/or unpublished. As a result, it is difficult to train and evaluate a model in a supervised manner to detect intrusions in the SDN network.

## II. RELATED WORK

The idea of “programmable networks” has been proposed as a way to facilitate the evolution of current networks. The concept of programmable networks and decoupled control logic has been around for several years. In the past, various technologies were developed to enable the programmability of communication networks. In the mid-1990s, Active Networks (AN) [24] were developed with the basic idea of injecting program into data packets. Switches extract and execute programs from data packets so that new routing mechanisms and network services can be implemented without the modification of the forwarding hardware. However, AN did not gain much attention because of its security and performance concerns. Also in mid 1990s, Devolved Control of ATM Network (DCAN) [25] was aimed at designing and developing the necessary infrastructure for scalable control and management of ATM networks. The premise of DCAN is that control/management functions of the various network devices (e.g., ATM switches)

should be decoupled from the device themselves and delegated to external entities dedicated to that purpose. In the first half of the 2000s, the separation of the control and data plane had been considered as one of the central points of simplifying network design. Forwarding and Control Element Separation (ForCES)

[26] is a pioneer in this area. ForCES classified the network components into two distinct types which are the forwarding element and the control element. The forwarding element only forwards and filters traffic. The control plane provides instructions for processing packets. These elements communicate with each other via a standardised open interface, which is considered to be a core feature of the ForCES protocol. Although ForCES is still under active development, it is not widely adopted by major vendors. The IETF Network Configuration Working Group proposed NETCONF [27], which is a management protocol for modifying the configurations of network devices, in 2006. Network devices can expose an API that helps to send and to retrieve extensible configuration data. However, there is no separation between control and data planes. In 2006, the SANE/ Ethane project [28] proposed a new architecture for enterprise networks. Ethane focuses on using a centralized controller to manage policy and security in a network. It can be said that Ethane is the predecessor and the foundation for what would become SDN today.

SDN is defined by the Open Networking Foundation (ONF) which was founded in 2011 by Microsoft, Google, Facebook, Yahoo, Verizon and Deutsche Telekom. As of 2015, the organization has more than 150 industry members and receives endorsement by several network equipment vendors such as Cisco, Dell, Brocade and HP. An SDN architecture decouples the network control and forwarding functions enabling the network control to become directly programmable. The separation of the control plane from the data plane lays the ground for the SDN architecture. Network switches become simple forwarding devices, and the control logic is implemented in a physical or logical centralized controller.

The SDN concept was initially designed with significant advantages over the traditional network. One of the crucial benefits of SDN is to make the highly vulnerable traditional network more secure and robust. By centralizing the control plane, SDN

considerably simplifies the way that we integrate security mechanisms into our network. The evolution of networking brings several advantages, but it also brings the development of the network attacks. Attacks can be initiated from malicious management applications, the controller, and compromised hosts or switches. The main causes of concern lie in the SDN's main benefits: network programmability and control logic centralization. These capabilities introduce new faults and attack planes, which open the doors for new threats that did not exist before or are harder to exploit. The security issues of SDNs has been re- searched extensively in [11], [12], [13] and [55]. According to Kreutz et al. [12].

### III. PROPOSED WORK AND RESULTS

Implementation of the 5 steps in the convolution neural network model life-cycle in Keras that we are going to look at.

1. Define Network.
2. Compile Network.s
3. Fit Network.
4. Evaluate Network.
5. Make Predictions.

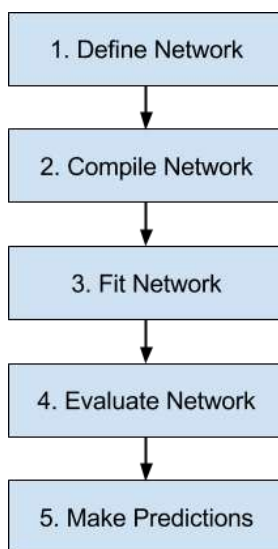


Figure 4.3 Life-Cycle for Convolution Neural Network Models using Keras

Input:

Software-Defined Network(SDN) dataset:

Step 1. Define Network:

The first step is to define your neural network. Neural networks are defined in Keras as a sequence of layers. The container for these layers is the Sequential class.

Step 2. Compile Network:

Once we have defined our network, we must compile it. Compilation is an efficiency step. It transforms the simple sequence of layers that we defined into a highly efficient series of matrix transforms in a format intended to be executed on your GPU or CPU, depending on how Keras is configured.

Think of compilation as a precompute step for your network. Compilation is always required after defining a model. This includes both before training it using an optimization scheme as well as loading a set of pre-trained weights from a save file. The reason is that the compilation step prepares an efficient representation of the network that is also required to make predictions on your hardware.

Compilation requires a number of parameters to be specified, specifically tailored to training your network. Specifically the optimization algorithm to use to train the network and the loss function used to evaluate the network that is minimized by the optimization algorithm.

Step 3. Fit Network:

Once the network is compiled, it can be fit, which means adapt the weights on a training dataset. Fitting the network requires the training data to be specified, both a matrix of input patterns  $X$  and an array of matching output patterns  $y$ .

The network is trained using the backpropagation algorithm and optimized according to the optimization algorithm and loss function specified when compiling the model. The backpropagation algorithm requires that the network be trained for a specified number of epochs or exposures to the training dataset.

Each epoch can be partitioned into groups of input-output pattern pairs called batches. This define the number of patterns that the network is exposed to before the weights are updated within an epoch. It is also an efficiency optimization, ensuring that not too many input patterns are loaded into memory at a time.

**Step 4. Evaluate Network:**

Once the network is trained, it can be evaluated. The network can be evaluated on the training data, but this will not provide a useful indication of the performance of the network as a predictive model, as it has seen all of this data before.

We can evaluate the performance of the network on a separate dataset, unseen during testing. This will provide an estimate of the performance of the network at making predictions for unseen data in the future.

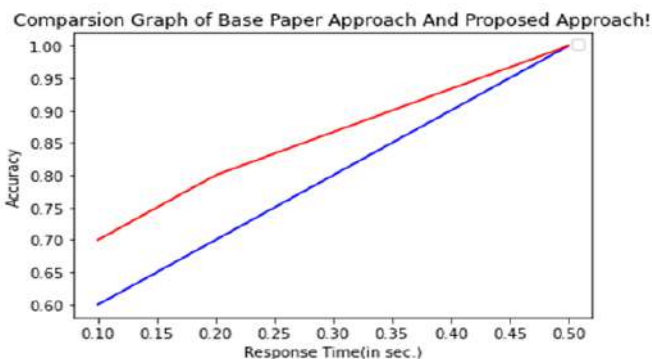
The model evaluates the loss across all of the test patterns, as well as any other metrics specified when the model was compiled, like classification accuracy. A list of evaluation metrics is returned.

**Step 5. Make Predictions:**

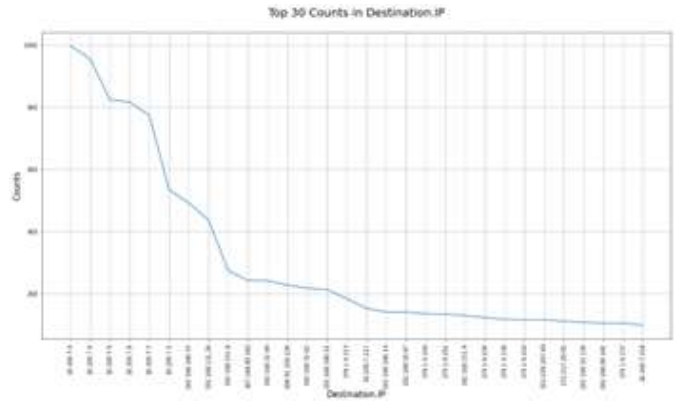
Finally, once we are satisfied with the performance of our fit model, we can use it to make predictions on new data.

This is as easy as calling the predict() function on the model with an array of new input patterns.

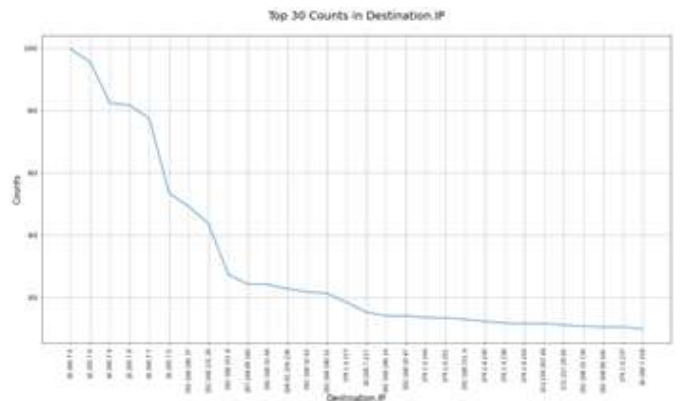
**IV. RESULTS**



(A) this shows the comparison on source IP and number of counts user hit on that IP address.



(B) This represents the comparison on Destination IP and number of counts user hit on that IP address.



(C) This represent comparison of our approach and base paper approach.

**V. CONCLUSION AND FUTURE WORK**

This work presents a framework that applies CNN algorithm is used as classifiers on the Software-Defined Network dataset. The experimental results show that, the best strategy is classifier getting an improved accuracy.

As mentioned in the previous chapters, SDN brings us a critical dilemma: an important potential evolution of networking architectures, along with a very dangerous increase in security problems. SDN introduces new faults, and attack planes that did not exist before or were harder to exploit.

These potential security issues are because of network programmability and control logic centralization in an SDN. However, an SDN can also be utilized to

strengthen network security. In this thesis, we have implemented an end-to-end NIDS - DeepIDS - for the SDN architecture. The DeepIDS can be deployed in any SDN and which then takes advantages of global network overview for intrusion detection.

## VI. FUTURE WORKS

Currently, all the work has been done in an offline manner. All the DL algorithms are trained with several datasets to detect intrusion, but some of these datasets are outdated. In addition, some legitimate and anomaly traffic in these datasets are synthetic, so they cannot reflect real network scenarios. It would be better to implement our approach in an SDN testbed with real legitimate and anomaly traffic for further evaluation. It would be interesting to see how our method works with real networks and how quickly it can respond to the network.

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# Study on the Application of Organizational Culture to Organizational Effectiveness and Efficiency

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## ABSTRACT

Organizational culture is a habit, tradition, and general way of doing things that exist in an organization, as a result, or result of what has been done before. Organizational culture is a system of shared meaning held by members that distinguish an organization from other organizations. This study aims to examine the application of organizational culture to the effectiveness and efficiency of the organization using a survey method with a sampling technique using a simple random sampling technique. The results of the study conclude that an organization that has a strong organizational culture will have a significant influence on the attitudes and behavior of its members. Therefore, organizational performance needs to be improved by establishing and developing organizational culture. Organizational culture is dynamic, meaning that it can change according to the demands of the development of the organization.

Keywords: Study, Organization, Effectiveness, Efficiency

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## I. INTRODUCTION

In general, there are three types of organizations in Indonesia, namely, government organizations, multinational companies, and private companies. These organizations are formed through the role of the internal and external environment where the internal environment creates a cultural and social milieu to achieve organizational goals and the external environment can identify opportunities and threats faced by the organization. The general environment for an organization can be distinguished by: (1) culture (historical background, ideology, values and norms, leadership patterns, science and technology, and interpersonal relationships) (2) technology application advancement rate, (3) education system, (4) political

forces and developments that determine the direction of organizational policies, and (5) law, all resources, population, sociological and economic, all of which can affect organizational change. Organizational change is open because the organization interacts with the environment closely so that the turmoil and changes that occur in society will have a direct impact on the changes and development of an organization [1];[2].

Organizational culture is expressed as a cognitive framework consisting of attitudes, values, norms, behaviors, and expectations formed by members of the organization. Organizational culture is a way of thinking, feeling, and reacting based on certain patterns that exist within the organization or in parts of the organization. It is the mental programming of

the organization which is a reflection of the 'capital' of the organization's personality [3];[4]. Organizational culture consists of basic assumptions that are learned both as a result of solving problems that arise in the process of adjusting to their environment, as well as as a result of solving problems that arise from within the organization, between organizational units related to integration [5];[6]. Culture arises as a result of shared learning from members of the organization to survive. Basic assumptions that are considered valid, are taught to new members as the right way to observe, think and feel about the problem [7];[8]. The cultural value system is the most abstract of customs [9], norms relating to the role a person has in society [10], laws based on these norms [11], and specific rules governing various activities [12].

Organizational culture has a function (1) organizational culture determines the boundaries of behavior in the organization, (2) organizational culture fosters a sense of belonging to the organization in its members, and (3) a sense of belonging to members who are willing to achieve organizational goals (4) organizational culture functions to maintain stability in the organization, and (5) management uses organizational culture as a means of controlling the behavior of its subordinates. Culture is a strength if it facilitates and expedites the communication process, encourages an effective decision-making process, facilitates supervision and fosters a spirit of cooperation, and increases commitment to the organization which in turn increases organizational efficiency [13];[14]. Organizational culture can be a source of weakness if the beliefs and value systems adopted are not in tune with the demands of the organization's strategy [15];[16].

The review of this study is increasingly clear that the factors that distinguish one organization from another are culture and organization. Therefore, to achieve success, every organization needs to improve organizational performance by forming and

developing its organizational culture. Based on an understanding of the phenomena above, the main purpose of the study is to identify the right and correct ways to implement organizational culture in the era of globalization and how determine the right way to apply organizational culture to organizational effectiveness and efficiency.

## II. METHODS AND MATERIAL

The research was carried out at the Faculty of Social and Political Sciences, Halu Oleo University for 5 (five) months, starting from October 2021 to March 2022. The study used a survey method with a sampling technique using simple random sampling and the research was also supported by studies literature by looking at the phenomena that occur in various organizations in Indonesia and comparing them with the results of the study. The results of the study are then concluded to understand the phenomena that occur.

## III. RESULTS AND DISCUSSION

Humans cannot meet all their needs alone but need the help of others to be able to meet their needs and then humans group and organize [17];[18]. Organizations consist of groups of people who work to achieve organizational goals and to achieve organizational goals developed and maintained certain patterns of behavior that are quite stable and predictable. The development of these behavioral patterns in achieving organizational goals will continue, even though members of the organization change from gathering/grouping to forming a social environment within the organization, and that environment includes leadership within the organization, rules, and policies of the organization, superior and subordinate relationships and between co-workers and norms. from the organization, as well as from certain groups within the organization.

Another interesting thing about the organization is that the organization is an open system consisting of subsystems that are interrelated and influence each other in fulfilling their goals. An open system means a system that affects and is influenced by its environment (interacts with its environment). The organization's point of view will survive and develop if the internal components function in harmony with one another and the system of good relations with the environment also functions. On the other hand, it shows that change continues over time in organizations which in the social system of the organization is called organizational change or development. The purpose of organizational change is to change the system, culture, and behavior of the organization to influence the effectiveness of the organization, while the goal of change is to intervene to change the attitudes and behavior of its people [19];[20];[21].

Every organization has a culture that is reflected in the behavior of its members and the policies and regulations of the organization. Talking about culture is speaking in two domains, namely the social realm and the individual realm. In the social realm, culture is born when humans meet other humans and build a life together and the individual cultural realm begins when individuals meet to build a common life where these individuals have their uniqueness and influence each other. When a culture has been formed, each individual is a cultural agent who gives uniqueness, brings change, and spreads it [22];[23];[24].

The review shows that culture greatly influences individual human behavior. Humans often face problems or problems caused by an unsupportive culture. Manifestations of organizational culture can be found in organizational practices, namely (1) organizational design (an organizational structure is arranged based on the main values and organizational culture, (2) selection and socialization strategies, (3) class distinction based on hierarchy in the organization,

(4 ) ideology, (5) symbols (titles, large workspaces, parking spaces, and special dining areas), (6) language, (7) rituals and ceremonies [25];[26];[27].

Culture becomes a burden if shared values do not match the values that will increase organizational effectiveness and may occur if the organizational environment is dynamic. When the environment changes rapidly, the organizational culture that has taken root may no longer be appropriate. Thus, behavioral consistency is an asset for organizations when the organization faces a stable environment, but consistency can be a burden and make it difficult to respond to environmental changes. These conditions require that organizational culture changes need to be made, such as dramatic crises, leadership changes, and weak culture. Three forces play a part in maintaining culture, namely (1), selection practice (finding prospective members who essentially have values that are consistent with the values of the organization), (2) top management actions (through their language and behavior enforcing norms). flowing downwards), and (3) socialization methods (the organization helps new members adjust to the organizational culture).

#### IV.CONCLUSION

As a summary of this study, it can be stated that an organization that has a strong organizational culture will have a significant influence on the attitudes and behavior of its members. Therefore, organizational performance needs to be improved by forming and developing organizational culture. Organizational culture is dynamic, meaning that it can change according to the demands of the development of the organization. Currently, there is a globalization of society, namely the process that produces a single world with interdependence consequences. On the other hand, in the era of globalization.



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# The Rainbow-Vertex Connection Number [RVCN] of Subdivision of Certain Graphs

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## ABSTRACT

Rainbow-Vertex Connection Number [rvcn] is computed for some graphs by the researchers. Here we have considered the subdivision graphs of certain graph classes. The rainbow edge connection number of subdivision of Triangular snake graph was already found<sup>[1]</sup>. Using the definition of rainbow-vertex connection number<sup>[5]</sup>, which is the smallest positive integer  $k$  such that the graph is rainbow-vertex connected, we find the rainbow vertex number of subdivision graph of Friendship graph  $rvc(S(F_n)) = n + 2 \forall n \geq 2$  ,, Triangular snake graph  $rvc(S(T_n)) = 2n - 1 \forall n \geq 3$  and Comb graph  $rvc(S(P_n \circ K_1)) = 3n - 1 \forall n \geq 2$ .

**Keywords:** Rainbow Vertex Connected Graph and Number, Friendship Graph, Triangular Graph, Comb Graph, Subdivision Graph.

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## I. INTRODUCTION

We consider simple, finite, connected, and undirected subdivision graphs. A graph is a set of vertices and edges  $(v_i, e_j)$ ,  $v_i$ 's are non-empty. Krivelevich and Yuster<sup>[5]</sup> introduced the rainbow-vertex connection number, and Li and Shi investigated it. The lower bound was stated by Krivelevich and Yuster as  $rvc(G) \geq diam(G) - 1$ .

Definition 1.1: Graph Colouring: Proper colouring is the process of colouring each vertex of a graph so that no two neighbouring vertices have the same colour.

Definition 1.2: Rainbow colouring: A path in an edge-coloured graph is claimed to be rainbow coloured if no colour repeats thereon path.

Definition 1.3: Rainbow vertex connected graph: If all of a graph's internal vertices have unique colours, the graph is said to have a rainbow vertex path. If there is

a path connecting every pair of vertices in the network or graph, it is said to be rainbow vertex connected.

Definition 1.4: Friendship graph: It is a planar graph with  $2n + 1$  vertices and  $3n$  edges. This graph is constructed by joining  $n$ -copies of the cycle graph  $C_3$  with a common vertex, which is called as universal vertex for the graph. It is also called as Dutch windmill or  $n$ -fan graph.

Definition 1.5: Triangular snake graph: This graph is obtained by starting with a path graph  $P_{n-1}$  and adding edges  $(2i - 1, 2i + 1)$  for  $i = 1, 2, 3, \dots, n - 1$ .

Definition 1.6: Comb graph: A path with  $n$  vertices is called path graph. Then,  $P_n \circ K_1$  with  $2n$  vertices and  $2n - 1$  edges is said to be a comb graph.

Definition 1.7: Subdivision graph: Subdivision graph is obtained by deleting an edge  $[u, v]$  from the graph  $G$  and addition of two edges  $[u, w]$  and  $[w, v]$  along with the new vertex  $V \cup \{w\}$ .

## II. RESULTS AND DISCUSSION

### Rainbow-vertex connection number [rvcn] of subdivision of friendship graph

#### Theorem 1

If  $F_n$  is the Friendship graph of order  $2n + 1$  and  $S(F_n)$  is the subdivision graph of  $F_n$ , then  $rvcn(S(F_n)) = n + 2 \quad \forall n \geq 2$ .

**Proof:** Let  $v_1$  be the universal vertex (common vertex) for the graph. Now join the  $n$  – copies of the cycle graph  $C_3$  to the universal vertex. Let  $\{v_1, w_1, w'_1, \dots, w_n, w'_n\}$  be the vertices of  $n$  cycles. Now insert new vertices  $\{u_1, y_1, u'_1, \dots, u'_n\}$  to the  $n$  –cycles to form the subdivision graph of  $F_n$ .

Vertex colouring algorithm:

1. The vertex  $v_1$  is assigned the colour  $c_i, 1 \leq i \leq n$ .
2. The vertices  $\{w_1, w'_1, \dots, w_n\}$  is assigned the colour  $c_i, 2 \leq i \leq n$ .
3. The vertices  $\{u_1, y_1, u'_1\}, \{u_2, y_2, u'_2\}, \dots, \{u_n, y_n, u'_n\}$  is assigned colour  $c_3, c_4, \dots, c_{n+2}$ .

Now let us consider any path of  $S(F_n)$

Case-i: For  $(v_1, w_t)$ , when  $1 \leq t \leq n$  then the rainbow- vertex path is  $v_1 u_t w_t$ .

Case-ii: For  $(v_1, w'_t)$  when  $1 \leq t \leq n$  then the rainbow-vertex path is  $v_1 u'_t w'_t$ .

Case-iii: If  $(v_1, y_t)$ , then the shortest path will be  $v_1 u_t w_t y_t$  which is a rainbow- vertex path for  $1 \leq t \leq n$ .

Case-iv: If  $u_s$  and  $w_t$  are the end vertices of the path, then  $u_s v_1 u_t w_t$  will be the shortest path and is the rainbow-vertex path for  $s \neq t, 1 \leq s, t \leq n$ .

Case-v: If  $u_s$  and  $w'_t$  are the end vertices of the path, then  $u_s v_1 u'_t w'_t$  will be the shortest path and is the rainbow-vertex path for  $1 \leq s, t \leq n$ .

Case-vi: For  $(u_s, y_t)$ , when  $1 \leq s, t \leq n$ , the shortest path is  $\begin{cases} u_s w_s y_s, & s = t \\ u_s v_1 u_t w_t y_t, & s \neq t \end{cases}$ . This is the rainbow-vertex path.

Case-vii: For the end vertices  $u_s, u_t$ , when  $1 \leq s, t \leq n$  the shortest path is  $u_s v_1 u_t$ , which will be a rainbow-vertex path.

Case-viii: For the end vertices  $u_s, u'_t$ , when  $1 \leq s, t \leq n$ , the rainbow-vertex path is  $u_s v_1 u'_t$ .

Case-ix: If the end vertices are  $u'_s, u'_t$ , when  $s \neq t$  and  $1 \leq s, t \leq n$  the rainbow-vertex path is  $u'_s v_1 u'_t$ .

Case-x: If  $u'_s$  and  $w_t$  are the end vertices of a path then the rainbow-vertex path is given by  $u_s v_1 u_t w_t$  for  $s \neq t, 1 \leq s, t \leq n$ .

Case-xi: If  $u'_s$  and  $w'_t$  are the end vertices then the rainbow-vertex path is given by  $u'_s v_1 u'_t w'_t, s \neq t, 1 \leq s, t \leq n$ .

Case-xii: The rainbow-vertex path for the end vertices  $(u'_s, y_t)$  will be  $\begin{cases} u'_s w'_s y_s, & s = t \\ u'_s v_1 u_t w_t y_t, & s \neq t \end{cases}$  for  $1 \leq s, t \leq n$ .

Case-xiii: The rainbow-vertex path for the end vertices  $(w_s, w_t)$  is  $w_s u_s v_1 u_t w_t$ , for  $1 \leq s, t \leq n, s \neq t$ .

Case-xiv: The shortest path between the vertices  $w_s$  and  $w'_t$  is  $\begin{cases} w_s y_s w'_s, & s = t \\ w_s u_s v_1 u'_t w'_t, & s \neq t \end{cases}$  for  $1 \leq s, t \leq n$  which is a rainbow-vertex path.

Case-xv: The shortest path between the vertices  $w_s$  and  $y_t$  is  $w_s u_s v_1 u_t w_t y_t$ , for  $1 \leq s, t \leq n, s \neq t$  which is a rainbow-vertex path.

Case-xvi: For the end vertices  $(w'_s, y_t)$ ,  $1 \leq s, t \leq n, s \neq t$  the shortest path will be  $w'_s u'_s v_1 u_t w_t y_t$  which is a rainbow vertex path.

Between each and every vertex, there is a rainbow-vertex path.

Therefore,  $rvcn(S(F_n)) = n + 2, \quad \forall n \geq 2$ .

Example 1.1

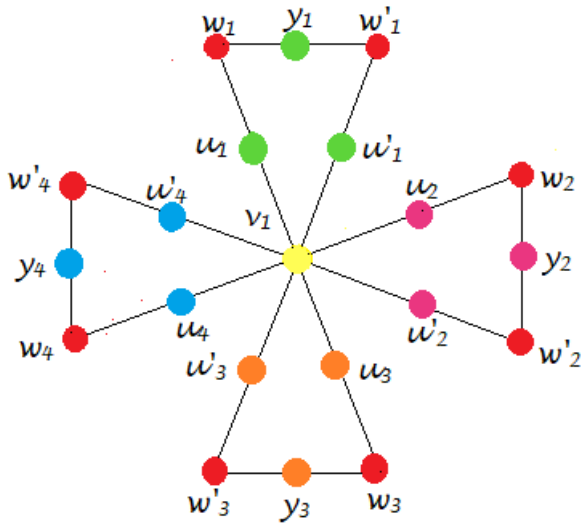


Figure 1: Rainbow -vertex colouring of subdivision graph of Friendship graph  $F_4$

The rainbow-vertex connection number  $rvcn(S(F_4)) = 6$ .

**Rainbow-vertex connection number [rvcn] of subdivision of triangular snake graph<sup>[1]</sup>**

**Theorem 2**

If  $T_n$  is the triangular snake graph<sup>[6]</sup> of order  $n$  and  $S(T_n)$  is subdivision of the triangular snake graph, then  $rvc(S(T_n)) = 2n - 1, \forall n \geq 3$ .

**Proof:** Consider a Triangular snake graph  $T_n$  starting with the path graph  $v_1 - v_n$ . Construct a triangular snake graph by adding new vertices  $\{u_1, u_2, \dots, u_{n-1}\}$ . Now insert new vertices  $\{w_1, w'_1, y_1, \dots, w'_{n-1}\}$  and construct the subdivision graph of triangular snake graph  $S(T_n)$ .

Vertex colouring algorithm

1. Assign  $c_1, c_2, \dots, c_{2n-1}$  colours to the path graph  $v_1 - v_n$ .
2. Assign colour  $c_1$  to  $w_i$  and  $u_i$ , colour  $c_2$  to  $w'_i, 1 \leq i \leq n - 1$ .

We now consider the any path of  $S(T_n)$

Case-i: For the end vertices  $(v_s, v_t)$ , when  $1 \leq s, t \leq n, s \neq t$  the shortest path is  $v_s y_s v_{s+1} \dots y_{t-1} v_t$  which is a rainbow-vertex path.

Case-ii: For the end vertices  $v_s$  and  $y_t$ , when  $1 \leq s, t \leq n - 1$  the rainbow-vertex path is  $v_s y_s v_{s+1} \dots v_t y_t$

Case-iii: If  $v_s$  and  $w_t$  are the end vertices,  $1 \leq s, t \leq n - 1$  and  $s \neq t$  then the shortest path between them is  $\begin{cases} v_s y_s v_{s+1} \dots v_t w_t, & s < t \\ v_s y_{s-1} v_{s-1} \dots v_t w_t, & s > t \end{cases}$  which is the rainbow-vertex path.

Case-iv: If  $v_s$  and  $u_t$  are the end vertices with  $1 \leq s \leq n, 1 \leq t \leq n - 1$ , then the shortest path is  $\begin{cases} v_s w_s u_s, & s = t \\ v_s y_s v_{s+1} \dots v_t u_t, & s < t \\ v_s y_{s-1} v_{s-1} \dots w'_t u_t, & s > t \end{cases}$  is the rainbow-vertex path.

Case-v: For the end vertices  $(v_s, w'_t)$ ,  $1 \leq s, t \leq n - 1$ , the shortest path is  $\begin{cases} v_s y_s v_{s+1} \dots v_{t+1} w'_t, & s \leq t \\ v_s y_{s-1} v_{s-1} \dots v_{t+1} w'_t, & s > t \end{cases}$  which is a rainbow-vertex path between these vertices.

Case-vi: If  $u_s$  and  $w_t$  are the end vertices,  $1 \leq s, t \leq n - 1$  and  $s \neq t$  then the rainbow-vertex path is  $\begin{cases} u_s w'_s v_{s+1} y_{s+1} \dots v_t w_t, & s < t \\ u_s w_s v_s y_{s-1} \dots v_t w_t, & s > t \end{cases}$

Case-vii: For the end vertices  $u_s$  and  $u_t$ ,  $1 \leq s, t \leq n - 1$  and  $s \neq t$  the rainbow-vertex path is  $u_s w'_s v_{s+1} y_{s+1} \dots v_t w_t u_t$ .

Case-viii: For the end vertices  $u_s$  and  $w'_t$ ,  $1 \leq s, t \leq n - 1$  and  $s \neq t$ , then the shortest path is  $\begin{cases} u_s w'_s v_{s+1} y_{s+1} \dots v_{t+1} w'_t, & s < t \\ u_s w_s v_s y_{s-1} \dots v_{t+1} w'_t, & s > t \end{cases}$  and is the rainbow-vertex path.

Case-ix: If  $(u_s, y_t)$  are the end vertices,  $1 \leq s, t \leq n$ , then the shortest path which is the rainbow-vertex

path is  $\begin{cases} u_s w'_s v_{s+1} y_s, & s = t \\ u_s w'_s v_{s+1} y_{s+1} \dots v_t y_t, & s < t \\ u_s w_s v_s y_{s-1} \dots v_{t+1} y_t, & s > t \end{cases}$  Case-x: If

$(w_s, w'_t)$  are the end vertices of a path,  $1 \leq s, t \leq$

$n - 1$ , then the rainbow -vertex path is

$$\begin{cases} w_s u_s w'_s, s = t \\ w_s v_s y_s v_{s+1} \dots v_{t+1} w'_t, s < t \\ w_s v_s y_{s-1} v_{s+1} \dots v_{t+1} w'_t, s > t \end{cases}$$

Case-xi: For the end vertices  $w_s$  and  $y_t, 1 \leq s, t \leq n - 1$ , the rainbow-vertex path is

$$\begin{cases} w_s v_s y_s, s = t \\ w_s v_s y_s v_{s+1} \dots v_t y_t, s < t \\ w_s v_s y_{s-1} v_{s-1} \dots v_{t+1} y_t, s > t \end{cases}$$

Case-xii: For the end vertices  $w_s$  and  $w_t, 1 \leq s, t \leq n - 1$  and  $s \neq t$ , then the rainbow- vertex path is  $w_s v_s y_s v_{s+1} \dots v_t w_t$ .

Case-xiii: If the end vertices are  $w'_s$  and  $w'_t$ , for  $1 \leq s, t \leq n - 1$  and  $s \neq t$ , the rainbow-vertex path is given by  $w'_s v_{s+1} y_{s+1} \dots v_{t+1} w'_t$ .

Case-xiv: The shortest path between the end points  $w'_s$  and  $y_t, 1 \leq s, t \leq n - 1$ , is

$$\begin{cases} w'_s v_{s+1} y_s, & s = t \\ w'_s v_{s+1} y_s, & s < t \\ w'_s v_{s+1} y_s v_s y_{s-1} \dots v_{t+1} y_t, s > t \end{cases} \text{ and is the rainbow-}$$

vertex path.

Case-xv: The shortest path between the end points  $y_s$  and  $y_t, 1 \leq s, t \leq n - 1$  and  $s \neq t$ , is  $y_s v_s y_{s+1} \dots v_t y_t$  which is a rainbow-vertex path.

Between each and every vertex, there is a rainbow -vertex path.

Therefore,  $rvcn(S(T_n)) = 2n - 1, \forall n \geq 3$ .

Example 2.1

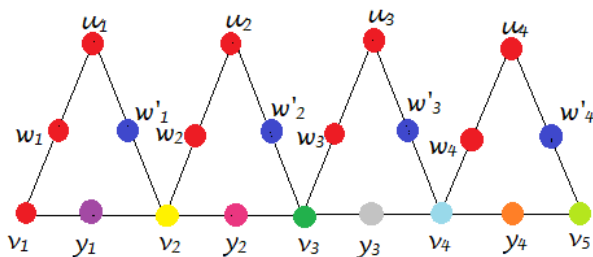


Figure 2: Rainbow-vertex colouring of subdivision graph of triangular snake graph  $T_5$

The  $rvcn(S(T_5)) = 9$ .

**Rainbow-vertex connection number [rvcn] of subdivision of comb graph<sup>[3]</sup>**

**Theorem 3**

If  $P_n \circ K_1$  is the comb graph of order  $2n$  and  $S(P_n \circ K_1)$  is the subdivision graph of comb graph, then  $rvcn(S(P_n \circ K_1)) = 3n - 1, \forall n \geq 2$ .

**Proof:** Let us consider the comb graph  $P_n \circ K_1$  with vertices  $\{u_1, u_2, \dots, u_n, v_1, v_2, \dots, v_n\}$ . Now insert the new vertices  $\{w_1, w_2, \dots, w_n, y_1, y_2, \dots, y_{n-1}\}$  and construct the subdivision graph of  $P_n \circ K_1$  i.e.,  $S(P_n \circ K_1)$ .

Vertex colouring algorithm

1. Assign colour  $c_i, 1 \leq i, j \leq n$  for the vertices  $\{v_1, v_2, \dots, v_n\}$ .
2. Assign colour  $c_1, c_2, c_3, \dots, c_{3n-1}$  for the remaining vertices.

We now consider any path of  $S(P_n \circ K_1)$

Case-i: The shortest path between the vertices  $(v_s, v_t),$  for  $1 \leq s, t \leq n$ , and  $s \neq t, s < t$

is  $v_s w_s u_s y_s u_{s+1} \dots u_t w_t v_t$  which is rainbow-vertex path.

Case-ii: If  $v_s$  and  $w_t$  are the end vertices with  $1 \leq s, t \leq n$  and  $s \neq t$ , then the rainbow-

vertex path is  $\begin{cases} v_s w_s u_s y_s u_{s+1} y_{s+1} \dots u_t w_t, s < t \\ v_s w_s u_s y_{s-1} u_{s-1} \dots y_t u_t w_t, s > t \end{cases}$

Case-iii: The shortest distance between the end points  $v_s$  and  $u_t$  for  $1 \leq s, t \leq n$ , is

$$\begin{cases} v_s w_s u_s, s = t \\ v_s w_s u_s y_s u_{s+1} \dots y_{t-1} u_t, s < t \\ v_s w_s u_s y_{s-1} u_{s-1} \dots y_t u_t, s > t \end{cases} \text{ which is a rainbow-}$$

vertex path.

Case-iv: The shortest distance between the vertices  $v_s$  and  $y_t$  for  $1 \leq s \leq n, 1 \leq t \leq n - 1$  is

$$\begin{cases} v_s w_s u_s y_s, s = t \\ v_s w_s u_s y_s u_{s+1} y_{s+1} \dots u_t y_t, s < t \\ v_s w_s u_s y_{s-1} u_{s-1} \dots u_{t+1} y_t, s > t \end{cases} \text{ and is a rainbow-}$$

vertex path.

Case-v: For the end points  $u_s$  and  $w_t, 1 \leq s, t \leq n$  and  $s \neq t$ , the rainbow-vertex path is

$$\begin{cases} u_s y_s u_{s+1} y_{s+1} \dots u_t w_t, s < t \\ u_s y_{s-1} u_{s-1} \dots u_t w_t, s > t \end{cases}$$

III.CONCLUSION

Case-vi: For the end points  $u_s$  and  $u_t$ ,  $1 \leq s, t \leq n, s \neq t$  and  $s < t$ , then the rainbow-vertex path is given by  $u_s y_s u_{s+1} y_{s+1} \dots y_{t-1} u_t$ .

Case-vii: If  $u_s$  and  $y_t$  are the end nodes of the path with  $1 \leq s \leq n, 1 \leq t \leq n - 1$  and  $s \neq t$  then the rainbow-vertex path is

$$\begin{cases} u_s y_s u_{s+1} y_{s+1} \dots u_t y_t, & s < t \\ u_s y_{s-1} u_{s-1} y_{s-2} \dots u_{t+1} u_t, & s > t \end{cases}$$

Case-viii: The shortest path between the end nodes  $w_s$  and  $w_t$ ,  $1 \leq s, t \leq n, s \neq t$  and  $s < t$ , is  $w_s u_s y_s u_{s+1} y_{s+1} \dots u_t w_t$ . This is the rainbow-vertex path between these vertices.

Case-ix: The shortest path between the nodes

$$(w_s, y_t), 1 \leq s \leq n, 1 \leq t \leq n - 1 \text{ is } \begin{cases} w_s u_s y_s, & s = t \\ w_s u_s y_s u_{s+1} \dots u_t y_t, & s < t \\ w_s u_s y_{s-1} u_{s-1} \dots u_{t+1} y_t, & s > t \end{cases} . \text{ This is the rainbow-vertex path.}$$

Case-x: The shortest path between the end points  $(y_s, y_t)$ ,  $1 \leq s, t \leq n - 1, s \neq t$  and  $s < t$  is  $y_s u_{s+1} y_{s+1} \dots u_t y_t$ . This is the rainbow-vertex path. Between each and every vertex, there is a rainbow-vertex path.

Therefore,  $rvcn(S(P_n \odot K_1)) = 3n - 1, \forall n \geq 2$ .

Example 3.1

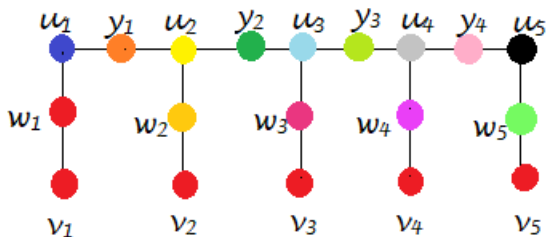


Figure 3: Rainbow-vertex colouring of subdivision graph of Comb

graph  $P_5 \odot K_1$

The  $rvc(S(P_5 \odot K_1)) = 14$

In this study, we discovered the rainbow vertex colouring number(rvcn) for the subdivision graph of comb, triangular snake, and friendship graphs.

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# Impact of Security Risks Mitigation on the Adoption of E-Government in Kenya

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## ABSTRACT

Inadequate security risks mitigation is one of the major concerns that is related with the adoption of e-Government in Kenya. Therefore, the purpose of this research was to determine the impact of security risk and how it influences behaviour and intention for using e- government services. The study targeted a population consisting of 612 Bungoma County employees. Specifically, ICT Officers, procurement officers, revenue officers, Chief Officers, finance officers and suppliers. A survey research design that provided a quantitative or numeric description of trends, attitudes, or opinions of a population was used. Purposive and random sampling were used and data was collected through content analysis, questionnaires, questioning protocol, and interview and think-aloud protocol. Face validity and content validity was done to ascertain the validity of the research instruments. Data were analysed using both statistical and narrative analysis, validity and reliability and the generalizability and transferability of data collected. The study found that the county government was committed to ensuring quality performance metrics through software development and safe business metrics. The study assessed the effect of security risk mitigation on adoption of E-government in Bungoma County through Availability, Disclosure of information and Confidentiality of the E-government users. The study concluded that County governments trusted their employees when disclosing information to the public. The study found that there was a significant contribution of security risk mitigation measures to the adoption of E-government. The study will benefit the following organizations, County Governments, National governments and also researchers for their further research in the areas of security risks in E-government system.

**Keywords:** Security Risk, Security Risk Mitigation, E-governance.

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## I. INTRODUCTION

E-government involves taking into account the various information technologies by the government and its departments for the purpose of implementing on its

operations (Alenezi, 2017). As a result, the operations of the government are improved through the use of information technology as well as enhancing the capacity of the workers, equipment, processes in providing government services. The recent evolution

of information technology has led to increased use of computerized support in resolving complicated problems by most individuals as well as corporations. According to Rodrigues (2016), most organizations are leaning towards systems that can help offer services cheaply, faster and with ease. In essence, measures are put in place to develop, implement as well as explore information systems in organizations. As observed by Anwer, Esichaikul, Rehmnam, & Anjum, (2016), the increase in the unpredictability of the demands of the people together with the unstable global procedures and legislations, organizations are required to provide timely and adequate public services to the citizens. As a result, governments have formulated flexible policies and procedures through the use of information technology in order to counter the challenges facing the citizens. In essence, there is a paradigm shift in the manner through which the government handles its day to day activities (United Nation, 2008). Notably, most governments are embracing e-government at both county and national levels of governance in order to enhance service delivery, offer cheaper solutions and increase the ability to deliver. According to Löfstedt (2005), more than 90 per cent members of the United Nations have confirmed that they are in the process of instituting e-government strategies in their departments as well as counties making information technology a global concern.

Performance metrics involves measuring the degree at which an organization, corporation or a government is achieving its major objectives (Deekue, 2016). According to Zhang (2018), performance metrics is the constant assessment of results and outcomes, which relays dependable information on the effectiveness and efficiency of programs. Organizations use key performance indicators (KPI) to evaluate their success at reaching targets. In the present business environment, the modernization of public services through the adoption of Information and Communication Technologies is in progress. Consequently, National and County Governments have

made noteworthy efforts to bring their services and information accessible on the Internet which has necessitated development of appropriate interaction mechanisms amongst the government and its citizens. This is in recognition that the success of these struggles depends on the willingness of the individuals who have been identified as prospective users for such services (Rodrigues, 2016).

As observed by Conklin (2007), the adoption of e-government services has many benefits. Most governments have noticed a decrease in the rate of corruption, increased efficiency in the provision of services to the citizens, better business relations, improved public perception due to increase in transparency as well as effective management of the government operations among others. Notably, most people are opting for e-government solutions as opposed to traditional methods in the implementation of policies (Deekue, 2016). Several elements have been identified as influencers of the E-government success in the County and national government. According to a report of the United Nation (2008), the factors comprise the accessibility of IT infrastructure and the adequacy of suppliers with IT solutions as well as the availability of technical and managerial competency. The adoption of E-government in a government unit will be affected by government commitment to the same and the perceived improvement to the delivery of service. The migration of government functions to the Internet had a profound impact on reducing the prevalent corruption in public procurements (Deekue, 2016). Research has indicated that the cost benefit was the main driver for local government to implement E-government systems.

According to Kenya National Bureau of Statistics (2007), the rate at which most business start-ups flop is alarming. However, a recent research conducted by Deloitte indicated that in the event these business start-ups embrace the use of information technology, there is a drastic reduction in the time, effort as well as capital

an organization needs in order to achieve its goals (Deloitte Research study, 2003). Through e-solutions, start-ups can drastically reduce the risk of underperforming by for instance; improving communication between government departments and business enterprises; using the available domain to offer data; reducing the amount of time in delivering service to citizens; enabling easy access to government data and services by business organizations; as well as reducing the amount of complexities when transacting (Suri, 2017). In essence, organizations embracing e-governments services stand a better chance of gaining strategic advantage over those that fail to embrace. An individual's approval of the fresh technological advancement is a necessity for the successful execution of the information (Lee, 2011).

Technology systems such as the e-governments. Various attempts to explain the adoption of information technology applications and systems by both individuals, organizations and governments have been witnessed (Moatshe, 2014). In the process, the theories and models advanced specifically emphasize determinants of information technology applications and systems implementation within an organization. The increase in the adoption of e-government by institutions has enhanced the time and amount of data transmission between government and both individuals and enterprises. Ideally, e-government can be defined as a system of managing the government through computerized information technology. The government through the use of electronic information is able to reduce the administrative challenges and in essence embrace a network of electronic systems of governance. Preferably, citizens can easily and readily access government information through electronic media. Embracing e-government can ensure that governments can liaise with each other, with business organizations, between government departments and counties electronically (Rana, 2015). Nevertheless, the adoption of e-government has its associated risks. On top of the list is the risk of security. According to the

National Computer Network Emergency Response Technical Team/Coordination Centre of China (CERT) in 2007, there were approximately 30,000 reported cases of network security breaches which was three times more than the previous two years. For that reason, it is paramount to put in place measures to curb the instances of security breaches by strengthening preventive measures in technology and management aspects.

According to the Organization for Economic Cooperation and Development (OECD), the term E-Government involves embracing fresh information and communication technologies by governments in the implementation of its functions. The transformation of the structures and operations of government can be greatly enhanced by networking through the internet. For the simple reason that the adoption of E-Government systems depend on the willingness of the users to use the systems. This calls for effective management of information security in order to increase trust (Lee, 2011). According to Karokola (2012) when rolling out the new technology, the government is faced with a myriad of challenges. In terms of security of the e-government systems, the players are concerned not only about how effective the systems are but also to what extent privacy measures are taken in order to create public confidence. Contrary to the traditional methods of communication that are grappled with many bureaucratic challenges, e-government is based on setting out clear standards, selecting departments, separation of duties as well as reduction of operational costs (Deekue, 2016). Further, e-government systems are structured to focus on the needs of the user while ensuring a harmonious coordination of activities for the benefit of the customer. According to Lee (2011), whereas e-government involves creating complex websites using computers, it does not stop there. The main purpose is to offer a network for connection between the government and its citizens. Ultimately, it is in the interest of the government that the citizens are able to

receive adequate and timely services. According to Rana (2015), the global integration of e-government systems by various institutions has been caused by many reasons. Among them is the accountability of the government, decrease in the cases of corruption, reduced costs, more efficiency, and increase in administrative and increase in citizens' participation. The term e-government has no specific definition to date. However, according to Deekue (2016), the definition of e-government is not only about advance in technology innovation but also about the development of governance. In essence, e-government involves the integration of information technology in matters of governance and in the long run there is an increased interaction and communication between the citizens and organizations. According to Conklin (2007), the exchange of information, offer of government services, transactions, communications and system integration is referred to as integration. According to (Alenezi, 2017), there is a possibility that a country can experience multi-dimensional initiatives in the event they fail to comply. There is need by the government to plan, identify and cautiously implement the goals of E-Government for the citizens in order to shield it from failure. According to West (2002), it is popularly believed that e-government is the integration of information technology through the use of internet, smart phones and cybercafés to offer information from the government to the citizens. Similarly, the manner through which the government can deliver services to the citizens through the internet and in the process engage with other business organizations is known as e-government (Tassabehji, 2005). Saleh (2011) observes that the government uses information technology and internet as tools to help it achieve its goals of better governance. On the other hand, this argument fails to clearly indicate how a government achieves its targets. According to Conklin (2007), the development of a nation goes hand in hand with e-government since the management of resources for communication development has a direct impact on socio-economic performance and good governance.

In a case study of the Malaysian government and the implementation of e-government, the ultimate objective is how its citizens are able to receive the services as opposed to the rules and norms in achieving it. Zhang (2018) maintains that more emphasis is placed on the results of e-government rather than the efforts the government uses in order to implement it. According to Alenezi (2017), in most circumstances, the government's report about its great efforts and results is usually misrepresented and unaccepted by the citizens. There is always a concern by the citizens that the governors will embrace new measures on the results to replace the efforts simply because the results are more important than the efforts of the government (Zhang, 2018). Ideally, the reason why governments adopt e-government is to help in matters of governance involving the citizens, businesses and government (Conklin, 2007). According to Anwer, Esichaikul, Rehmnam and Anjum (2016), e-government motivates effective governance by improving the relationship amongst the citizens, businesses and the government.

Deekue (2016) argues that the sole purpose of e-governance is to facilitate information and service delivery in order to uplift the morale of the citizens and increase public participation in matters of governance. In comparison, the definition of e-governance is wider as compared to e-government as it has the ability to bring about a positive transformation in the citizens perception towards the government. The government has to set goals that favours the citizens for it to change the perception of the public. In order to attain these goals, the government needs to familiarize themselves with the needs of the public and provide e-solutions that are efficient and effective to the citizens. Ultimately, the fact that the government ought to deliver quality service to the citizen through e-government leads to a responsible government (Zhang, 2018).

## II. METHODS AND MATERIAL

This section explains how the research was carried out.

### A. Research Design

The research adopted the use of survey that is descriptive in nature because the researcher wanted to understand what is in a specific situation with the identified population. According to Creswell (2014), a numeric and quantitative depiction of trends, opinions or attitudes of a population by analysing that population is known as research design.

The researcher made claims or generalizations based on the sample results. According to Creswell (2014), to generalize from a sample to a population to get to a conclusion regarding the attitude, characteristic, or behaviour of a population, the researcher used survey.

### B. Location of Study

The study was carried out in Kenya involving sampled Bungoma County, based on the level of implementation and use of E-government Technologies. This was denoted sampled sets attached to county government in the public domain.

### C. Study Population

The target population consisted of respondents who use the E-government and directly affected by it. The population for this study include

Finance Officers, Revenue officers, ICT officer, chief officers, Procurement officers and Suppliers of Bungoma County. The Researcher focus on group of individuals depending on the frequency of use, level of knowledge and understanding of E-government in Kenya.

### D. Target Population

Target population of 612 of employees and suppliers of Bungoma county Government. Respondents was randomly identified from county executives, suppliers, ICT officers and procurement officers. Data collection involved use of questionnaire, while data analysis was done with use of descriptive statistics that helps to summarise our data and reporting was done using

graphs, charts, and tables. The table 1 shows the target population that will be used in the research.

**Table 1: Target Populations**

Category	Population
ICT Officers	65
Procurement officer	55
Revenue officers	150
Chief officers	14
Suppliers	300
Finance officers	28
<b>Total</b>	<b>612</b>

Source: Bungoma- County Secretary, 2019

### E. Sampling Procedure

The study was carried out at Bungoma county Government, only 612 out of 1200 employees and suppliers of the county will be utilized for the study. Cluster sampling as used to select the sample population so that additional appropriate and intended responses would be included in the sample. A questionnaire was used to gather data required for the study.

### F. Sampling Technique

As observed in the United Nation (2008), the procedure of identifying certain individuals from a population in a way that the identified group comprises representation of characteristics available in the rest of the target population is referred to as sampling technique. Similarly, a sample is a small group acquired from the available population which represents the rest of the population. A strategy for finding a sample from a certain population is known as a sample design.

The study used purposive and stratified sampling. Purposive sampling was used because the sample was taken from Bungoma county employees and suppliers that directly deal with E-government systems. The respondents was selected through stratified sampling which was used to classify the users of E-government in Bungoma County to ICT officers, Procurement

officer, Revenue officers, Chief Officers, Finance officers and Suppliers of Bungoma County.

Homogeneous sampling is type of purposive sampling technique that aimed at achieving a homogeneous sample: that is, a sample whose units involved ICT officers, Procurement officer, Revenue officers, Chief Officers, Finance officers and Suppliers of Bungoma County. Purposive sampling was useful in this study because it provided a wide range of non- probability sampling techniques for the research to draw on. This will involve separating the population into related groups. Each group contains subjects with similar characteristics. Simple random sampling was then applied to select samples from each stratum proportional and representative of the whole population. It was very flexible, convenient and enable correlations, comparison to be made between sub-sets. The population will be portioned into non overlapping groups called strata.

The researcher used Yamane’s formula for sample size determination to calculate the sample size for this study. The procedure is shown below;

$$N_0 = \frac{N}{1 + N(e^2)}$$

N<sub>0</sub> = Desired number at 95% confidence interval

N = TARGET POPULATION

e = Confidence level of 5% (0.005 decimal equivalent)

$$N_0 = \frac{612}{1 + 612(0.052)} = 241$$

Thus desired sample will be

$$N_0 = 241$$

For individual sample size i.e.

$$ICT\ officers = 65/612 * 241 = 25.60 = 26 \text{ (simple random sampling)}$$

**Table 2 : Sampling Grid**

Categories	Target Population	Sampling Size	%	Sampling Technique
ICT Officers	65	26	40	Simple random
Procurement Officers	55	22	40	Simple random
Revenue Officers	150	59	39.3	Simple random
Chief Officers	14	6	42.9	Purposive
Suppliers	300	118	39.3	Simple random
Finance Officers	28	10	35.7	Purposive
<b>Total</b>	<b>612</b>	<b>39.4</b>		

**G. Sample Size**

The sample size comprised of 26 ICT Officers, 22 Procurement officers, 59 Revenue officers, 6 Chief Officers, 118 Suppliers and 10 Finance officers. This is as shown in table 3

**Table 3: Sample Size**

population	Study Population (category)	Target population	Sample size
Employees and suppliers of Bungoma county Government	ICT officers	65	26
	Procurement Officers	55	22
Bungoma county Government	Revenue Officers	150	59
	Chief Officers	14	6
	Suppliers	300	118
	Finance Officers	28	10

## H. Instruments of Data Collection

The researcher used various methods which comprise of interview, heuristic evaluation, and performance measurement, think aloud protocol, questionnaires, focus groups and user response. The purpose of the interview was to reinforce the findings of the questionnaire and get deeper insight of performance metric and security risks mitigation as determinant for E-government adoption. The pilot study was conducted in pre-testing the efficacy and proficiency which was vital in the study.

## I. Content Analysis

According to Mwangi (2018), the examination of the contents of both written and verbal materials like journal articles, magazines, books, newspapers is referred to as content analysis. This method was used to analyse e-governance and its documentation. Therefore, this method used to collect and analyses literature of previous research in the study area to establish strengths, weaknesses and trends in governance and performance.

## J. Questionnaire

In the words of Deekue (2016), a questionnaire comprises of a series of queries on a piece of paper in a chronological order. For effective gathering of information and data about a population in the subject of social science, questionnaires have proved to be more efficient. They could collect information that is not directly observable since they will be able to enquire about feelings, motivation, and individual's experience. The questionnaires was framed centred on the aims of the study.

The study used both structured and unstructured questionnaires. Structured questionnaires are those questionnaires in which there are definite, concrete and pre-determined questions. As Deekue (2016) advices, the questions was presented with exactly the same wording and in the same order to all respondents. The questionnaires included both closed and open questions. According to Deekue (2016), structured

questionnaires are simple to administer and relatively inexpensive to analyze.

Questionnaires are free from the bias of the interviewer, they offer respondents adequate time to give well thought out answers, they are handy in case respondents are not easily approachable and large samples can be made use of and thus the results can be made more dependable and reliable (Rodrigues, 2016).

## K. Thinking-Aloud Protocol

During usability testing, thinking aloud was a good method of data collection. Ordinarily, the participants to be tested are required to express their thoughts verbally while performing some tasks. Participants' suggestions are treated as important compliments according to the behaviours observed during the test. The advantage of using thinking aloud method is that participants are able to express their feelings about a particular product and how it affects their daily life. Also, thinking aloud method offers the capability of a near perfect interpretation of performance measurements.

Recording of the participants comments using a tape recorder is encouraged as the data can be kept for later reference. This method is basically used during focused group discussion.

## L. Focus Groups

To gather important information about the usability and design for products on application, focus groups was used. Participants are assembled into groups of not less than six individuals to discuss the usability issues arising upon the usage of the product and concept of the product.

## M. Data Analysis

Data was analyzed by using a statistical software; Statistical Package for the Social Sciences (SPSS). The collected data was fed into the system, and it helped to generate the outcome in different formats. The main statistical findings were presented as descriptive results

and inferential statistics, which formed the foundation for the development of the framework.

#### N. Quality Control

Quality control refers to the reliability and validity of research that will be used in the research.

##### i) Validity of Research Instruments Results

According to Zhang (2018), the extent to which a test measure is able to measure well is known as test validity. As observed by Löfstedt (2005), a research that is academic in nature must ensure accuracy, replication as well as generalizability. In this research, content and face validity will be used to determine validity of research tools. According to Alenezi (2017), expert opinion from individuals who assessed the relevance, appearance and representativeness of its elements will be crucial in securing face and content validity. The approximation to the extent to which a measure is clearly and explicitly tapping the construct it purports to assess is known as face validity. Experts analysed the interview schedules and questionnaires before they are administered. The tools will be examined by three experts and rated on the scale of one to ten. According to Mwangi (2018), in the event the face validity has an average score of 60% or above after calculation, the instruments will be considered to have a face validity. In essence, face validity assessment is a measure of an instrument's clarity, ease of use and readability.

In order to measure the extent to which information gathered using a particular instrument signifies a content of a particular concept or definite domain of indicators, content validity is assessed.

Expert opinion on content validity was used to assess the concept the instrument was trying to measure and whether the concept being studied is well represented by a set of items or checklists. Expert opinion on content validity was sought on the scale of one to ten.

##### ii) Reliability of Research Instruments Results

The precision and accuracy of a measurement procedure is or an instrument is known as reliability.

Also, it's an assessment of the extent to which results are consistent for a period of time and a perfect depiction of the entire population under study.

This means that an instrument is stable and was to collect the same data if used in other similar studies. Ideally, the stability of such instrument is not questionable and can be used to collect the same data if used in new related studies. According to Santa and MarioFerrer (2018) reliability is the assessment of the extent to which a research instrument is able to produce consistent data or results after several trials. The reliability of the questionnaire used in this study was ascertained through a pilot study. According to Deng (2018), actual users and designers were represented by more than two representatives in the pilot studies.

##### iii) Variable Reduction and Reliability test

A pilot study is a small-scale test of methods and procedures to be used on a large scale (Porta, 2006). This was carried out in Kakamega County where 20 different respondents were drawn from county executives, suppliers, ICT officers and procurement officers. This was done to ensure that the research instruments were valid and reliable enough for the main study (Perry, 2004). The scale used in the questionnaires was tested to ascertain their reliability and this was done using Cronbach's Coefficient alpha of 0.7 (Perry, 2004). The findings of this test were as presented in the following table.

**Table 4 : Reliability Test**

	Cronbach's Alpha	Reliability
Performance metrics	.991	>.7 Reliable
Security adoption	risk.942	>.7 Reliable
E- government adoption	.948	>.7 Reliable
Overall	.973	>.7 Reliable

(Source: Pilot study 2020)



### O. Data analysis

Data collected was converted into useful information based on descriptive statistical analysis and correlational analysis. Descriptive analysis was computed to obtain summaries by using measure of central tendencies, variability or dispersion from mean. Descriptive data was graphically presented. Regression and Correlation analysis was carried out to examine the predictability and association of the variables.

### P. Ethical Consideration

To begin with, the researcher got an approval letter from School of Graduate Studies (SGS) and senate of Kibabii University. The National Commission for Science, Technology and Innovation (NACOSTI) issued the research permit to the researcher. The questionnaires was accompanied by a signed introductory letter to introduce the researcher and a brief explanation of the purpose of the study to all the target respondents. Before conducting the focus group discussion, the researcher sought consent of participants and explained to them the purpose of the focused discussion as well as confidentiality of the information they provided. The researcher acknowledged all the sources and authors of all sources of information that was used to develop this study. The references was listed and cited as appropriate.

## III. RESULTS AND DISCUSSION

The section discusses results for the study.

### A. Response Rate

The researcher distributed 241 questionnaires to public offices in Bungoma County. The responded questionnaires were only 211 which represented 87.55%. The response rate of 87.55% was considered adequate for data analysis. This could be supported by Kothari (2014) who stated that the response rate of 60% and above is good while over 70% was very good. Table 5 and 6 shows the response rate.

### B. Demographic information of the respondents

On gender distributions, the study showed that 120 of the respondents were male representing 56.9% of the respondents while female was 91, which 43.1%.

Majority of the respondents working in county government were of both gender. The percentage difference is not bad. Men are slightly higher than women. It implies the study considered both sexes in the study which is inclusive.

### C. Education level of the respondents

The level of education of respondents who participated in the study was also examined

The results presented showed that 133(63.0%) of the respondents were qualified with University level, 51(24.2%) of the respondents were also qualified on college level, 15(7.1%) had secondary qualification and finally 12(5.7%) had primary education qualification. The study established that the majority of the respondents had university qualifications. Therefore, the results implies that most the participants were educated and could properly understand and effectively participate in the research.

### D. Experience of working in the position

The study also requested the respondents to indicate their experience of working in the position. The results were presented in table 9.

111(52.6%) of the respondents have worked for 5 to 10 years, while 57(27.0%) have worked for below 5 years, 43(20.4%) of the respondents have worked for over 10 years.

The study showed that the majority 111(52.6%) of the respondents have worked for 5 to 10 years, while 43(20.4%) of worked for less than over (10) years. It therefore implies that the study got most working experience respondent who gave a deep insight of E-government adoptions.

**E. Security Threats**

This section covers the different types of security threats and analyses their occurrence in Bungoma County. Majority experienced security threats in their system.

The results show that most the system users experienced Spamming 125(59.2%) and the minority were those affected by identity theft on their system.

**F. Impact Security Risks Mitigation in the Adoption of E-government**

The study sought to assess the effect of Security Risks Mitigation in the Adoption of E-government in Bungoma County. The results were presented in table 12.

Table 12 : Security Risks Mitigation

Statement	1		2		3		4		5		Mean	STD
	F	%	F	%	F	%	F	%	F	%		
Access to information in e-government systems (e.g. e-tax information) should be accessible to allowed e-government users only	11	5.2%	37	17%	21	10%	75	35.5%	67	31.8%	3.711	1.226
I use the e-mail service if the system and my personal information are accessible to allowed e-government users	16	7.6%	49	23.2%	85	40.3%	36	17.1%	25	11.8%	3.024	1.086
Personal information be kept private in the e-health system	14	6.6%	36	17.1%	63	29.9%	72	34.1%	26	12.3%	3.284	1.091
I am more likely to use the e-commerce system if the transactions are to be kept confidential	4	1.9%	17	8.1%	36	17.1%	55	26.1%	99	46.9%	4.081	1.061
E-banking information be accessible to allowed	2	0.9%	6	2.8%	43	20.4%	86	40.8%	74	35.1%	4.062	0.866

e-government users only

I am concerned that E-government resource can be susceptible to malicious interests	14	6.6 %	34	16.1 %	53	25.1 %	71	33.6 %	39	18.5 %	3.412	1.154
I am concerned that data transit may increase exposure to spying threats	36	17.1 %	15	7.1%	40	19.0 %	55	26.1 %	25	11.8 %	3.105	1.351
I am concerned that there is insufficient support from E-government service providers due self-service type support	42	19.9 %	74	35.1 %	15	7.1 %	55	26.1 %	25	11.8 %	2.749	1.348
I am concerned there is inadequate expertise to support E-government services	85	40.3 %	74	35.1 %	30	14.2 %	13	6.2%	9	4.3 %	1.991	1.084
I am worried that there could be security and privacy gaps if I use the E-government services	7	3.3 %	12	5.7%	60	28.4 %	95	45.0 %	37	17.5 %	3.678	0.939
I am certain that user behaviour has impact on adoption of E-government	4	1.9 %	9	4.3%	7	3.3 %	112	53.1 %	79	37.4 %	4.199	0.842
<b>OVERALL</b>											<b>3.867</b>	<b>1.098</b>

Overall Security Risks Mean (%Mean) Std. Dev.	
Std. Error of the mean	Minimum Maximum
Mitigation	3.867 (26.50%) 0.075636 1.098 1.00 5.00

(1 – Strongly Disagree, 2 – Disagree, 3 – Neutral (neither disagree nor agree), 4 –Agree, 5 – Strongly Agree).

Findings of table 11 shows that majority of the respondents, Agreed (46.07%)and Strongly Agreed (34.73%) that Security Risks Mitigation was enhanced in the county government. 15.46% were undecided on whether there was Security Risks Mitigation, 2.72% Disagreed, and 1.02% Strongly Disagreed that Security Risks Mitigation was enhanced in the county government. On average the general Security Risks Mitigation in Bungoma county was 40.40% (mean=3.4136, Std. Dev. = 1.098) rated high; an indication that Safe E-government adoption in Bungoma county seemed to be enhanced at a very high rate.

**G. Correlation analysis**

**Table 12: Correlation analysis**

	Security Risk Mitigation
Security Risk Mitigation	1
Performance Metrics	.968**
	.000
	211

Pearson Correlation	.971**
E-government adoption	.000
Sig. (2-tailed)	211
N	

**\*\* Correlation is significant at the 0.01 level (2-tailed)**

The findings of Pearson Correlation analysis (r= 0.968\*\*, p-value= 0.00 < 0.05) indicate that there was a strong positive correlation between security mitigation E-government adoption in Bungoma County.

**H. Regression Analysis**

Security risks mitigation (Availability, Disclosure of information, Confidentiality) as determinants for e-government adoption. This analysis was achieved by use of Multiple Linear Regression model which determines the partial effects of the independent variables (Performance metrics and security risks mitigation) on the outcome variable (E-government adoption in Bungoma County). However, first a multicollinearity test was conducted to ascertain if it was in order to include all the independent variables in the same multiple linear regression model as detailed below.

**Collinearity Test**

Multicollinearity (also collinearity) is a phenomenon in which one feature variable in a multiple regression model is highly linearly correlated with another feature variable (Echambadi, 2007); in this situation, the coefficient estimates of the multiple regression may change erratically in response to small changes in the model or the data. Variance Inflation Factor (VIF) was adopted in this study to test for multicollinearity. According to Morwitz (2001), independent variables with VIF higher than 5 or a tolerance value less than 0.2 should be expelled from multiple linear regression model as this is an indication of multicollinearity. The results of collinearity test were as shown in table 4.12.

**Table 12** Regression Analysis

Variable	Tolerance (1/VIF)	VIF
Security Mitigation	.063	15.793

Therefore, the findings indicates a strong presence of multicollinearity among of the explanatory variables disqualifying the data for a multiple linear regression analysis

**IV. FRAMEWORK DEVELOPMENT**

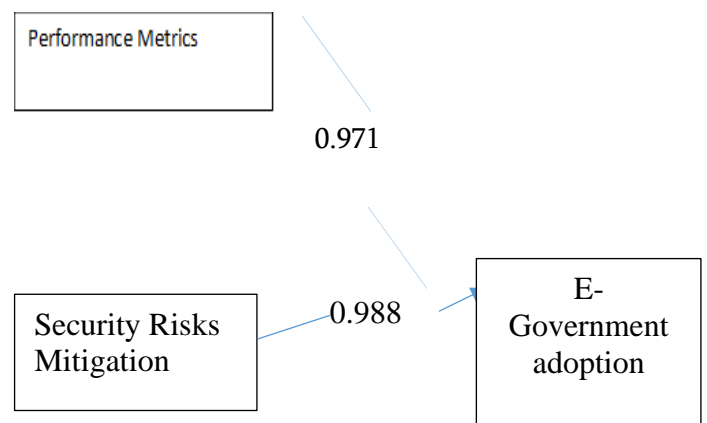
The framework developed by the study is as indicated in the figure 1. The study proposes that to look at security risk issues thoroughly, items under denial of service, spamming and identity theft have to be addressed

**A. Framework Construct**

The developed framework has performance metrics and security risk as the outer constructs and behavior intention to use E-government and E-government adoptions as the inner constructs. The study findings shows that 35.5% and 31.8% do agree and strongly agree respectively that Access to information in e-government systems (e.g. e-tax information) should be accessible to allowed e-government users only had [Mean=3.711, Std. Dev.=1.226]; 17.1% and 11.8% do agree and strongly agree that I use the e-mail service if the system and my personal information are accessible to allowed e-government users had [Mean=3.024, Std. Dev.=1.086]; 34.1% and 12.3% agree and strongly agree that Personal information be kept private in the e-Government system it had [Mean=3.284, Std. Dev.=1.091]; 26.1% and 46.9% agree and strongly agree with a [Mean=4.081, Std. Dev.=1.061] I am more likely to use the e-Government system if the transactions are to be kept confidential; 40.8% and 35.1% agree and strongly agree with a [Mean=4.081, Std. Dev.=1.061] that E-banking information be accessible to be allowed e-government users only; 33.6% and 18.5% agree and strongly agree with a [Mean=3.412, Std. Dev.=1.154] that I am concerned that E-government resource can be

susceptible to malicious interests; 26.1% and 11.8% agree and strongly agree with a [Mean=3.105, Std. Dev.=1.351] that I am concerned that data transit may increase exposure to spying threats ; 26.1% and 11.8% agree and strongly agree with a [Mean=2.749, Std. Dev.=1.348] that I am concerned that there is insufficient support from E-government service providers due self-service type support; 6.2% and 4.3% agree and strongly agree with a [Mean=1.991, Std. Dev.=1.084] that I am concerned there is inadequate expertise to support E-government services ; 45.0% and 17.5% agree and strongly agree with a [Mean=3.678, Std. Dev.=0.939] that I am worried that there could be security and privacy gaps if I use the E-government services and 53.1% and 37.4% agree and strongly agree with a [Mean=4.199, Std. Dev.=0.842] that I am certain that user behaviour has impact on adoption of E-government.

Security risks mitigation in adoption of E-government in Kenya The study found that majority of the respondents, agreed (46.07%) and strongly Agreed (34.73%) that Security Risks Mitigation was enhanced in the county government. On average the general Security Risks Mitigation in Bungoma county was 40.40% (mean=3.4136, Std. Dev. = 1.098) rated high; an indication that Safe E-Government adoption in Bungoma county seemed to be enhanced at a very high rate.



**Figure 1** : Security Risk and E government Framework

## B. Framework Validation

The framework Validation process involved “outsiders” who were not respondents to the study but work in the various position in the county Government and it was done via a focus group discuss through an organized seminar. The study engaged ten IT professional to validate the developed framework. Experts who reviewed the items and commented on their behavior tested context validity of the developed framework. Three of the evaluators were working for a computer company which is using E-government services and were also county officials, four were senior staff in the ministries of the county government while the other three were technical staff in the information technology department in the county.

**Table 13 :** Validation of Framework

Respondent	Frequency	Percentage %
Administrator	4	40
IT Experts	6	60
TOTAL	10	100

## V. CONCLUSION

The study assessed the effect of security risk mitigation on adoption of E-government in Bungoma County through Availability, Disclosure of information and Confidentiality of the E-government users. On average the general Security Risks Mitigation in Bungoma county was 40.40% (mean=3.4136, Std. Dev. = 1.098) rated high; an indication that Safe E-government adoption in Bungoma county seemed to be enhanced at a very high rate. The study concluded that County governments trusted their employees when disclosing information to the public. The study found that there was a significant contribution of security risk mitigation measures to the adoption of E-government.

Finally, the study confirmed that security risk mitigation had a positive significant effect on adoption of E-government users. It was recommended that county governments should be advised to embrace

high security metrics in improving E-government adoption.

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# Available Legal Regime and The Use of Mercury for Small-Scale Gold Mining in Ghana

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## ABSTRACT

The aim of this study was to examine the effects of mercury (Hg) and available laws to regulate its use in the Artisanal and Small-Scale Gold Mining (ASGM) Community in Ghana. Research shows that the use of Hg in the ASGM causes damage to the cognitive and neurological function of the miners, as well as to the physical and mental disabilities to children in the ASGM communities. Furthermore, number of publications also shows that the use of Hg causes significant damage to water bodies and the environment in most mining communities. Additionally, in an attempt to protect the environment from these high levels of Hg in these mining sites and beyond, has led to some conflict and military intervention. Even though, Ghana has adequate laws to regulate Hg use by reducing and where feasible eliminate the use of Hg for small-scale mining. However, due to some legal limitations to the current situation there is the need to amend some of these laws to help address these challenges. In addition, certain policies, technological and educational initiatives taken to address the use of Hg in our environment, have proven largely ineffective. The results of this study shows that the implementation of mining regulation without careful analysis of mine community dynamics, the organization of activities, operators' needs and local geological conditions has resulted in some challenges. However, significant improvements can only be achieved in this area if the state and the organs of government tackle the illegal mining "galamsey" menace; introducing cost-effective techniques for the reduction of the use of Hg in mining; effective government sponsored participatory training exercises as mechanisms for communicating information about appropriate technologies and the environment; and strengthening compliance and enforcement of existing laws.

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In conclusion there is the urgent need to properly regulate the use of Hg in mining communities in Ghana.

**Keywords** : Contamination, Galamsey, Mercury, Mental Disabilities, Neurological function, Environment.

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## I. INTRODUCTION

The Artisanal and Small-Scale Gold Mining (ASGM) sector is very important to the Ghanaian economy. A properly regulated ASGM sector provides employment, increase earnings of people in the local and surrounding communities, alleviates poverty, generates revenues for local Assemblies, and contributes towards community development through implementation of Corporate Social Responsibility (CSR), among other benefits.

In Ghana, elementary Hg is used in ASGM. Hg metal is used to extract gold from ore as a stable amalgam. The amalgam is then heated to evaporate the Hg and isolate the gold. Hg is abundant and inexpensive, and can be obtained from a variety of industrial supply chains or mined directly from cinnabar, making it a readily available tool for mining gold. Mine operators depend on Hg to amalgamate gold but generally discard it freely into the natural environment.

Mercury (Hg) use in ASGM has become a growing crisis in environmental and human well-being. Hg causes damage to human health and to the wider environment. The tailings in ASGM are also a major source of Hg pollution. After the amalgam is isolated from the trommel, the leftover crushed ore, water, and unrecovered Hg are either released

directly into the environment or processed further in large tanks containing aqueous sodium cyanide. When cyanide leaching is used to process tailings, the final waste stream is typically dumped in rudimentary tailing ponds or released into waterways; often the same water sources used for irrigation, drinking and fishing. Because significant amounts of Hg are also made water soluble by complexing with cyanide, this practice results in substantial release of highly toxic and mobile Hg species into aquatic environments, which leads to Hg methylation by bacteria and bioaccumulation of methyl Hg.

In ASGM, the amalgamation process and gold recovery from the amalgam can result in substantial release of Hg into the environment. During the amalgamation process, substantial amounts of Hg can be lost in the tailings. In particular, milling ore and Hg in trommels can result in the formation of tiny Hg droplets that become finely dispersed in the tailings. This “Hg flour” is especially problematic because it can be easily washed away with water and transported far from the mining site. In cases in which the tailings are released directly into the environment, the Hg contaminates water and soil. The release of Hg from tailings into soil and water is a serious hazard to human health because it can compromise food safety and contaminate drinking

water. Hg contaminated water used for irrigation also leads to contaminated food crops, such as rice.

Heating mercury–gold amalgams to vaporize Hg is another major source of Hg emission in ASGM. Hg gas is harmful to the lungs, kidneys, liver and nervous system, so these emissions are especially dangerous.

In Ghana, emphasis has been placed on finding technical solutions to mining processing problems, with little attention being paid to the underlying economic, labour and social issues, an approach which has proved inappropriate environmentally. The government and donor agencies have repeatedly designed and implemented costly technologies and educational programmes that have yielded marginal improvements. In addition, there has been failure to analyse community dynamics and consider miners concerns in the decision-making processes has perpetuated the mercury pollution problem in Ghana's ASGM sector.

Officers at ILO have stressed the importance of implementing site-specific solutions to mining problems, namely, interventions which best reflect the culture and backgrounds of target populations. Few, including Ghana have embraced these ideas. Donor organizations and international experts continue to promote “effects-based” Hg contamination work that provides minimal added value. In addition, there has been a fixation on implementing generic technologies and support programs, as opposed to site-specific solutions that best reflect local conditions. The need to analyze local community dynamics before devising solutions to the Hg

pollution problem has become increasingly evident: centralized processing facilities, effective solutions in countries with localized gold deposits, have proved unsustainable where activities are comparatively more chaotic and gold is widely dispersed; sophisticated training exercises, perhaps appropriate strategies for literate mining populations, are inappropriate in locations characterized by high levels of illiteracy; and mass implementation of mercury retorts is bound to be less successful over the short-term in countries with numerous widely dispersed marginal gold deposits, and therefore, scattered mining populations. The heterogeneity of small-scale gold mining in terms of the skills levels, literacy, operating conditions and geology makes the application of generic solutions inappropriate.

An analysis of the main prevailing laws on Hg show that Ghana has adequate legislation to regulate Hg, however, there is need to strengthen compliance and enforcement of existing laws. This paper discusses the effects of Hg pollution on the environment and the prevailing laws available to regulate Hg use in the ASGM sector of Ghana.

### **A. Objective**

The main objective of this study is to determine the effect of mercury pollution on human health and the environment. In addition, to examine the available legal regime to regulate the use of mercury in the ASGM communities of Ghana, and the extent to which these laws are effectively enforced by the regulatory agencies.

## II. METHODS

The research employed two comprehensive data collection methodologies and statistical analytical tools. The first source of data collection methodology was interviews, conducted with randomly selected participants at various mining communities in Ghana. Secondly, the paper also relied on qualitative research design by utilizing texts of existing primary and secondary sources of information on mining in Ghana. These included international treaties, conventions and protocols, the Constitution of Ghana, relevant domestic legislation and subsidiary legislation, and legislative instruments and case law. In addition to information from textbooks, professional journals and periodicals, research papers and conference materials, official government and policy papers, the internet and online library materials. All information and data were collated, coded, analyzed and interpreted to clarify issues, to answer the relevant questions and finally provide the basis for recommendations and the way forward.

## III. Results and Discussion

### A. Presentation of Results

A total number of 30 participants took part in the interview conducted with their educational background (Table 1) ranges from: First Degree, Master's Degree and PHD. Most of the people interviewed were first degree holders. Additionally, the interviewees professional qualification (Table 2) includes, Civil servants (Directors & Assistant Directors), academics, lawyers, lecturers, scientists and Environmental law experts and environmental activists. All the participants worked in their current position in organizations between 5 to 25 years.

**Table 1: Educational background of participants**

Educational background	Number of participants	Percentage Distribution
BSC/BA	3	10
MSC/MPHIL	9	30
PhD	9	30
Others	9	30
Total	30	100

**Table 2: Professional Background of Participants**

Profession Background	Number of participants	Percentage Distribution
Civil Servants	6	20
Academics	3	10
Lawyers	3	10
Scientists	6	20
Environmental law experts	9	30
Environmental Activist	3	10
Total	30	100

Table 3 represent the awareness and knowledge of participants regarding the available mercury laws in Ghana. Out of the total of 30 participants 25 people said yes, 3 said not too much or limited laws and 2 people said no.

**Table 3: Knowledge of Mercury Laws**

Mercury Laws	Yes	Not too much	No	Total
Knowledge of available Mercury laws	25	3	2	30
Percentage Distribution. %	83	10	7	100

**Table 4 shows the adequacy of mercury laws in Ghana of which 27 people responded yes, 3 participants said not too adequate.**

**Table 4: Adequate Mercury Laws**

Mercury Laws	Yes	Not adequate	No	Total
<b>Are mercury laws adequate</b>	27	3	0	30
Percentage Distribution. %	90	10	0	100

**Table 5 represent the response to the question of effective implementation and enforcement of mercury laws by regulatory institutions in Ghana: 18 people said yes and 12 said not effectively implemented. The reasons of these include the fact that most small-scale miners are illegal miners and the lack of adequate human capacity by the regulatory institutions.**

**Table 5: Implementation and Enforcement of Mercury Laws**

Mercury Laws	Yes	Not effectively	No	Total
<b>Is there effective implementation and enforcement of mercury laws by regulatory institutions</b>	18	12	0	30
Percentage Distribution. %	60	40	0	100

**Table 7: Adequate compliance of mercury laws:**

Mercury Laws	Yes	Not adequate compliance	No	Total
<b>Is there adequate compliance of mercury laws</b>	5	5	20	30
Percentage Distribution. %	16.7	16.7	66.7	100

**Table 8 provided information on the available sanctions for no-compliance being enforced: 8 people said yes, 22 people say no. The reasons for these include the political will to prosecuted culprits in courts, some regulatory officials are complicit; regulatory institutions lack adequate human capacity to enforce mercury laws).**

**Table 8: Available sanctions for no-compliance**

Mercury Laws	Yes	Sanctions not effectively enforced	No	Total
<b>Are available sanctions for no-compliance being enforced</b>	8	0	22	30
Percentage Distribution. %	27	0	73	100

## B. Discussions

Mercury (Hg) poisoning is a tremendous burden to human health, especially in ASGM communities. Hg gas, such as that encountered in ASGM amalgam processing, is readily absorbed in the lungs and then further transported to other organs. Elemental Hg is able to cross membranes including the blood-brain barrier and the blood-placenta barrier, posing a threat to neurological function and fetal development, respectively. Acute Hg exposure can lead to tremors, memory loss, respiratory distress and even death. Chronic exposure to Hg gas may lead to renal failure, tremors, movement disorders, and various psychosis and memory impairment. Inorganic Hg, formed through oxidation of mercury metal lost during ASGM may contaminate water and also lead to kidney damage if consumed. Conversion of mercury pollution from ASGM into methyl Hg also poses a tremendous risk as this highly toxic form of Hg accumulates in food supplies, such as fish, crustaceans and mollusks. Consumption of methyl Hg is particularly harmful to

the central nervous system, causing nerve and brain damage. Kidneys are also affected and methyl Hg presents an extreme risk to fetal development.

Another troubling consequence of Hg pollution from ASGM is the effects on embryos, fetuses, and children. Hg levels in women of child-bearing age near ASGM activities are often high due to consumption of mercury-contaminated water, seafood or rice; direct handling of Hg in mining or other gold-related processing; or through exposure to Hg gas during amalgam processing. Because maternal transfer of Hg to the fetus is efficient for elemental and methyl mercury, it is perhaps not surprising that children in ASGM communities have high incidence of physical and mental disabilities.

While the human cost of Hg poisoning in ASGM is the most important and immediate concern, Hg pollution also damages the wider ecosystem; compromising food chains and biodiversity. Hg emissions can adversely affect algal growth; crustacean health; fish growth, brain function, and reproduction; and amphibian larval health and survival. It is also known that Hg bio-accumulates in fish, which then poses a threat to any bird or mammal that consumes it, including humans. It is also common for the people living near these ASGM areas to eat fish as a major source of dietary protein, which leads to high Hg levels even in non-miners. In this way, Hg pollution threatens food security.

Aquatic plants are bio accumulators of Hg and uptake of the heavy metal may, in some cases, compromise plant health. Inorganic Hg in water, for instance, can lead to decreased chlorophyll content and protease activity for floating water cabbage *Pistia stratiotes*. Likewise, the pond weed *Elodea densa* presented with abnormal mitotic activity upon exposure to methyl mercury.

Regarding crop contamination, mercury uptake in rice in ASGM communities has been documented. In these cases, rice paddies were irrigated with mercury contaminated water, resulting in mercury levels as high as 1.2 ppm in the edible grain - more than 10 times the limits recommended by the World Health Organization (WHO). While mercury uptake into crops is clearly undesirable, mercury uptake into non-edible plants may be a useful way to remediate mercury pollution in water and soil due to ASGM.

### **International Regulation of Mercury**

As a response towards the effects of Hg to human health and the environment, the Minamata Convention was adopted in 2013. The objective of the convention is to protect human health and the environment from anthropogenic emissions and releases of Hg and Hg compounds. The Convention addresses Hg use in ASGM among other forms of Hg pollution. Ghana signed the Convention on 24<sup>th</sup> September 2014 and ratified it on 23<sup>rd</sup> March 2017.

The Convention does not require a ban of Hg use in ASGM; rather, Article 7 of the Convention requires signatories to take steps to reduce, and where feasible eliminate, the use of Hg and the emissions and releases to the environment of Hg from, mining and processing. Countries must also submit a National Action Plan that describes how they will achieve Hg reductions. There are also specific provisions for member nations to help educate miners and promote research into sustainable, Hg-free mining. Annex C of the Convention, requires that further actions are prescribed that include the elimination of four especially problematic activities: whole-ore amalgamation, open heating of amalgams, heating amalgams in residential areas, and the use of cyanide to extract gold from Hg-rich tailings.

ASGM is considered an “allowable use” under the Convention, which means that Hg can be imported and exported for use in this sector. However, there are restrictions on this trade. Exporting countries must

notify and receive consent from importing countries. The convention presents challenges, particularly for developing countries like Ghana. It is quite complex to implement and this will take time. There main challenges to implementation are: the large number sectors concerned, the many stakeholders involved and the high cost of replacing Hg.

Ghana and many other countries have not yet done their assessments or estimated the costs of replacing Hg. The Convention mentions financial support, technical assistance and technology transfer to countries with economies in transition and developing countries. Two international funds are earmarked for this purpose: Global Environmental Facility Trust Fund, set up in 1992, which is already supporting Hg projects in countries; and an international programme to be set up by the United Nations Environment.

Without vital international support, Ghana and many implementing countries in Africa and Asia could run into severe difficulties. The cost of phasing out the use of Hg could be a reason why some African countries are hesitating to join the Convention.

### **Ghanaian Regulation of Mercury**

An analysis of the main prevailing laws in Ghana show that there is adequate legislation for the implementation of the Minamata Convention. The Mercury Law (PNDCL 217) requires that Small-Scale gold miners observe good mining practices in the use of Hg. Small-scale gold miners can buy from licensed Hg dealers a reasonable quantity of Hg that can be shown to be necessary for their operations. Any small-scale miner who does not observe good mining practices in the use of Hg for his mining operations, sells or deals in Hg, possesses excess Hg, commits an offence and shall on conviction be liable to a fine or to imprisonment or to both. Any person who imports Hg into Ghana; possesses or buys, sells or transfers Hg without a license to another person, commits an offence and is liable to a fine or term of imprisonment

or to both. The Minister for Trade may issue a licence to a person to import, possess, buy, sell or deal in Hg. However, the Minister may cancel a license if the licensee breaches any term of the license, the Hg Act or if it is not in the national interest a court may order the cancellation and forfeiture of a licence if a licensee is convicted under the Hg Act.

The Minerals and Mining Act, 2006 (Act 703), requires small-scale miners to buy from an authorized Hg dealer quantities of Hg that may be reasonably necessary for mining operations. The Minerals and Mining (Health, Safety and Technical Regulations) requires a person who wants to use Hg for small-scale mining to use a retort to apply for written permission of the Chief Inspector of mines. In addition, a holder of a small-scale mining license must ensure that the environment within the mine does not expose workers in the mine to environmental hazards.

The Environmental Protection Agency Act established the Environmental Protection Agency (EPA) as the leading body responsible for the protection and improvement of the environment in Ghana. The EPA is responsible for issuing environmental permits and pollution abatement notices for controlling wastes discharges, emissions, deposits or other source of pollutants and issuing directives, procedures or warnings for the purpose of controlling noise. The EPA has the authority to require an EIA, is responsible for ensuring compliance with EIA procedures and is the lead EIA decision-maker.

The Environmental Protection Agency Act, provides for the establishment of a multi-stakeholder Hazardous Chemicals Committee, comprising representatives from key government organizations with an interest in chemical management, to monitor and advice the EPA on the importation, manufacture, distribution, sale, use and disposal of hazardous chemicals; to advice the EPA on the regulation of hazardous chemicals, and; to

perform any other functions relating to chemicals that the EPA may direct.

To perform its duties under the Act, the EPA through its Chemicals Control and Management Centre (CCMC), collects information on all chemicals imported into Ghana. The CCMC's primary objective is to protect human health and the environment from possible effects of chemicals. The CCMC issues chemical clearance permits to importers of industrial chemicals like Hg. It is mandatory for applicants to submit an application form and copies of the Material Safety Data Sheets (MSDS), which provide technical information on the chemicals. The documents may also suggest disposal options of such chemicals as well as information about toxicity.

The EIA process is legislated through the Environmental Assessment Regulations, the principal enactment within the EPA Act. The EIA Regulations require that all activities likely to have an adverse effect on the environment or public health must be subject to environmental and issuance of a permit before commencement of the activity. Schedule 2 includes mining (both small-scale and large scale). The Regulations define what is to be addressed within the EIA, how the EIA process should involve the public and outlines the steps to be followed within the process.

The Standards Authority Act, provide facilitation for examination and testing of commodities and manner in which they may be manufactured, produced or processed; to assist industries in setting up and enforcing quality assurance and environmental management systems and procedures. The Act mandates the Ghana Standards Board to ensure the health, safety, environment and general welfare of the people of Ghana. The Act can be used to directly control Hg added products as provided for in Article four of the Minamata Convention.

The Food and Drugs Act 1992, (P.N.D.C.L. 305B) was enacted to control the manufacture, import, export, distribution, sale, use and advertisement of foods, drugs, cosmetics, household chemicals and medical devices. The Act provides for the efficient and comprehensive regulation and control of food, drugs, medical devices, cosmetics, herbal drugs and poison. The Act can be used to implement Article 4 of the Minamata Convention on Hg – added products and its subsequent Part I of Annex A, which calls for the phasing down of the use of cosmetics (with Hg content above 1ppm).

The objective of the Water Resources Commission Act is to ensure that Ghana's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account the prevailing principles. The Act prevents water pollution of water resources and calls for preventive measures to avoid any such pollution from occurring, continuing or recurring. The strict enforcement of this Act may help reduce activities around water bodies that cause pollution by use of Hg. Enforcement of this provision is provided for under the Minerals and Mining Act, which mandates all mineral right holders to apply for a licence from the Water Resources Commission before commencing mining activities.

#### IV. CONCLUSION

In conclusion, Mercury (Hg), although useful in many ways, its harmful effects to human life and existence, and the environment are far damaging than the benefits derived from its use. The use of Hg is considered to be an economic problem as it is easily accessible and cheap, therefore a political solution alone will not solve the problem as Hg functions as a financial 'tool' for impoverished miners in producing income from gold mining quickly and cheaply.

Although Ghana has enacted various laws to deal with the use and disposal of Hg waste. Whereas these laws show the political will of the governments to control the use of Hg there still remains a question of enforcement of these laws. Ghana must enforce its laws. The various institutions must engage those in small scale mining, educate these primary stakeholders; teaching and making available to them improved ways of mining.

Ghana has sufficient laws to regulate Hg by reducing and where feasible elimination the use of Hg. However, minor amendments are needed in some of the laws in place. There is also the need to raise more public awareness on the effects of Hg to ASGM; strengthen compliance and enforcement of existing laws; and ensure effective collaboration between EPA (the coordinating institution) and Key Ministries, Departments and Agencies (MDAs) that constitute the various committees aimed at sound management of chemicals, like Hg in the ASGM.

In addition, the international community can help to address the challenge of reducing, or where possible eliminating the use of Hg in ASGM through funding education programs, financial mechanisms for investment in better technologies, and support to government to create enabling policies to support the miner's participation in the formal sector.

## V. ACKNOWLEDGEMENTS

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# Analysis of Machine Learning and Deep Learning Models to Classify ASD Using fMRI

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## ABSTRACT

Diagnosis of autism spectrum disorders (ASD) is a complex task, the solution of which usually depends on the experience of the physicians due to the lack of specific quantitative biomarkers. Machine learning and Deep Learning approaches are increasingly being used as a diagnostic tool for ASD classification, with the potential to improve discrimination validity among ASD and typically developing (TD) individuals. This paper describes the use of feature selection and two classification techniques to successfully distinguish between individuals with ASD and individuals without ASD, using data from a large resting-state functional magnetic resonance imaging (rs-fMRI) database.

**Keywords:** ASD, fMRI, Functional Connectivity, Machine Learning, Deep Learning

## I. INTRODUCTION

Autism spectrum disorder (ASD) is a disorder that affects a person's social and communication abilities as well as their interests and repetitive behaviours. According to recent research, it is estimated that worldwide about one in 160 children is affected by ASD. Early diagnosis of ASD is critical for the implementation of early intervention and providing a proper treatment plan. The symptom-based diagnosis of ASD generally requires a lot of behavioural assessments under the guidance of a highly experienced multidisciplinary team.

One of the promising candidates for data-driven diagnosis is resting-state functional connectivity MRI (rs-fc MRI) data. Previous research has found that people with autism have abnormal brain connectivity.

Despite extensive research evidence that ASD is a disorder of brain connectivity, it lacks a distributed framework for brain abnormalities. It is still unclear whether brain abnormalities are associated with specific brain regions of ASD.

In this study, we implemented a data-driven approach to classify ASD patients and typically developing (TD) participants by using the rs-fMRI features extracted from Blood Oxygen Level Data (BOLD) in the regions of the brain. The goal of this paper is to apply and analysing machine learning algorithms and deep learning algorithms to classify ASD patients and TD participants using the rs-fMRI data from a large multisite data repository ABIDE (Autism Brain Imaging Data Exchange) and identify the important brain connectivity features.

## II. LITERATURE SURVEY

### A. Functional Connectivity

Karampasi A. et al. [1] used the ABIDE Preprocessed Dataset along with CC200 atlas. Feature extraction was done using functional connectivity, along with Divergence and Haralick Texture. Five feature selection algorithms were used to select the optimal parameters - Recursive Feature Elimination with Correlation Bias Reduction (RFE-CBR) using both linear and Gaussian kernel, Local Learning Based Clustering FS (LLCFS), Infinite FS (InffS), minimal Redundancy-Maximal-Relevance (mRMR) and Laplacian Score (employing the Feature Selection Library Toolbox). Features selected from each of these algorithms were fed into the classification algorithms - Support Vector Machines (SVM) with linear and Gaussian kernels, k-Nearest Neighbours (kNN), Linear Analysis (LDA) and Ensemble Trees Discriminant. Highest accuracy of 72.5% was obtained with SVM (Linear) when FS is done using RFE-CBR (Linear).

Chaitra N. et al. [2] used the ABIDE Preprocessed dataset along with CC200 atlas. Data Processing Assistant for Resting-State MRI (DPARSF) software was used for pre-processing of resting-state fMRI. Blind deconvolution was carried out to reduce non-neural variability because of hemodynamic response function (HRF). Feature extraction is done using functional connectivity using Pearson's Correlation and complex network analysis. T-test was performed for feature selection. Data after functional connectivity alone, complex network analysis (graph measures) alone and both together were fed into Recursive Cluster Elimination Support Vector Machine (RCE-SVM) classification algorithm. It was seen that combined connectivity and graph measures gave a better accuracy of 70.01% when compared to the rest (67.31% for connectivity and 64.47% for graph measures). Not only this, but they were also able to find the differences in brain connectivity between a control and a patient.

X.Yang et al. [3] used ABIDE Preprocessed dataset and tested the classification algorithms on all atlases - AAL, Dosenbach, EZ, HOA, TT, CC200 and CC400. Feature extraction is done using functional connectivity between 2 regions of the brain. This correlation value ranges between -1 and 1. After feature extraction, the data of each atlas was fed to classification algorithms - Support Vector Machines (SVM), Logistic Regression (LR), Ridge and Random Forrest (RF). It was found that the Ridge classifier along with CC400 produced the best accuracy of 71.98%.

### B. Machine Learning

In the past few years, an increasing number of neuroscience research studies have used machine learning models like Naive-Bayes and Decision Tree[4], Support Vector Machines[5] - [8] and deep learning approaches like Convolutional Neural Network[10] and mathematical approaches like Graph theoretical measures[12] to implement data-driven diagnosis of ASD, which would lead to more effective treatment outcomes.

Parikh, et al. [5] Applied linear and non-linear Support Vector Machines (SVM), Random Forest (RF), k-Nearest-Neighbour (KNN) algorithms to diagnose autism in individuals, based on ABIDE I pre-processed data. In SVM, each personal characteristic data (PCD) feature was normalized into a [0, 1] scale to prevent any feature from dominating the optimization of SVM models. For the decision tree model, the CART algorithm was applied (Breiman, L., et al. Classification and Regression Trees, 1984) to create decision trees. For the random forest model, the number of trees were optimized by searching the empirical values [50, 60, 70, 80, 90, 100]. The number of trees was selected when the AUC was the best on the training data.

Wang, et al. [6] defined 35 spheres with the MNI coordinates of these regions as the centre and 5 mm as

the radius. Time courses were extracted from each of the 35 spheres and averaged within each region. Pearson's correlation coefficients ( $r$ ) were computed between these average time courses. Individuals'  $r$  values were normalized to  $z$  values using Fisher's  $z$  transformation. The SVM and XGB were applied to identify these features, separately. GridSearch CV strategy was used to search for the optimal parameters for the three classifiers. The SVM achieved a mean classification accuracy of 90.60% Applied SVM-RFECV to the obtained data to compare the performance of SVM-RFECV (90.6%) with XGB (72.56%).

### C. Deep Learning

Meszlényi, et al. [9] described a convolutional neural network architecture for functional connectome classification called connectome-convolutional neural network (CCNN). The results on resting state fMRI (functional magnetic resonance imaging) network-based classification and a publicly available dataset for amnesic mild cognitive impairment classification demonstrate that the CCNN model can efficiently distinguish between subject groups. The connectome-convolutional network is capable to combine information from diverse functional connectivity metrics and that models using a combination of different connectivity descriptors are able to outperform classifiers using only one metric is also shown. From this flexibility follows that the proposed CCNN model can be easily adapted to a wide range of connectome-based classification or regression tasks, by varying which connectivity descriptor combinations are used to train the network.

F. Ke, et al. [11] investigated the structural and strategic bases of ASD using 14 different types of models, including convolutional and recurrent neural networks. Using an open-source autism dataset consisting of more than 1000 MRI scan images and a high-resolution structural MRI dataset, the paper demonstrated how deep neural networks could be used

as tools for diagnosing and analyzing psychiatric disorders. Training 3D convolutional neural networks to visualize combinations of brain regions is achieved, thus representing the most referred-to regions used by the model whilst classifying the images. Recurrent neural networks to classify the sequence of brain regions efficiently were also implemented. We found emphatic structural and strategic evidence on which the model heavily relies during the classification process.

## III.METHODS AND MATERIAL

This paper is a data-driven analysis to classify subjects as neurotypical or autistic, with the data being obtained from ABIDE under a specific ROI atlas. Here, we use Craddock 200 (CC200). The time-series data undergoes further pre-processing to deem it suitable for the next steps.

The functional correlation between the regions of interest (ROI) is calculated, after which the matrix undergoes a dimensionality reduction. This ensures that only significant correlations are retained. The resulting dataset is fed to RCE-SVM and CNN models. The results obtained are collected and compared for analysis.

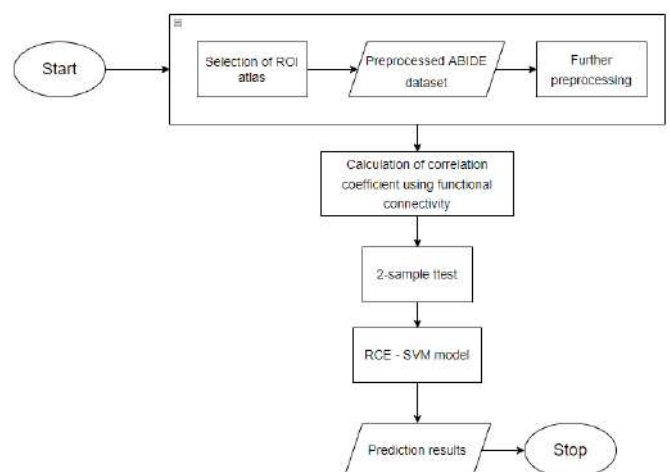


Fig. 1. Methodology

### I. Dataset

The ABIDE consortium of 16 imaging sites has aggregated data from 539 individuals with ASD and 573 individuals without ASD, sharing the data openly so that researchers can learn more about the differences between these groups. These 11112 datasets are composed of structural and resting state functional MRI data along with an extensive array of phenotypic information.

ABIDE data can be used in various formats. There a number of atlases available, such as CC200, C400 and AAL which map out the human brain into several sections, each following a different set of areas, partitions and labelling. The data extracted from the ABIDE dataset first undergoes pre-processing to remove any unwanted information such as noise, outliers, incorrect values and values in inconsistent formats. There are various pipelines that can be used to filter the data, such as CCS, CPAC, etc. This data is then processed to extract features. The algorithms used to extract the features determine which have a higher correlation to ASD symptoms. These features are then used, while the irrelevant ones are discarded. The finalized features are then fed as input to the classification algorithms.

The paper is a data-driven analysis to classify subjects as neuro-typical or autistic, with the data being obtained from ABIDE under a specific ROI atlas. Here, we use Craddock 200 (CC200). The processed dataset used in the paper was segregated on the basis of the university from which the time-series data was obtained. We have made use of data from four universities, namely Caltech, UCLA, Yale and CMU. The time-series data is stored in the form of 1D files per patient in each college, as shown below:

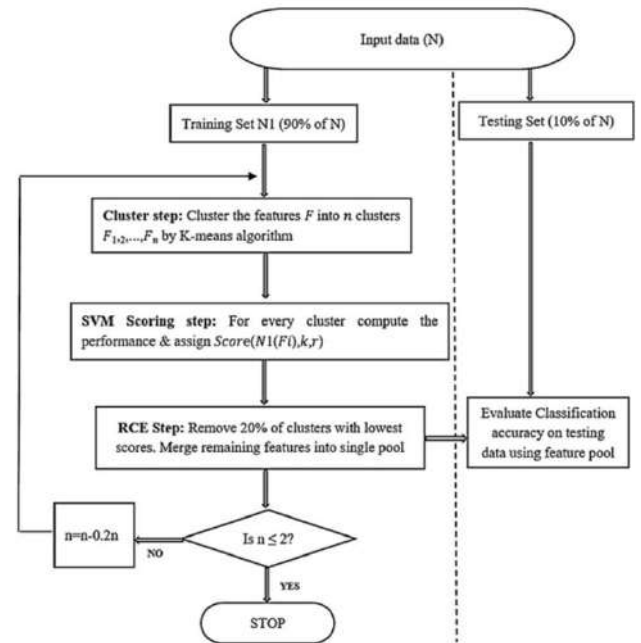
ROIS CC200	CMU_a_0050653_roids_cc200.1D
1	#1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11 #12
2	-22.528225 -9.658229 -8.58878 0.764776
3	-18.691798 -22.752668 -2.308194 -1.731526
4	-16.308761 -28.892603 3.776652 -1.189408
5	-15.79153 -23.678346 2.195081 2.512485
6	-11.085301 -9.476474 -8.64767 10.101422
7	0.787822 6.543935 -21.472713 21.921497
8	13.730187 16.509708 -25.375607 33.321258
9	18.278797 16.248162 -15.12768 34.275791
10	12.109015 8.313014 4.050718 18.035408
11	2.738198 0.621843 21.029855 -9.234075
12	-0.162027 0.234703 28.468229 -30.96479
13	6.583639 7.830798 28.307167 -35.328318
14	18.888333 14.258751 27.971969 -26.93732
15	30.848527 16.283794 31.775102 -20.811446
16	38.662698 14.89931 36.72085 -24.888948

Fig. 2. Time series data

The time-series data undergoes further pre-processing to deem it suitable for the next steps.

### II. Data Preprocessing

Time series data taken from ABIDE’s public S3



bucket on AWS data undergoes pre-processing where it undergoes slice timing correction, motion realignment, normalization, nuisance removal and standardization.

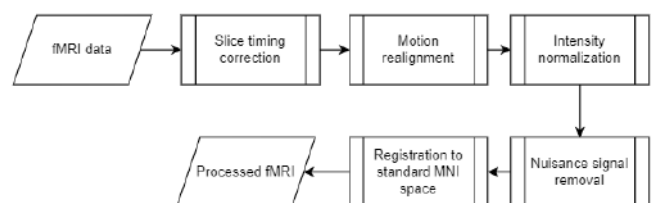


Fig. 3. Data Preprocessing

### III. Feature Extraction

The correlation of the different regions of the brain are calculated using functional or effective connectivity. This is done for each subject.

### IV. Feature Selection

The goal of feature selection is to remove noisy, redundant or irrelevant features from the data while minimizing the information loss. Feature selection can often be an advantageous pre-processing step for training supervised learning algorithms. Feature selection can be performed in a supervised or unsupervised fashion. The T-test estimates the true difference between two group means using the ratio of the difference in group means over the pooled standard error of both groups. It can only be used when comparing the means of two groups. T-Tests is used to perform feature selection.

### V. Learning and Classification

1) Recursive Cluster Elimination Support vector machines (RCE-SVM): The SVM is one of the most commonly used classification and regression algorithms in rs-fMRI studies. The support vector machine finds an optimal separating hyperplane between classes to maximize the margin. The RCE-SVM tool facilitates the easy assessment of the performance of every individual cluster of functional connectivity groups. This helps to identify those clusters that offer the least significance in classification of the data. These clusters are excluded from the analysis, with clusters showing higher performance in the classification retained. After each elimination, the data is re-clustered to form new clusters. These clusters may be stronger than the previous clusters.

Fig. 4. Flow of RCE-SVM [14]

2) Deep neural networks: A CNN uses a system much like a multilayer perceptron that has been designed for reduced processing requirements. The layers of a CNN consist of an input layer, an output layer and a hidden layer that includes multiple convolutional layers, pooling layers, fully connected layers and normalization layers. Generally, CNN's have multiple layers that process and extract features from data. Firstly, convolution layer which has several filters to perform the convolution operation. It is followed by Rectified Linear Unit (ReLU) to perform operations on data elements, the rectified feature map output is then fed into the pooling layer which is a is a down-sampling operation that reduces the dimensions of the feature map. The pooling layer then converts the resulting two-dimensional arrays from the pooled feature map into a single, long, continuous, linear vector by flattening it.

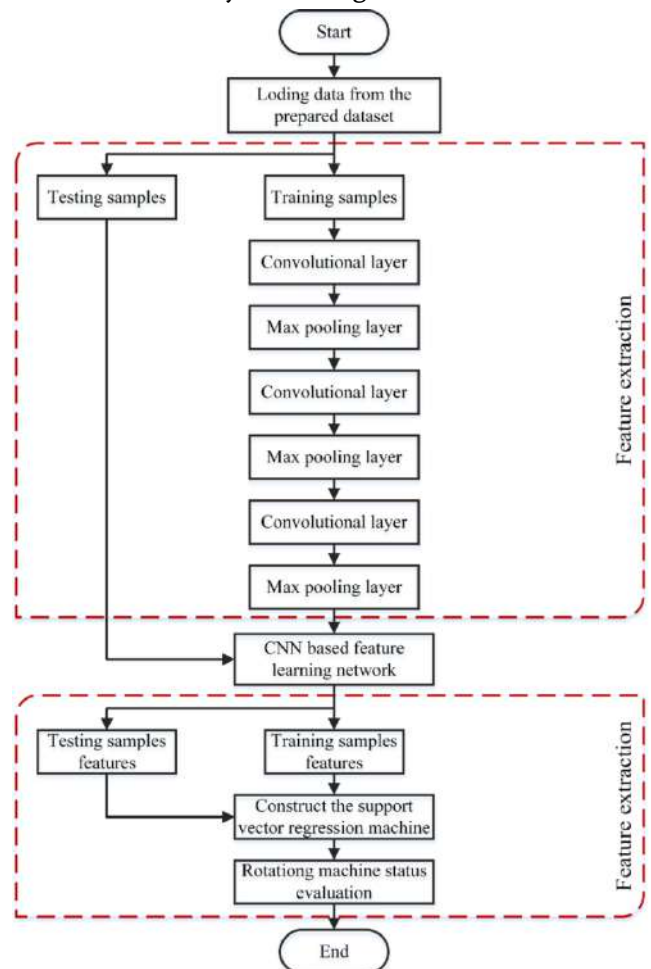


Fig. 5. Flow of CNN [13]

#### IV.IMPLEMENTATION

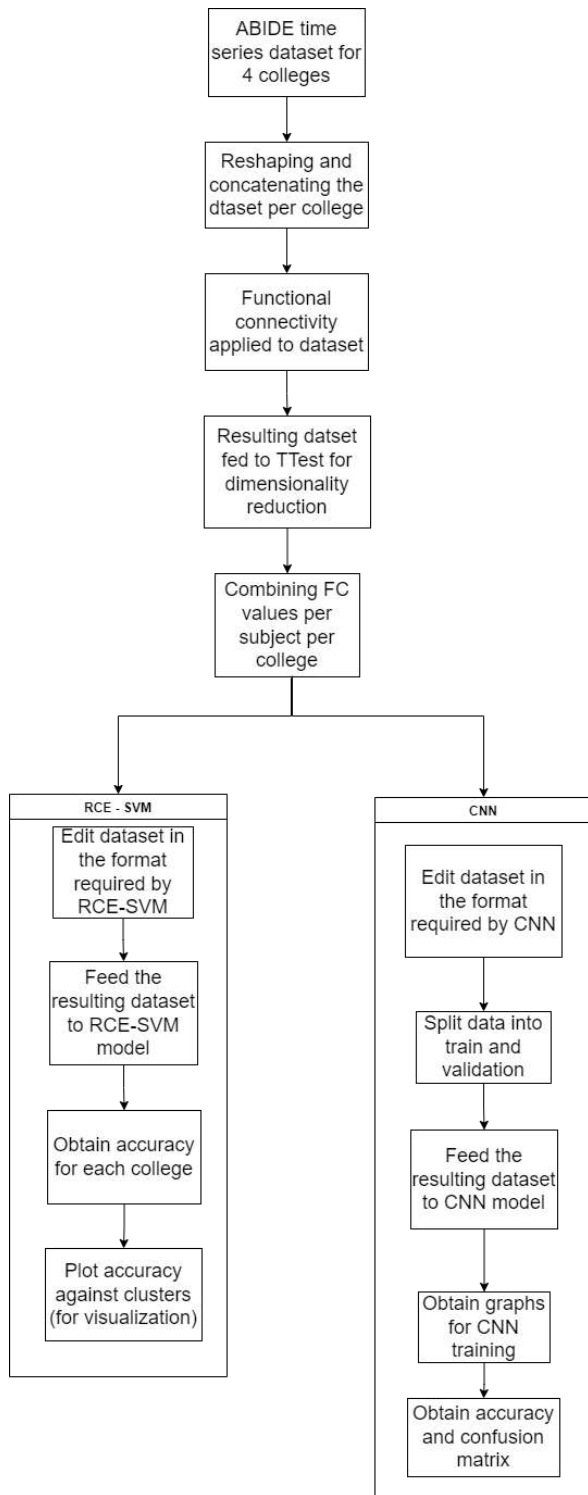


Fig. 6. Flow of the implementation

The system is designed and developed on MATLAB (MATrix LABoratory), which is a programming and computing platform that is used extensively by scientists, research students and engineers to analyse and build systems. It is often used for technical computing and visualization. Many functions, such as matrix manipulation, function plotting, graphs are used, along with supplementary programs that help to simulate graphics, neural networks, embedded systems, etc.

First, we downloaded the ABIDE time series dataset for four colleges – Yale, UCLA, CMU and Caltech. Each college had multiple subjects. Every subject’s time-series data is stored in one file. We performed reshaping and concatenation of the data in such a manner (flat 1D files to 3D) that it can be fed to the functional connectivity algorithm. Resulting dataset of functional connectivity between multiple regions of the brain is fed to the t-test algorithm for dimensionality reduction.

We then combined the functional connectivity data for each subject per college into one excel file which will be converted to mat file and fed to both CNN and RCE-SVM.

For RCE-SVM: After obtaining the accuracy for each college, we plot the accuracy against the number of clusters for visualization.

For CNN: We split the data into train and validation (the amount of split varies each time) and obtain the accuracy and confusion matrix for each split.

```

MATLAB R2012a
File Edit Debug Desktop Window Help
Shortcuts How to Add What's New
Command Window

#Iteration:600

Start the Learning...
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (8/8) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (11/11) (classification)
Accuracy = 100% (8/8) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (11/11) (classification)
Accuracy = 88.8889% (8/9) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (8/8) (classification)
Accuracy = 100% (9/9) (classification)
Accuracy = 100% (9/9) (classification)

```

Fig. 7. RCE-SVM in progress

### V. RESULTS

We investigated how machine learning and deep learning models can be applied to identifying individuals with a complex psychiatric disorder such as ASD. We primarily used the RCE-SVM algorithm and CNN as analysis and diagnosis tools, building them with various architectures.

#### RCE-SVM

In Fig 7, we displayed the classification of RCE-SVM in progress. The input data an Excel file format (.xlsx) is split into training and validation in a ratio of 60-40 (according to the k-fold value of 6). The accuracy obtained on the input data collected from patients across various universities, such as UCLA, CMU, Caltech and Yale are presented below. Each university has a set of patients segregated into two classes - control (CNT), who are neurotypical individuals, and autistic (ASD), who are individuals suffering from Autism Spectrum Disorder. The results for each of these universities implementing RCE-SVM is given below:

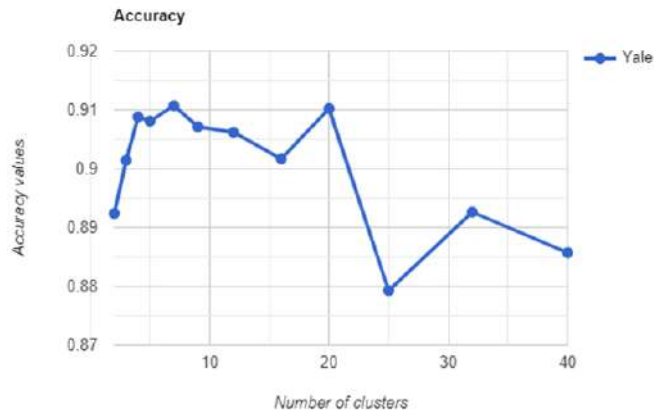


Fig. 8. RCE-SVM results for Yale

In Figure 8, RCE-SVM for Yale is seen to perform best on the data when the number of clusters are 20, with a steep improvement in accuracy. It finalizes its accuracy at 87.93% at a cluster level of 2.

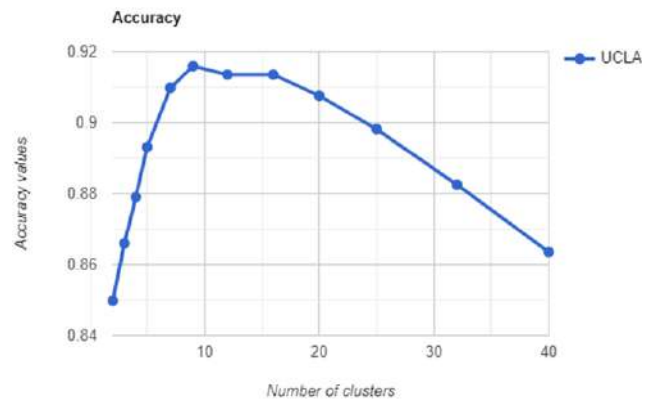


Fig. 9. RCE-SVM results for UCLA

In Figure 9, RCE-SVM for UCLA performs best on the data when the number of clusters are 8, and sees a rapid decline with a further decrease in clusters. It finalises its accuracy at 84.98% at a cluster level of 2.



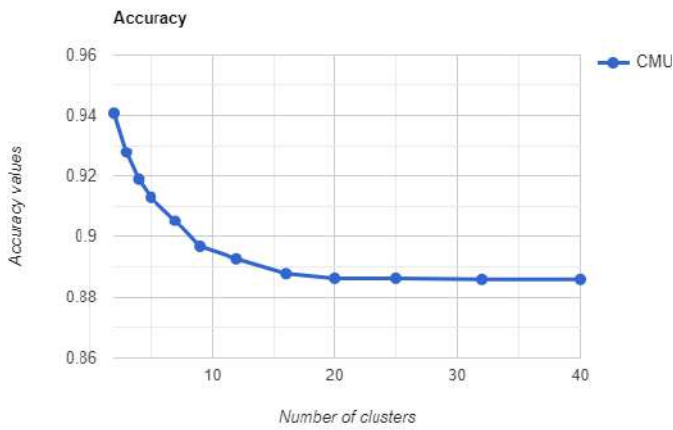


Fig. 10. RCE-SVM results for CMU

In Figure 10, RCE-SVM for CMU is seen to have a steady improvement in accuracy as the number of clusters decrease. It performs best on the data when the number of clusters are 2, facing no decline in accuracy as the algorithm proceeds further. It achieves its final accuracy at 94.07% at a cluster level of 2.

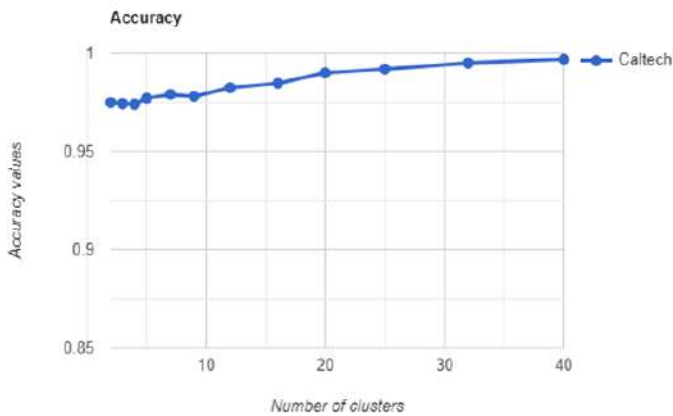


Fig. 11. RCE-SVM results for Caltech

In Figure 11, RCE-SVM for Caltech is seen to have a steady decline in accuracy as the number of clusters decrease. It performs best on the data when the number of clusters are 40, facing a slight decline in accuracy as the algorithm proceeds further. It achieves its final accuracy at 97.50% at a cluster level of 2.

**CNN**

The training progress, validation results and confusion charts are illustrated for the data retrieved

from mentioned universities. In the implementation, part of the data is split for modelling, testing and training and the experimentation involves three different cases for each of the individual university data collection. For every university, 30% of the data for training and 70% for validation, similarly 50% for training with 50% for validation and 70% for training with 30% for validation.

**Caltech**

Train-Validation split: 70-30

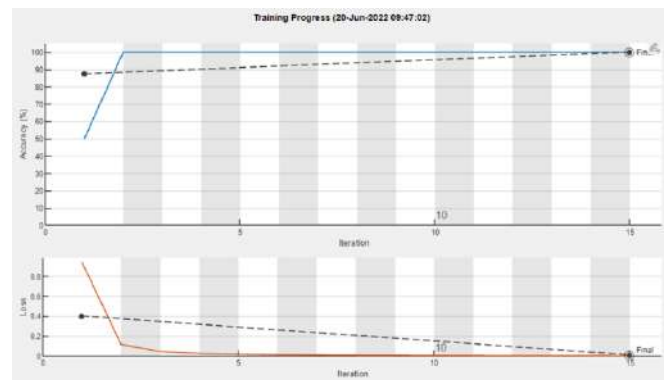


Fig. 12. CNN results for Caltech 70-30

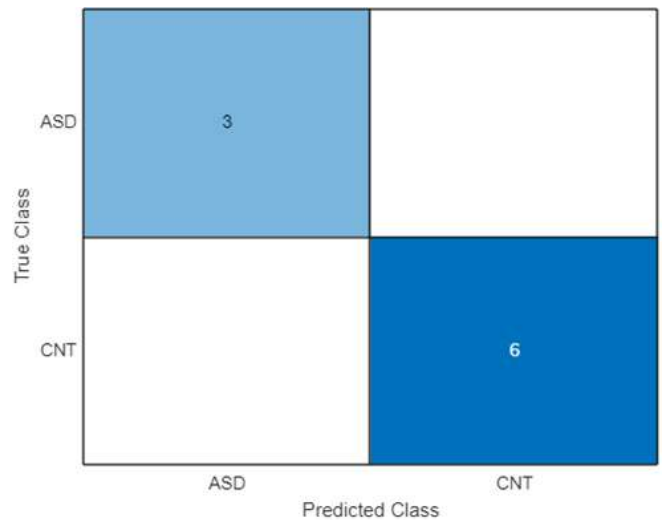


Fig. 13. CNN confusion matrix for Caltech 70-30

Results	
Validation accuracy:	100.00%
Training finished:	Max epochs completed
Training Time	
Start time:	20-Jun-2022 09:47:02
Elapsed time:	28 sec
Training Cycle	
Epoch:	15 of 15
Iteration:	15 of 15
Iterations per epoch:	1
Maximum iterations:	15
Validation	
Frequency:	50 iterations
Other Information	
Hardware resource:	Single CPU
Learning rate schedule:	Constant
Learning rate:	0.001

Fig. 14. CNN validation results for Caltech 70-30

For data collection retrieved from Caltech University, the data is split into 70% for training and 30% for validation and the training progress and validation results are displayed in Figure 11 and Figure 13 in which we can observe that accuracy is increasing after each epoch(iteration). Figure ## shows confusion chart where parameter representing patients suffering from Autism is ASD and CNT represents control that is neurotypical individuals. The confusion matrix displays the total number of observations in each cell. The rows of the confusion matrix correspond to the true class, and the columns correspond to the predicted class. Diagonal and off-diagonal cells correspond to correctly and incorrectly classified observations, respectively. The accuracy obtained using our proposed 1D CNN is 100% for this case.

Comparatively, we have fed the Caltech data to the network with 30 -70 and 50 - 50 training and validation split leading to 95.45% and 100% accuracy. Similarly, for data retrieved from patients across universities like Yale, UCLA and CMU, the training and validation split levels are experimented and the resulting training - validation progress, confusion charts, and the accuracies are recorded.

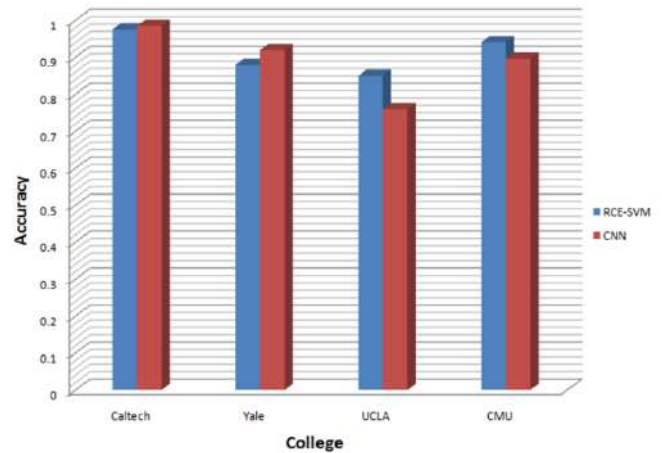


Fig. 15. Comparison of Accuracy for CNN vs RCE-SVM

COLLEGE	ACCURACY
Caltech	0.975
Yale	0.8793
UCLA	0.8498
CMU	0.9407

Fig. 16. Consolidated results for RCE-SVM

COLLEGE	TRAIN	VALIDATION	ACCURACY
Caltech	0.3	0.7	0.9545
	0.5	0.5	1.00
	0.7	0.3	1.00
Yale	0.3	0.7	0.8996
	0.5	0.5	0.8571
	0.7	0.3	1.00
UCLA	0.3	0.7	0.6667
	0.5	0.5	0.7143
	0.7	0.3	0.8966
CMU	0.3	0.7	0.8889
	0.5	0.5	0.9231
	0.7	0.3	0.875

Fig. 17. Consolidated results for CNN

## VIII. REFERENCES

Figure 15 and Figure 16 specify the obtained accuracies for the universities Caltech, Yale, UCLA and CMU patients data for experimentation done using RCE-SVM and CNN. We compared classification performances of both RCE-SVM and CNN for simulated data of every college and the accuracies are graphically represented in the below figure, having blue bar and red bar representing machine learning model, RCE-SVM and proposed deep learning model, CNN respectively.

## VI. CONCLUSION

As seen from the results, the outputs from the deep learning model (CNN) are slightly better than the results obtained from the machine learning model (RCE-SVM). This can be attributed to the fact that deep learning model out performs other techniques when the data size i.e., the number of features, is large. The number of features for each college is 2000+. Thus, deep learning gives a slightly better output. In the paper we have considered 4 colleges separately. There is a lack of understanding of how the functional connectivity data relates to ASD. In such situations, deep learning techniques outshine others as they will draw conclusions when the relationship between the label and features isn't apparent.

## VII. FUTURE ENHANCEMENTS

As a future enhancement, we can perform effective connectivity on the time-series data instead of functional connectivity and compare the two methods of feature selection. Apart from this, the scope of this paper extends only to 4 colleges, but in the future a combined dataset can be fed to the deep learning and machine learning models and observed.

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# Active Filter and Reactive Compensation Using Dstatcom

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## ABSTRACT

The purpose of this study is to exploit the DSTATCOM demo model and the block Using MATLAB Simulation, the controller's parameters are tweaked. The primary goal of the study is to demonstrate how distribution statcom (DSTATCOM) may be used to lessen voltage variations such as sag and swell situations in distribution systems. Different DSTATCOM (distribution static compensator) topologies are examined in this paper. The distribution static compensator (DSTATCOM) is a shunt-connected device that may correct load current power quality issues. The installation of a shunt active filter on a power distribution system is the intended use. By regulating reactive power, the active filter also has the capacity to control the voltage on the distribution line. The dynamic performance of coupled harmonic damping and spectral analysis is investigated theoretically. As a result, harmonic damping makes it feasible to increase both the stability of the combined harmonic damping and the control loop for voltage regulation. In Matlab/Simulink, the system with the control strategy is implemented. Figures display the simulation findings. The primary goal of the study is to demonstrate how DSTATCOM may be used to lessen voltage swings in distribution systems, such as sag and swell circumstances.

**Keywords :** PWM, DSTATCOM, DVR, Artificial Immune System, Direct Current Control, Voltage Source Converter, Power Quality

## I. INTRODUCTION

Reregulating the industries and allowing for private competition would help the electrical power utilities operate the power system networks more efficiently. For overload relief, effective operation, and dependability, new techniques to power system operation and control must be developed. In order to support dynamic disturbances including switching of transmission lines, loss of generation, short circuits, and load rejection, active control must be quick enough to maintain the appropriate voltage levels and

system stability [1]. Beyond the fundamental idea of independent control of active and reactive power flows, Flexible AC Transmission Systems (FACTS) are a successful approach to the issue of reactive power control and voltage in transmission and distribution systems, providing a desirable alternative for achieving such goals. Initially, thyristor-based devices such as TCR (Thyristor Controlled Reactor), TSC (Thyristor Switched Capacitor), and SVC (Static Var Compensator) were used to solve these issues, but nowadays, controlled switch-based devices like GTO, IGBT, and IGCT are widely used. The dynamic voltage

control is the main purpose of the Static Synchronous Compensator (StatCom) and Static VAR Compensator (SVC), two different types of shunt controllers for the injection of reactive current. In relation to the SVC, the square of the line voltage is a function of the current's reactive power, which is a function of the line voltage. Thus, the injected reactive power is lowered to 64% while the dynamic voltage, let's say, is at 80%, precisely when more is required. StatCom size would be far less for comparable performance, and should be the more cost effective of both. One of the most popular FACTS devices [2] for numerous applications is the StatCom. The StatCom varies from the SVC in that it may create reactive power from tiny values of storage elements and behaves similarly to the SVC while working in the linear area. The SVC, on the other hand, is seen as a variable admittance by the system, while it is a source of synchronous voltage [3][4]. The StatCom has operating characteristics from the perspective of reactive power that are comparable to those of a rotating synchronous compensator without the mechanical inertia, and it offers quick controllability over the three-phase voltages in both magnitude and phase angle. Due to the wide range of construction and operating options, it has drawn a lot of attention. The improvements and benefits that can be gained when using a StatCom include the following:

- Rapid response to system disturbances.
- Provides smooth voltage control over a wide range of operating conditions.
- Dynamic voltage control in transmission and distribution systems;
- power oscillation damping in power transmission systems;
- transient stability improvement; • ability to control not only reactive power but, if needed, also active power (with a DC energy source available)
- a small footprint, due to the replacing of passive banks by compact electronic converters;

- modular, factory-built equipment, reducing site works and commissioning time;
- use of encapsulated electronic converters, which minimizes environmental impact on the equipment.

## II. LITERATURE REVIEW

Mrs. M. Sindhubala and Ms. Allan Mary George (2013) provided the precept of this paper is to realize the consequences of harmonics in a strength system and to limit the consequences of the energy machine harmonics. This distortion will bring about low strength nice and stepped forward disturbances in strength system. So this harmonic technique is used to improve the electricity excellent. The increase in power high-quality the use of a technique is explained in element right here.

Geena Sharma and Kanchan Jaswal (2016) proposed lively energy filters are the emerging gadgets, which can decrease harmonic pollutants successfully. Normally, the shunt APF is managed such that it eliminates the load modern harmonics and supplies load reactive electricity to acquire harmonic unfastened supply currents at unity strength component. However, those manipulate objectives can not be performed simultaneously when the deliver voltages are distorted and unbalanced (non- ideal).

Daniel Fallows et al. (2018) offered a comprehensive literature review of strategies for harmonic associated strength high-quality development of electrical technology systems. An increasing interest in those elements is due to the ever extra stringent energy satisfactory requirements, deriving from new grid codes and compliancy requirements, aimed toward restricting waveform harmonic distortion at all points of the distribution network.

Daniel J. Carnovale et al. (2016) offered within the near destiny, predictions regarding the “virtual economic system” imply that greater than 50% of all electricity ate up inside the North America might be thru energy digital devices including transfer-mode strength substances, variable frequency drives, and other electricity electronic gadget. Harmonics drawn by way of these masses have appreciably modified the energy system requirements to guard those loads and to protect the device from these loads. The feature of the distribution system is to supply essential modern to the terminals of the weight. Generally, essential present day is the handiest issue of current which plays beneficial paintings. In comparison, harmonic cutting-edge is in reality the “by-product” of the manner non-linear loads draw modern-day and are not essential to carry out beneficial work.

Jonathan K. Piel (2004) Power intake of harmonic drawing loads is an increasing challenge for cost conscious facility managers and engineers. The paper illustrated that up to 8% kW reduction might be realized by means of casting off harmonic present day at diverse points in a power distribution gadget, with the greatest advantages achieved with harmonic mitigation implemented at the point of use. The research and effects were reached thru mathematical modeling of gadget losses and performance. This paper presents the design and simulation hybrid lively clear out based on voltage detection together with seventh-tuned LC passive strength filter and a  $3\phi$  energetic electricity filter related in collection to mitigate the harmonic propagation under the worst-case state of affairs that is beneath no load. The filter is attached in parallel to the device. Simulation is accomplished for a 415V, 50Hz machine in MATLAB. The THD is reduced from 19% without filter out to 15% with the addition of hybrid clear out.

### III. OPERATING PRINCIPLE OF THE DSTATCOM

A controller, a series of coupling reactors, and a VSC make up the three primary components of the DSTATCOM system. The creation of a controlled ac voltage source via a voltage source inverter (VSI) linked to a dc capacitor is the fundamental working concept of a DSTATCOM deployed in a power system (energy storage device). Typically, the transformer leakage reactance is hidden by the ac voltage source. The voltage differential across this reactance is what drives the transfer of active and reactive power between the power system and the DSTATCOM. The voltage-quality issue at a PCC, where the DSTATCOM is coupled to the power networks, is a worry. The controller receives all necessary measurements of voltages and currents to compare with the directives. The power converter's primary semiconductor switches (IGBTs, which are employed at the distribution level) are driven appropriately by a series of switching signals that the controller produces after performing feedback control. Figure 1 shows the DSTATCOM's fundamental diagram.

Figure 1: Block Diagram of the voltage source converter based DSTATCOM

By controlling the firing angle, the ac voltage is controlled. The bus voltage, to which the DSTATCOM is linked, and the output voltage of the VSI should ideally be in phase. In steady state, there is no actual power exchange other than losses and the dc side capacitance is kept at a set voltage. The DSTATCOM is different from other reactive power producing devices (such as shunt Capacitors, Static VAR Compensators, etc.) in that the capacity for energy storage is only necessary for system imbalance or harmonic absorption. The DSTATCOM has two control goals in place. The power system's ac voltage control at the bus where the DSTATCOM is linked is one, and the other is dc voltage regulation the capacitor inside the DSTATCOM. Shunt reactive power injection can be used to regulate the bus voltage, as is well known. Two voltage regulators are created for these reasons in the traditional control scheme: an ac voltage regulator for bus voltage management and a dc voltage regulator for

capacitor voltage control. Both regulators are proportional integral (PI) type controllers in the most straightforward method. As a result, d-axis and q-axis components of the shunt current are separated. By using different PI regulators, respectively, dc voltage errors and ac-bus voltage errors are used to get the reference values for these currents. Another set of PI regulators, whose outputs are the d-axis and q-axis control voltages for the DSTATCOM, are then used to regulate these reference currents.

#### IV.MATHEMATICAL MODELLING & SIMULATION USING MATLAB

DSTATCOM essentially comprises of a DC capacitor attached to one end of a PWM voltage source inverter circuit. Due to their smaller size and reduced switching losses, integrated gate bipolar transistors (IGBT) are used in inverter circuits at the distribution voltage level (11kv). Additionally, specialised power devices have relatively modest power ratings. As a result, the pulse width modulation (PWM) switching mechanism may be used to adjust the output voltage. The Universal Bridge Block from Sims Power Systems' Power Electronics subset is used to create IGBT-based PWM inverters. a coupling transformer that guarantees network and PWM inverter connection at 25kV/1.25kV. an IGBT bridge and two voltage-sourced PWM inverter. Compared to a single bridge, this dual inverter system produces less harmonics, leading to smaller filters and improved dynamic response. The initial harmonics in this situation will be about 3.36 kHz since the inverter modulation frequency is  $28 \times 60 = 1.68$  kHz. At the inverter output, there are LC damped filters attached. At 60 Hz, a sequence of resistances and capacitors provide a quality factor of 40. a 10000-microfarad capacitor serving as the inverter voltage regulator's DC voltage source and managing the voltage at bus B3 a PWM pulse generator with a 1.68 kHz modulation frequency. Figure 2 depicts a 25KV Power Dstatcom pwm demo model that was utilized in this paper.

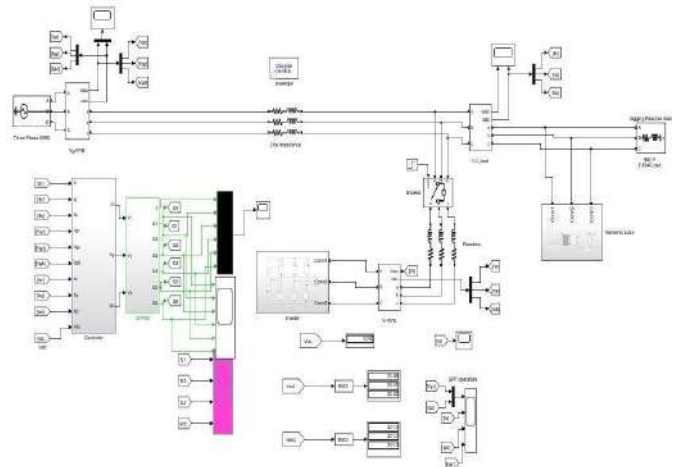


Figure 2: Simulink model

When VSI Block activated the grid current is reduced with compare with input current. The Fig 3 shows the load current graph when VSI activities.

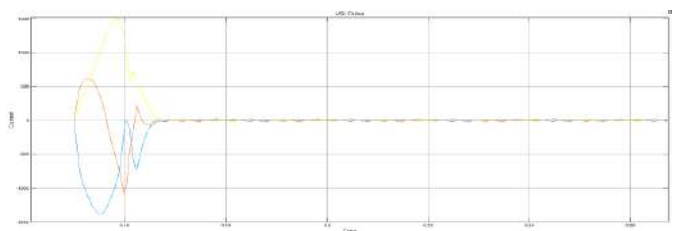


Fig3 VSI Current control

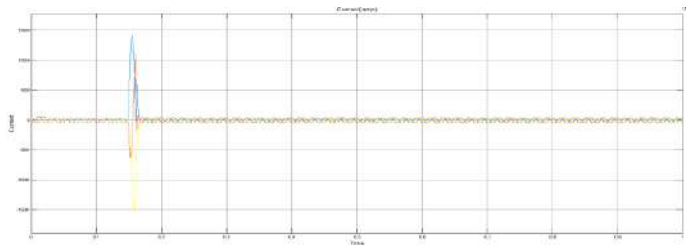


Fig 4 Current distortion Due to Harmonic

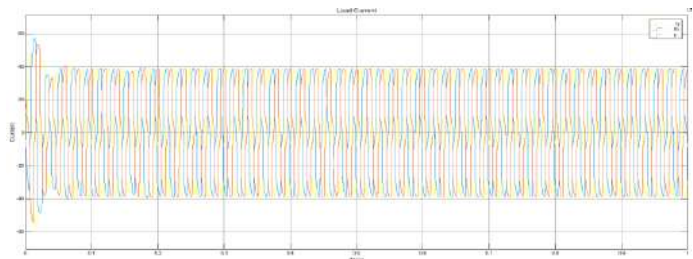


Fig 5 Load Current with reduce harmonic Using DSTATCOM



To total harmonic distortion of individual phase Current.

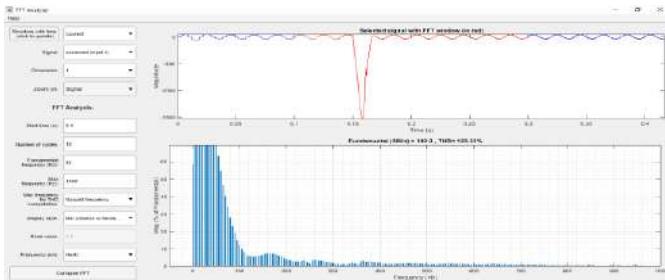


Fig 6 THD= 123.33% of Input Current of R Phase.

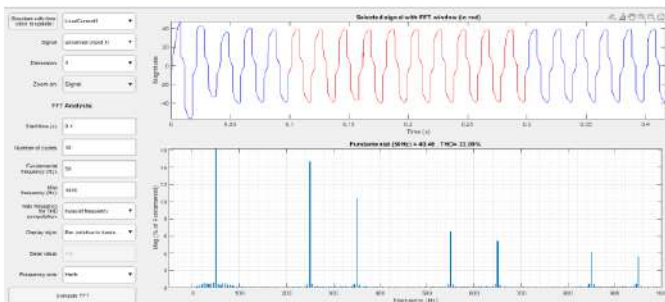


Fig 7 THD=22% of Load Current of R Phase After harmonic reduce.

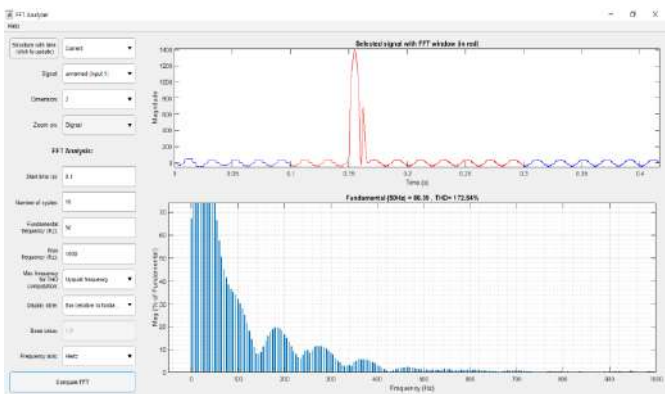


Fig 8 THD=172% of Input Current of Y Phase.

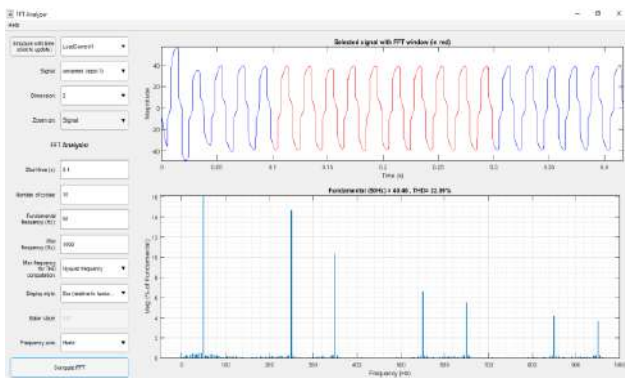


Fig 9 THD= 22% of Load Current of Y Phase After harmonic reduce.

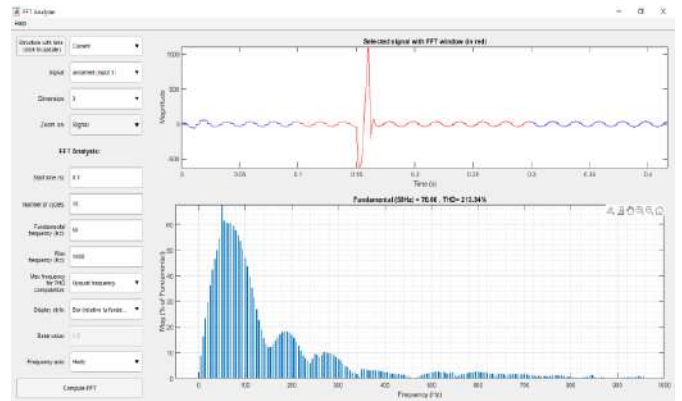


Fig 10 THD = 213% of Input Current of B Phase.

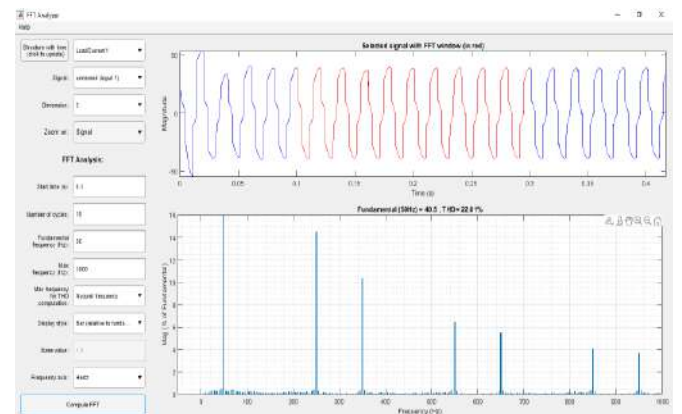


Fig 11 THD=22% of Load Current of B Phase After harmonic reduce

## V. CONCLUSION

It is possible to look at the voltage sag and swell issues in a distribution system. Positive numbers show the DSTATCOM's consumption of active or reactive power, while negative values represent its generation. As a result, the network's voltage sag and swell conditions are improved and the voltage is recovered to around 1 pu of voltage by the use of DSTATCOM. Consumers of energy at all levels of consumption place a growing amount of importance on the issue of power quality. Both the industrial and home environments frequently contain sensitive machinery and non-linear loads, which has led to a growing concern over power quality. PID controllers are the sort of controllers utilized by DSTATCOM. The modulation method is employed to trigger IGBT's is PWM. In the simulation, the DSTATCOM with capacitor bank energy source is

utilized. It is thus because the capacitor bank costs less money, needs less upkeep, and charges and discharges more quickly. The DSTATCOM is being connected to loads on the distribution network. The matlab/simulink programmed is used for simulations and results of DSTATCOM employing ultra-capacitor and electrolytic capacitor. When compared to an electrolytic capacitor, an ultra-capacitor creates less distortion. In the case of an ultra-capacitor, the modulation index is improved. When we look at the converter's voltage, the ultra-capacitor produces good voltage stability in DSTATCOM. However, ultra-capacitor provides far better harmonics as compared to an electrolytic bank when using DSTATCOM. In many circumstances, DSTATCOM offers superior performance to conventional mitigation techniques. The characteristics of the supply at the point of connection, the demands of the load, and economics, or the value supplied to the customer by the installation of a power electronics-based device, ultimately determine which option is best. The possibilities and affordability of cutting-edge technologies like DSTATCOM will further rise with the ongoing development and commercial availability of high power transistors.

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# Study of Solar energy dependent determination of wavelength using LASER source

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## ABSTRACT

The study of Sun light i. e. solar energy utilized to convert it into electrical energy by means of using solar panel at small scale. The Sun is naturally a source of heat energy by using the fission process inside it, enabling it to generate vast amounts of heat energy. We used the solar panel or photovoltaic (PV) panels on which surface the sun light falls after successfully falling on its surface the solar (Photon) energy converts into electrical energy i.e., photon conversion into electrical energy. The generated electricity can be stored in batteries or it can be utilized directly. We reported the wavelength of LASER light using solar energy conversion into electrical energy. We planned this investigation to be further designed for large scale production of solar energy by designing large sized solar panels or photovoltaic panels.

Keywords: Solar energy, LASER source, Wavelength, Photons, photovoltaic panels.

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## I. INTRODUCTION

The supply and demand of energy determine the course of global development in every sphere of human activity. Sufficient supplies of clean energy are intimately linked with global stability, economic prosperity, and quality of life.

Our primary source of clean, abundant energy is the sun. Solar energy is radiant light generated from the Sun that is harnessed utilizing a wide range of technologies including solar power to generate electricity [1], solar water heating, solar architecture [2]. The rotation of the sun is made evident by the sunspots that cross the solar disk in about two weeks, then disappear, and then reappear at the opposite limb (or curved edge) two weeks later. Observations of the

sun reveal that different parts of the Sun rotate at different speeds. For example, the equatorial rotational period is 25.38 days, but at latitude 35°, the period is 27 days. Sunspots aren't seen at higher latitudes, but use of the Doppler effect for light observed at latitude 75° reveals a longer period of 33 days [3-6]. This differential rotation reveals that the Sun is not solid, but is gaseous or liquid.

The total energy emission of the sun, or luminosity, is  $4 \times 10^{26}$  watts. This is found by measurement of the solar constant, the energy received per square meter (1,360 watts/m<sup>2</sup>) by a surface perpendicular to the direction of the Sun at a distance of 1 astronomical unit and multiplying by the surface area of a sphere of radius 1 AU. The term *solar constant* implies a belief in a constant luminosity output for the Sun, but this may

not be completely correct. The Maunder minimum, an era of very few detectable sunspots in the century after their discovery in 1610, suggests the solar sunspot cycle was not in operation at this time. Other evidence suggests the presence or lack of a solar cycle is related to changes in the solar luminosity output. Past ice ages of the Earth could be the result of a diminished solar luminosity output. Monitoring of the solar constant in the last decade from spacecraft suggests there are variations on the order of one-half percent. Thus, our Sun perhaps is not as constant a source of energy as was once believed [7].

The temperature of the solar “surface” (the photosphere) can be defined in several ways. Application of the Stefan-Boltzman Law (energy emitted per second per unit area =  $\sigma T^4$ ) yields a value of 5,800 K. Wien's law, which relates the peak intensity in the spectrum to the temperature of the emitting material yields  $T = 6,350$  K. This discrepancy between the two values results for two reasons. First, the emitted light comes from different depths in the photosphere and thus is a mixture of emission characteristics of a range of temperatures; thus, the solar spectrum is not an ideal black body spectrum. Second, absorption features significantly alter the spectrum from the shape of a black body spectrum.

The strongest absorption features were first studied by Fraunhofer (1814) and are called **Fraunhofer lines**. Absorption lines from over 60 elements have been identified in the solar spectrum. Analysis of their strengths gives temperatures at different depths in the photosphere and chemical abundance ratios [8-10].

## II. EXPERIMENTAL METHOD



Figure 1: Experimental setup Solar energy dependent determination of wavelength using LASER source with optical bench.

The optical bench is used to assemble the experimental setup solar energy dependent determination of wavelength using LASER source[11-14]

The above experiment was performed by our B.Sc. Second year Physics (optional) student in the department of physics. The solar cells (rechargeable) were fully charged by means of putting solar panel in sunlight as shown in figure 2.



Figure 2. Production of LASER beam using Solar energy or cell for determination of wavelength.

After putting the solar panel approximately two hours in the vicinity of sunlight the solar cells fully charged. We connected the solar energy assembled kit as shown in fig.2. The LASER light is illuminated as shown in fig.2.

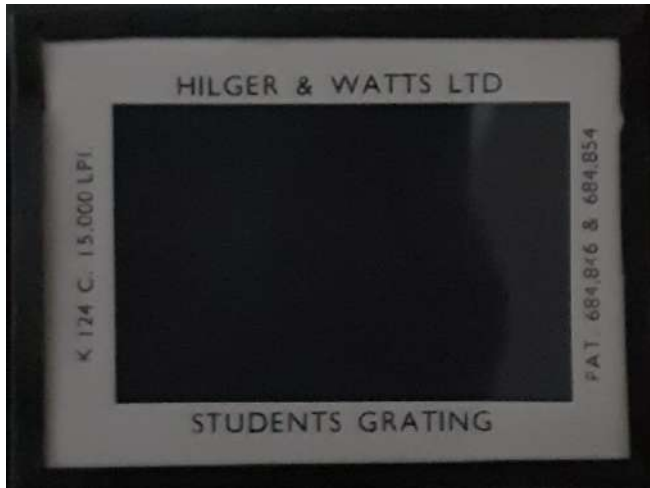


Figure 3. The grating with 15000 LPI, LASER beam fall grating to calculate its wavelength.



Figure 4. LASER beam falls on grating, it is generated from a Solar unit for determination of wavelength.

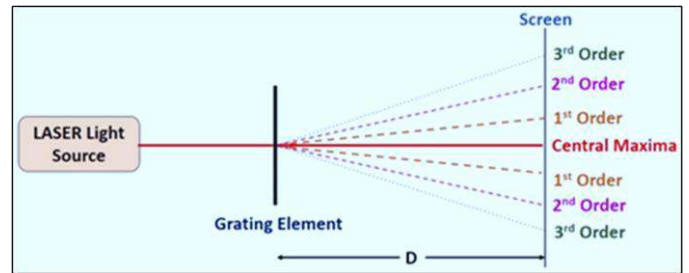


Figure 5. Schematic diagram of LASER diffraction by plane diffraction grating.

The figure 5 shows the schematic diagram of LASER diffraction by plane diffraction grating with its various components including laser source, grating screen. Apparatus used are plane diffraction grating, laser source, scale and prism table.



Figure 6. Order of LASER beam spots when diffraction taking place from plane diffraction grating.

The figure 6 indicates the spots of LASER beam obtained by plane diffraction on screen.

### III. RESULT AND DISCUSSION

#### Properties of the Sun

The energy that we receive from the Sun dictates the environment on Earth that is so important to humanity's existence. But to astronomers, the Sun is the only star that can be studied in great detail; thus, studying the sun is vital to the understanding of stars as a whole. In turn, the study of stars shows us that our Sun is merely an average star, neither exceptionally bright nor exceptionally faint. Evidence from other stars has also revealed their life histories, allowing us a

better understanding of the part and future of our particular star [15-20].

The solar diameter equals 109 Earth diameters, or 1,390,000 kilometers. What we see when we look at the sun, however, is not a solid, luminous surface, but a spherical layer, called the photosphere, from which the bulk of the solar light comes (see Figure 4). Above the photosphere the solar atmosphere is transparent, allowing light to escape. Below the photosphere, the physical conditions of the material of the solar interior prevent light from escaping. As a result, we cannot observe this interior region from the outside. The solar mass is equivalent to 330,000 earth masses, or  $2 \times 10^{30}$  kg, for a mean or average density (mass/volume) of  $1.4 \text{ g/cm}^3$  [20-26].

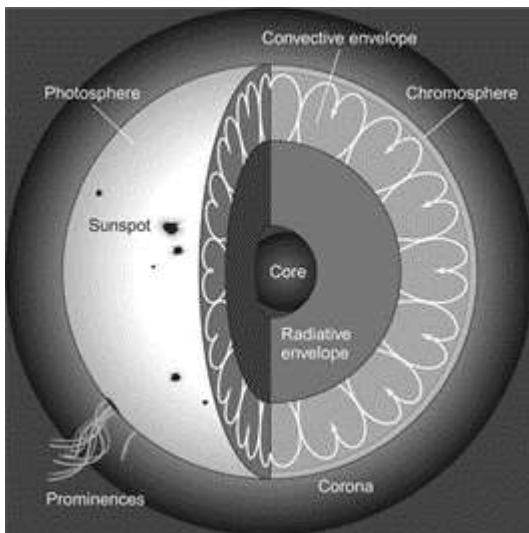


Figure 6. The cross section of the Sun.

Figure 6. shows the cross section of the sun with its internal view.

The formula used to calculate wavelength of LASER beam using diffraction grating is calculated from the Bragg’s diffraction equation

$$\lambda = \frac{2.54 \sin\theta}{n N}$$

Where  $\lambda$  =LASER wavelength

$\theta$ =Diffraction angle

$n$ =Diffraction order

$N$ =Number of parallel lines per inch in grating element =15000  $N = \frac{15000}{2.54} \text{ cm}$

$D=14$  for first and second order LASER spot observed on the screen

Table 1. Experimental data obtained from LASER source.

Diffraction order	Distance (Left) $D_1$ cm	Distance (Right) $D_2$ cm	Mean distance $D_m = \frac{D_1 + D_2}{2}$ cm	$\frac{\sin \theta}{D_m} = \frac{1}{\sqrt{(D_m^2 + D^2)}}$	$\frac{\lambda}{2.54 \sin \theta} = \frac{\lambda}{n \cdot N}$ (cm)
1	5	5	5	0.371	6208
2	12	11	11.5	0.677	5731
				Average	6009 A.U.

#### IV. CONCLUSION

We used the solar panel or photovoltaic (PV) panels on which surface the sun light falls after successfully falling on its surface the solar (Photon) energy converts into electrical energy i.e., photon conversion into electrical energy. The generated electricity can be stored in batteries or it can be utilized directly. We successfully reported the wavelength of LASER light using solar energy conversion into electrical energy. This investigation can be further designed for large scale production of solar energy by designing large sized solar panels or photovoltaic panels.

We successfully determined the wavelength of LASER light determined using plane diffraction grating by means of supplying solar energy to illuminate LASER light.

The most common theoretical value wavelength of laser pointers red is 11905 A.U.

Our reported value of laser wavelength is 6009 A.U. as shown in table 1.

## V. ACKNOWLEDGMENTS

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## Performance Analysis on 2.5 kW CI Engine Using Ethanol-Diesel Blends

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### ABSTRACT

Diesel engines are one of the major contributors of air pollution as they emit exhaust gases like particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOX); unburnt hydrocarbon (UHC) and other harmful compounds, which are very toxic for living beings as they can cause many diseases, even cancer. They are even causing damages to our environment. So it is very important for us to switch to a cleaner fuel.

Ethanol secures a special place as it has a lot of advantages over others. Most important reason for using alcohols is: it is cheap, renewable and eco-friendly. In very small blend percentage it has an ability to drive the existing CI engines without modifications. Many researchers have concluded that the brake thermal efficiency and brake power due to combustion process in diesel engines can be increased further by allowing the diesel fuel to combine with more oxygen atoms to form better combustion. As ethanol has oxygen atoms, when blended with diesel fuel it improves fuel characteristics. This whole process of addition of oxidants to the diesel fuel can reduce the smoke, carbon monoxide (CO) and unburnt hydrocarbon (UHC) emissions to a great extent.

The objective of this research work is focused mainly on performance analysis of diesel engine by using diesel- ethanol blends. The tests are conducted with a single cylinder, four-stroke, naturally aspirated, 2.5 kW air cooled diesel engine. Present research work is focused on the test conducted on a diesel engine using diesel – ethanol blends by having 5% & 10% ethanol blend with diesel. The performance tests are carried out under normal engine operating conditions and the evaluations are compared with that of diesel fuel. All experiments have been conducted at 0% to 50 % load conditions to study the performance of different proportions of ethanol on CI engine. Overall results of the methods show that with the increase in percentage of ethanol in diesel fuel, highest temperature in cycle kept on decreasing also exhaust gas temperature goes on decreasing. Power developed and torque also increases with increase in percentage blend.

Keywords: Diesel, Ethanol, Blending, Nitrogen Oxides, Particulate Emissions, Torque, Power.

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## I. INTRODUCTION

The world is facing major crises of fossil fuel depletion. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources. Due to their excessive extraction and very slow rate of replenishment, they are on verge of extinction in upcoming decade. On seeing the current scenario of fossil fuel utilization and rate of consumption, it is believed that they would be exhausted soon. In addition to that the fossil fuels are the primary source for the environmental degradation. More specifically, the continuous addition of greenhouse gases into the atmosphere by fossil fuel combustion is increases the threat of global warming.

One another issue is that the diesel engines emits higher percentages of nitrogen oxides, CO, particulate matter (PM) ,stinking odor and smoke which are hazardous to the earth's environment causing various global hazards such as acid rain, ozone layer depletion, global warming, smog and climatic changes etc. Researchers have found some alternatives to overcome these issues by employing various methods, namely - engine design modification, fuel blending and treatment of exhaust gases. So switching towards another fuel is one of the possibilities. After many researches ethanol occur as a new alternative fuel to overcome this problem.

Various tests suggested ethanol as an alternative fuel for conventional fossil fuels. Ethanol is considered widely as a replacement for diesel fuel due to its unique properties like biodegradability, non-toxic and reduced toxic emissions during combustion etc. some performance test suggested a result that power generation by ethanol blended diesel is somehow similar to conventional diesel engine. The blends of diesel with biofuels like alcohols, biodiesel can offer better solutions in reducing the fuel consumption without any modifications to the engines. Various studies concluded that by using diesel ethanol blends

there is a significant reduction in particulate matter (PM) , NO<sub>x</sub> and CO emissions.

### BENEFITS OF ETHANOL AS A FUEL

Ethanol is used as an automotive fuel nowadays by itself and can be mixed with gasoline to form "gasohol". Gasohol blend contains 15% ethanol and 85% gasoline. Over 1 billion gallons of ethanol has been used every year to produce gasohol in the United States. The greatest advantage of blending ethanol with gasoline reduces emission and gasoline usage. Since ethanol is produced from plants sources it is renewable and eco-friendly. It is used as renewable fuel because it can burn completely and cleanly when compared to gasoline and diesel fuel. According to the production process and feedstock used for manufacturing of ethanol, the Green House Gases emissions are reduced. These natural sources have less pollution to atmosphere.

Ethanol can reduce country's investment towards oil import. Also local farmers can generate some income by fulfilling demand of ethanol for fuel which will ultimately help to stabilize the price of fuel. Ethanol helps to improve quality of the environment as it reduces hazardous emissions emitted by convention fossil fuels. It also helps to generate employment in country by encouraging farmers to grow more grains to have an abundant supply for ethanol production.

### PROPERTIES OF ETHANOL

Several studies have reported that Ethanol and diesel fuel have different chemical structures and characteristics but are inherently immiscible. Thus the addition of ethanol to diesel affects various properties of the blends like viscosity, lubricity, cetane number, energy content, volatility and stability.

Properties	Diesel	Ethanol
Chemical Formula	C <sub>10</sub> H <sub>22</sub>	C <sub>2</sub> H <sub>5</sub> OH
Self Ignition Temperature °C	210	420
Octane number	30	107
Centane number	45-55	8
Gross Heating Value kJ/kg	42500	26900
Flash point	56-65	13
Latent Heat of Vaporization kJ/kg	923	923
Stoichiometric air fuel ratio	14.7	9
Boiling Point	163-399	78
Density, kg/m <sup>3</sup>	830	790
Ignition limit air-fuel ratio	1-5	3.57-17

Table 1.1: Various properties of Diesel and ethanol.

## II. LITREATURE REVIEW

Cenk Sayin et al. (2010) found that there are considerable effects on the system's performance while using methanol–diesel (M5, M10) and ethanol–diesel (E5, E10) fuel blends. The results showed that brake specific fuel consumption and emissions of nitrogen oxides increased while brake thermal efficiency, smoke opacity, emissions of carbon monoxide and total hydrocarbon decreased with methanol–diesel and ethanol–diesel fuel blends with comparison to pure diesel.

**Mukesh Kumar Saini et al. (2010)** finds that ethanol blended petrol and diesel have enormous growth potential in India for use as fuels in transport sector as it provides cleaner and greener environment and less dependency on import of crude oil. In order to implement ethanol blending program (EBP) throughout the country, all the concerned stakeholders i.e. policy makers, regulators, producers and OMCs must agree on the point that while allocating ethanol as transport fuel we should not neglect its huge demand in chemical industries and its revenue potential in potable sector. Distilleries in India are not lagging behind in technology as well as capacity to produce the required ethanol to meet its demand in India, instead they struggles between the availability of raw material i.e. molasses and assured market for its product i.e. ethanol for fuel at right price. In addition, the present purchasing mechanism of

ethanol by OMCs discourage distilleries to supply their product on lower bid price.

**Mukesh Saxena et al. (2013)** conducted the experiments for engine emission and performance with blends of ethanol of 5% & 10% with diesel termed as fuel E5 & E10. The experiment was performed for 50% load condition & studies showed that with increase in the percentage of ethanol emissions were reduced significantly.

**Yahuza et al. (2015)** concludes that the properties of ethanol-diesel blends have a significant effect on safety, engine performance and durability, and emissions. It is accepted that the addition of ethanol to diesel fuel will have a beneficial effect in reducing the PM emissions at least. The amount of improvement varies from engine to engine and also within the working range of the engine itself. While there is considerable value in being able to use the fuel directly in an unmodified engine, small adjustments to fuel injection characteristics may result in further gains in reducing emissions.

**Bhushan S Dalvi et al. (2017)** conducts test with pure Diesel, and Diesel blended with ethanol 0%, 05%,7.5%,10%,12.5% and 15% by volume without any engine modifications. The results showed that blending ethanol with Diesel increases the Indicated power, brake thermal efficiencies and fuel consumption, while it decreases the brake specific fuel consumption and volumetric efficiency.

The CO and CO<sub>2</sub> emissions concentrations in the engine exhaust do not vary substantially while NO<sub>x</sub> reduces up to 50%. The 15% ethanol in fuel blend gives the best results for all measured parameter at all engine speeds.

**P.C. Seth et al. (2017)** concludes that different type biodiesel in exhaust system directly affects the performance and the emission characteristics of the internal combustion engine. For improvement in the performance of an engine, it is necessary to control the temperature in automotive exhaust system. So it is economical and environment friendly to select biodiesel.

**Dilip Borkar et al. (2019)** concludes that Nitrogen oxide (NO<sub>x</sub>) emissions decreased by 17% by using ethanol-diesel blend as fuel compared to pure diesel. There was a reduction of 77 % of hydro carbon (HC) emissions by using ethanol-diesel blend as fuel when compared to pure diesel. The minimum carbon dioxide (CO<sub>2</sub>) emission was observed for ethanol-diesel blend with the introduction of 20 % EGR.

**Ho Young Kim et al. (2020)** states that the maximum combination pressure and maximum heat release rate of ethanol-blended fuels were higher than those of pure diesel fuel. The BSFC increased when ethanol was blended, and increased with the blend ratio; however, the BTEs of ethanol-blended fuels were lower than when pure diesel fuel was used. When ethanol was blended and the blending ratio increased, the NO<sub>x</sub> and soot opacity decreased, but CO emissions increased. The levels of HC showed a tendency to increase as the ethanol blending ratio increased, although the HC emissions of ethanol-diesel blended fuels are lower than those of pure diesel fuel. As the ethanol blending ratio increased, the mean size of the soot particles decreased, and the distribution of small particles increased.

**Ajay Sharma et al. (2021)** concludes that the emissions for carbon monoxide were recorded to be lower for all dual biodiesel samples than that of mineral diesel at maximum compression ratios. Further, the exhaust emissions of hydrocarbons were also reduced significantly for all dual biodiesel samples. The carbon dioxide gas emission was higher for all dual biodiesel samples in comparison with mineral diesel at all compression ratios.

The fuel parameters tested on the engine in terms of combustion, efficiency, and emissions reported better results for dual biodiesel samples.

## EXPERIMENTAL SETUP

This experimental work is to investigate the performance of single cylinder 4-stroke diesel engine using ethanol- diesel blends. The test bench used is a computer controlled test bench for single-cylinder

engine, power output of 2.2 kW, model no: TBMC3, designed by EDIBON. The unit has an element to exert the braking torque, an asynchronous motor fed by a variable frequency drive. The shaft of the motor is connected to the shaft of the engine by means of an elastic coupling. The unit also includes:

Instrumentation: several sensors that provide us measurements of the variables under study.

Start system: engine includes its own electric starter motor that facilitates its operation.

Fuel supply system: it carries the required fuel to the internal combustion engine.

Cooling system: The refrigeration is obtained by the passing of ambient air through the fins of the engine.

Air intake system: it allows the intake of fresh air in the engine. It contains the oxygen required to generate the combustion.

System to remove the exhaust gases: it removes from the engine the substances generated during the combustion and reduces the noise inherent to the gases flow.

## ENGINE SPECIFICATIONS

Test bench for single-cylinder combustion engines up to 2.2 kW. It has a computer controlled electric motor to generate the load having braking torque: 8 Nm & maximum speed of 3600 rpm. The motor also works as the engine starter. Transmission between the engine and the brake is through elastic couplings. Acceleration/deceleration of the combustion engine through the computer controlled fuel valve. It has a capacity of fuel tank nearly 5 Liter. Speed (rpm) of the engine varies in range: 0 – 6000 rpm. Fuel consumption ranges from : 2 – 30 ml/min. Inlet air flow as well as exhaust gases outflow both ranges from: 0 – 300 m<sup>3</sup>/h.

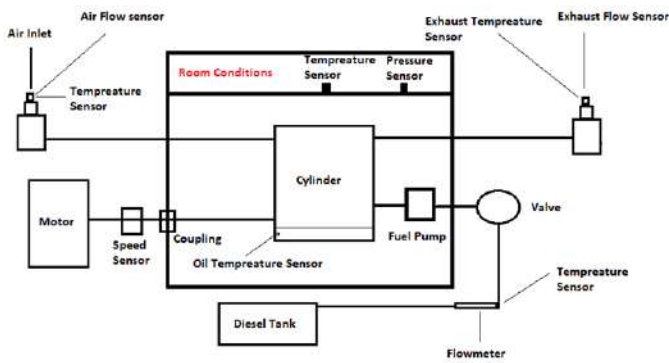


Diagram Showing various Sensors

Number of Cylinders	1
Number of Strokes	4
Type of Cooling	Air Cooled
Bore	69 mm
Stroke	60 mm
Compression Ratio	21:01
Maximum Torque	10.4 Nm/2400 rpm
Rated Output	4.2 HP

Table shows Specifications of Engine

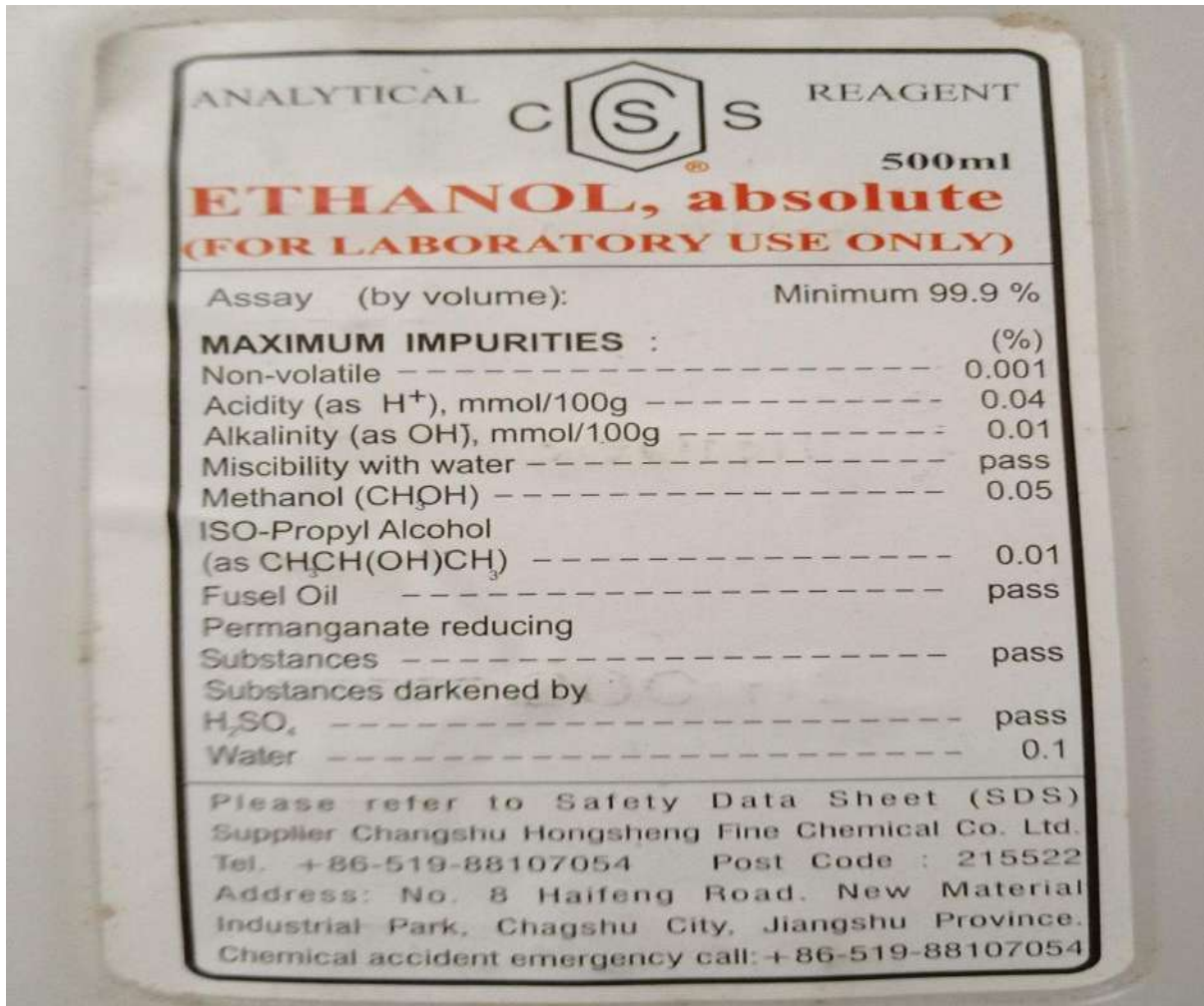
Make	Edibon
Type Of Air Intake	Naturally Aspirated

### III. EXPERIMENTAL RESULTS & DISCURSSION

Two blends were prepared with 5% & 10 % ethanol with diesel.



Figure Shows preparation of diesel-ethanol blends

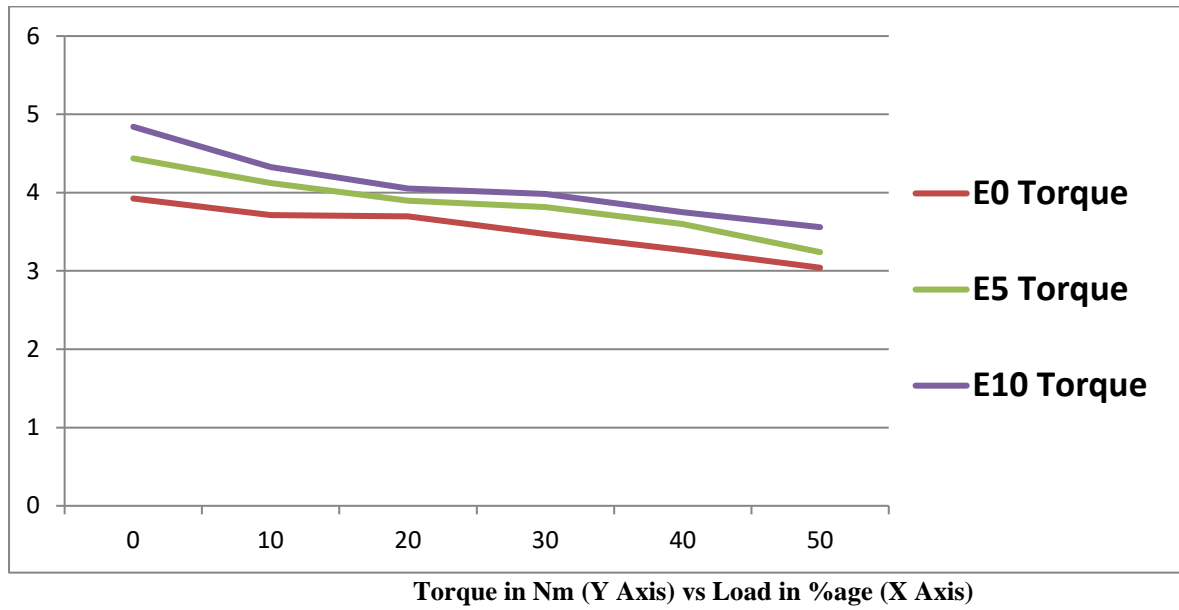


Ethanol used for experiment is 99.99 % pure. Its constituents are shown in figure.

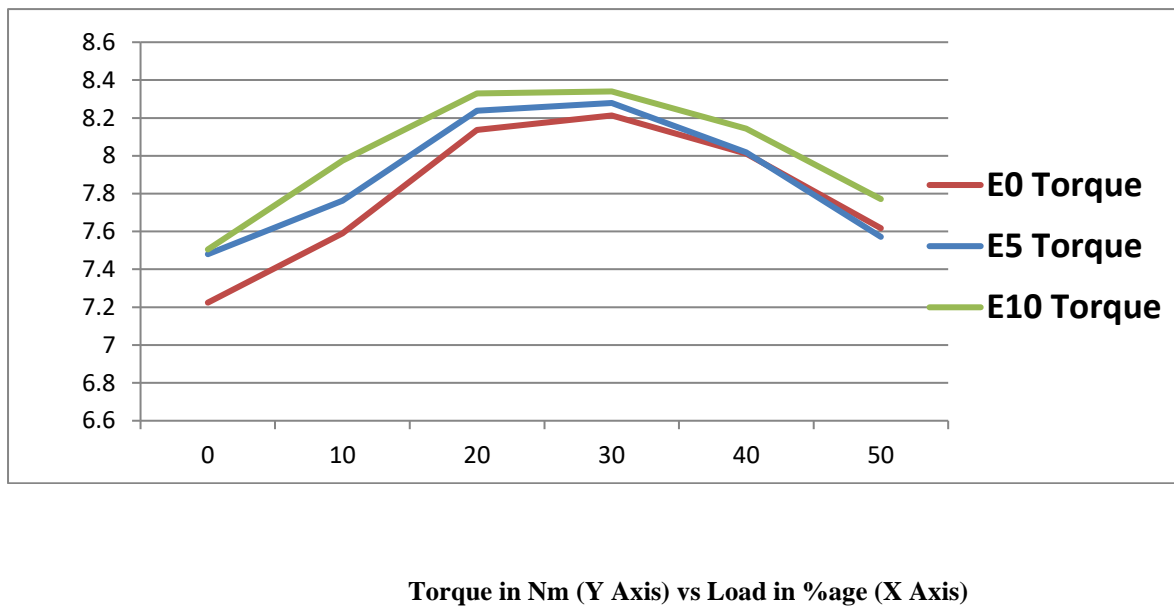
The engine was run for E0 blend, E5 blend and E10 blend and various reading were taken for exhaust gas temperature, oil temperature , fuel temperature, exhaust and air inlet flow, torque , power developed etc. by varying load from 0% to 50%.

## Torque Vs Load Curve

### A. Closed Throttle (Idle Rpm)



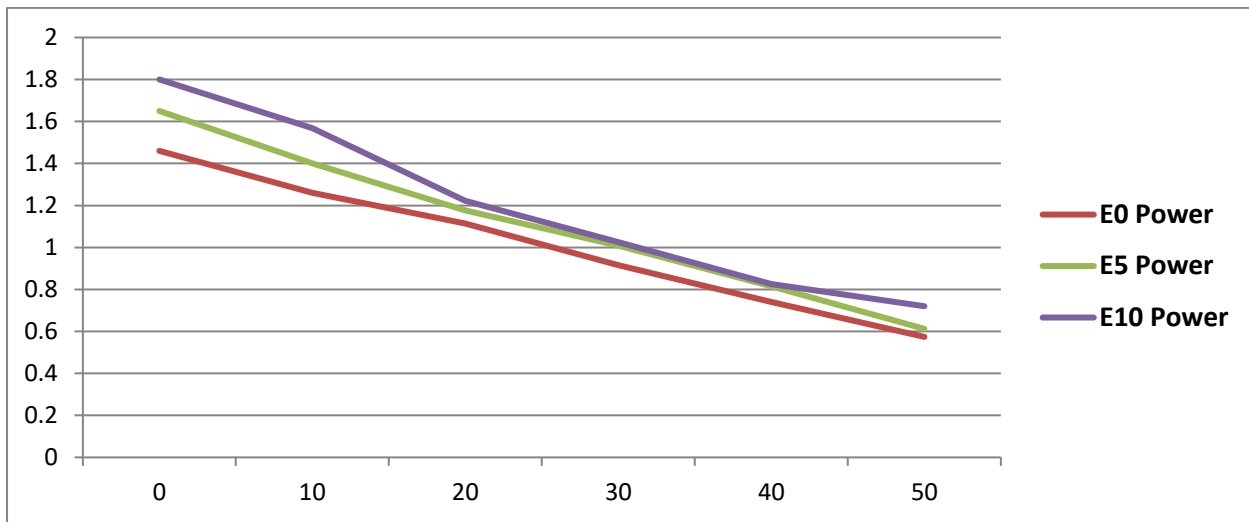
### B. Open Throttle (Full RPM)





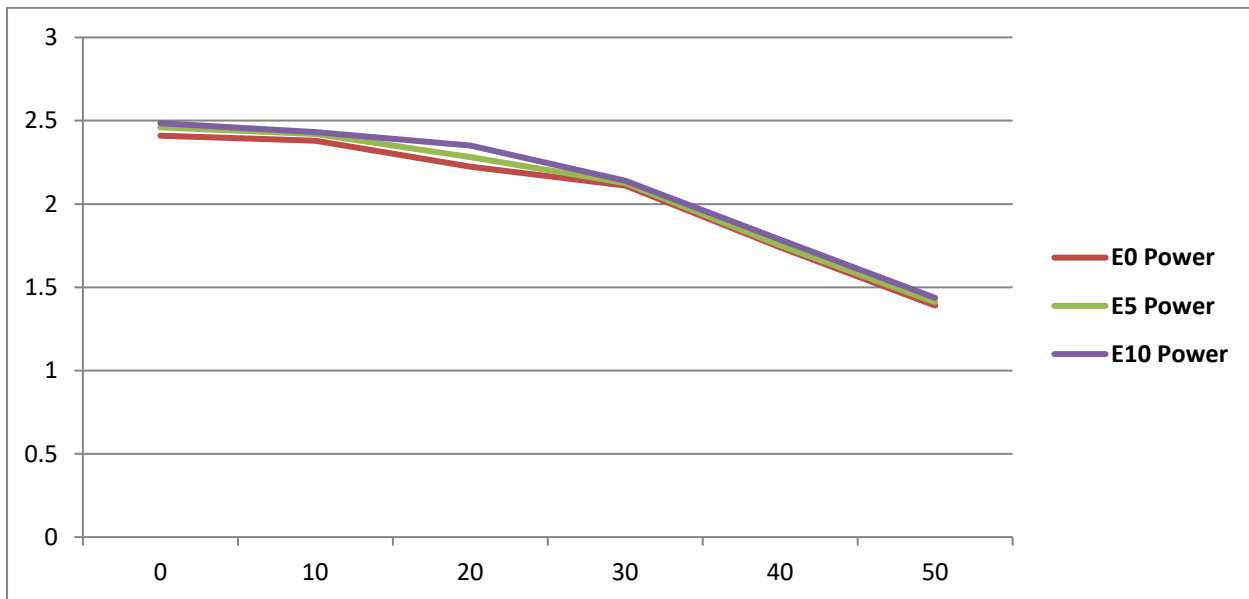
## Power Vs Load Curve

### A. Closed Throttle (Idle Rpm)



Power in kW (Y Axis) vs Load in %age (X Axis)

### B. Open Throttle (Full RPM)



Power in kW (Y Axis) vs Load in %age (X Axis)

#### IV.CONCLUSION

Highest Temperature in engine never raised beyond 1200 k therefore Exhaust Gas Recirculation system was not introduced. Maximum Value for Highest Temperature in cycle was found to be of pure Diesel fuel while it kept on decreasing with increase in percentage of blend. Exhaust gas Temperature was found to be more for pure diesel and kept on decreasing while increasing blend percentage. Power Developed goes on increasing by increasing the blend %age of ethanol in diesel. Torque Developed goes on increasing by increasing the blend %age of ethanol in diesel. The Brake Specific Fuel Consumption increases from pure diesel to increase in blending %age in diesel. This is because more fuel was consumed due to the lower calorific value of ethanol. Brake Thermal Efficiency goes on increasing from pure diesel to increase in blend %age because of high Oxygen content, combustion become more complete or more stoichiometric therefore, flame temperature and cylinder pressure rise to their higher values. Thus mean indicated work and mean indicated pressure increases because of the increases in cylinder pressure. Therefore, engine power output and thermal efficiency increases.

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## Geo-Spatial Modeling in the Assessment of Environmental Resources for Sustainable Water Resource Management in a Semi- Arid Region : A Case Study of Bhandara District, India

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### ABSTRACT

The present study is geospatial modeling in the assessment of environmental resources for sustainable water resource management in a Bhandara district, India, using by geographical information system (GIS) and remote sensing (RS) techniques. The study will be based on secondary data. Secondary data was collected during the time period between are 1971 to 2013. After data collection the data were edited and coded. Then all the collected data were scrutinized carefully and recorded in master sheets. The monsoon rains in district are concentrated in the four months from June to September and receive 90.81% rainfall, post-monsoon 1.86% pre-monsoon 4.83% and winter 2.48%. Sandy red soil has covered 31% area; median black soil has covered 47% and Lomi red soil 22% covered the area of district. There are 580 large and 13,758 small and medium sized lakes in the district. The percentage of total area under forest 12.25%, especially during 2001 to 2011 periods it was in Bhandara (12.33%), Mohadi (19.89%), Tumsar (13.27%), Lakhani (11.13%) and Lakhandur (16.24%) decreased on large scale. There is a tremendous increase in the forest area in Sakoli (9.31%). Well irrigation is very important, in 1981; the total irrigated area was 66009 hect. of these 7.67% area is under well irrigation in 2011, the total irrigated area was 128165 hect; of these, 19605 hect. (15.30%) area was under well irrigation in the district. The aim of this present study was to evaluate environmental resource units that have been delineated based on the geospatial modeling of environment parameters with appropriate weights in GIS and RS techniques. The data can be used for area management, utilized in restoration and conservation of natural resources studies in the future.

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## I. INTRODUCTION

Even though the water content of the earth is 71%, it is not drinkable. Sea water is about 96.5%. The Antarctic Glacier, which contains 61% of all freshwater on Earth, is not available for regular use. The amount of potable water on earth is only 3%. Therefore, water should be used as much as required. Water should not be wasted [1]. Water is the most important gift given by nature. So water is a natural resource. Water is extremely useful for all living things and nature. This has made it an integral part of human life [2, 3]. Water is used in a variety of ways in our daily lives. Water is used not only for drinking but also for washing clothes, washing dishes, cleaning and other activities. Similarly water is also used in industrial areas. Not only this, energy is also generated from water [4, 5, 6].

The biggest need for water seems to be for farming. Because human beings cannot grow any crop without water and if they grow crops, they cannot get food, so water has a very important place in human life. Not only has that, our nature and plants needed a lot of water [7, 8, 9, 10]. There are many factories running business around you. And with the financial help that comes from it, people are making a living. But some of these industries are in dire need of water [11, 12, 13, 14, 15]. If such industries do not have water, they may come to a standstill, so water also plays an important role in industrial causes [16, 17, 18, 19].

What exactly is groundwater management? So, use the available groundwater to meet your needs of drinking water, irrigation in such a way that it can be used for a long period of time without affecting the natural availability of groundwater. Groundwater

management requires attention to availability planning and demand control i.e. 'demand-supply chain'. 'Ensuring demands planning' is the core of groundwater management. Groundwater balance is first presented in any watershed area for groundwater management. Groundwater balance helps in measuring the availability and demand of groundwater in our catchment area [20, 21, 22, 23, 24, 25]. Water is a community asset. Given that it cannot be created artificially, it is imperative that people participate in groundwater management [26, 27].

In the study, an attempt has been made to delineate distinct physiography, soil types, geology, slope, relief, climate and rainfall, water quality analysis, demographics, water resource management, resource units, inventory of existing medium/minor/lift irrigation schemes constructed the areas through geospatial modeling for sustainable development in Bhandara District, central India.

## II. Study Area

The Bhandara district (Fig. 1) is located on 20°30' N to 21°38' N and 79°27' E to 80°07' E. Spread over an area of 4087 sq. km. covered 1.3% area of the District. It covers an area of 3,716 sq km and is bounded by Gadchiroli and Chandrapur in the south, Nagpur in the west, Balaghat in the north and Durg in the north. Bhandara, Gondia and Sakoli are the three talukas of the district. To the north is the natural boundary of the rivers Bawanthari, Wainganga and Wagh between Balaghat and Bhandara districts. The Wainganga River forms the boundary between Nagpur-Bhandara in the southwest and Chandrapur-Bhandara in the south. Bhandara district in Maharashtra falls entirely in the

Wainganga river basin. Wainganga is the main river in the district. Its flow does not dry out even in summer. The terrain of the district is generally flat. Occasionally there are loose mountain ranges. There are 7 talukas in Bhandara district, as follows. Bhandara, Sakoli, Tumsar, Pawani, Mohadi, Lakhni, Lakhandur.

### III. DATABASE & METHODOLOGY

The analysis includes relief, forest, soil, drainage, rainfall and water analysis, Collection of rainfall and long term rainfall data for the entire Wainganga basin as well as small tributaries, particularly for district area have been collected from Indian Meteorological Department (IMD). Water sample has been collected from the tehsil area and also at river Wainganga and physio-chemical water has been analyzed, Satellite data products Multispectral imageries have been acquired for time series analysis of various hydrological as well geomorphological features of in study area. The following steps have opted for the study environmental network of the tehsil was analyzed. Using SOI topographic maps and Universal Transverse Mercator (UTM) zone 44N projection was georeferenced using WGS 84 datum, in ArcGIS desktop 9.3. The study will be based on secondary data. Secondary data was collected during the time period between are 1971 to 2013. After data collection the data were edited and coded. Then all the collected data were scrutinized carefully and recorded in master sheets (28, 29). Present study deals with 20 years changes in rice production in the Bhandara district. This study contains how decrease of rice production affects rice mills. Information regarding area, production and productivity collected from different sources.

### IV. RESULT ANALYSIS

The state of Maharashtra is intertwined. There are a total of 36 districts in Maharashtra. Each district in Maharashtra has a different identity. Each district has

some history, some tourist destinations and some differences. One of them is the district with the highest number of lakes. The district is known as the district of lakes. There are about three thousand 648 small lakes in this city. There are no such lakes in any city in Maharashtra. The district is a major producer of rice. The district is known for the production of fragrant rice and copper. Bhandara is a district known as the "Rice Warehouse" of Maharashtra. Bhandara is known as the largest rice growing district in Maharashtra. Agriculture is the main occupation of the people of the district. The economy of the district depends on this income. The population of the district is 11 lakh 35 thousand 835. Due to the unfavorable climate of the district, it receives relatively good rainfall.

#### 4.1 Climate of the district

The weather in Bhandara district is warm and dry in summer, cold and dry in winter and humid in the rainy season. The average maximum temperature in month of May is 47.5°C. The average daily temperature is 25.9°C. Running into months of November to February the average maximum temperature is 31.8°C and minimum temperature is 9.7°C. Bhandara, Pawani and Sakoli are the places cleared from the 35 years rainfall data from 1987 to 2001 that more than 90% of annual rainfall falls during monsoon period. In monsoon period 100% of the total rainfall in some years has been recorded and 7% to 75% of the total rainfall in some years has been also recorded. During the monsoon period, the uncertainty of rainfall is evident (Kudnar et al, 2022). The annual rainfall of Bhandara place is 1246 mm. The median value is 1250 mm. That's it, from this it is clear that they are not very different from the average, the same view seems to apply in the place of Pawani & Sakoli, with a slight curvature. The standard deviation of annual average rainfall is 296.63 in Bhandara district. The 'V' value of this place's rainfall is 23.80 and quartile deviation is 198.90. It looks like the rainfall is very reliable compared to the annual average of the monsoon rainfall. In comparison, standard deviation of rainfall of monsoon period is more than annual average rainfall. With this 'V' value

also more, so it is evident that the rainfall in the monsoon is more reliable than annual average rainfall. It is clear that annual rainfall is low than median value in the dispersion of rainfall. This situation is generally found in Sakoli and Pawani and this is a main cause of agricultural hazard. As Bhandara district is far from the coast, the climate here is uneven. Generally January is the coldest month and May is the hottest month. The climate of Bhandara district is temperate and will be as severe as summer and winter. Mostly rainy. The actual amount is between July and August. It started raining from the second week of June and ended in October. It rains for weeks. About 90% of the annual rainfall falls during this period. By the end of 2020 in Bhandara district 1394.3 mm (**Figure 2**) It is raining (Pithnya). This is 11.5% more than the average Pithna. The year 2013 as well Compared to the average Pithna, Pithna has been declining significantly since 2014. 2020 compared to 2019. The average rainfall in India fell by 3 per cent and today the average Pithnya days have increased by 7 days. The temperature changes according to the season. The maximum temperature of the year is 45°C. This summer, the minimum temperature is 8°C To It lives in Jahwala [30, 31, 32, 33].

#### 4.2 Relief Structure

Naturally, Bhandara district is considered as a part of the Wainganga basin on the plateau of the Deccan which is considered as a plain of this area is called "Plains of Wainganga". It is an average altitude of 270 meters (Figure 3) above from sea level, with Chandpur hills (465 m.), Ambagad hills (533 m.), Gaimukh hills (394 m.) on the north side of this vast plain. Gaikhuri hills (520 m.) and Koka hills (418 m) are on east side of plains and Bhimsen hills (452 m.) and Pawani hills (365 m.) are scattered in the central and southern parts of Bhandara district. In Bhandara district 84% area is plains and 16% is hilly. Bhandara district in Maharashtra falls entirely in the Wainganga river basin. Wainganga is the main river in the district. Its flow does not dry out even in summer. The terrain of the district is generally flat. Occasionally there are loose mountain ranges. The northwestern and eastern

parts of the district are hilly. Ambagad mountain range in the northwestern part of the district is an extension of Satpuda mountain range. There are Gaimukh, Ambagad and Chandpur hills and Ambagad built in 1700. The soils of Bhandara district are mainly Kalikanar, Jashar, Morand, Kharadi and Bardi. Kanhar Min is low. The truth is worth it. On the banks of the Wainganga River, there is a moraine mine of Kali Kanhar and Prem Di. She digs deep, Sand deposits in Wainganga valley Is found. It retains deep moisture and moisture and is suitable for rice cultivation. In the case of Morand type minis, especially: Sorghum, wheat and sorghum are also grown. In Kharadi and Bardi soils, light variety of paddy is cultivated. Due to the formation of many hilly areas due to Satpuda Pavatha, precious metals like Magnesium, Kainite, Jaslijamnite An underground structure with a treasure trove is found [34, 35, 36, 37]. It retains moisture and moisture and is taken twice a year. Bhandara district is known as the district of lakes. These lakes have contributed to the increase in irrigation. The area of the district has also become scenic. The rich forests of the district, abundant minerals, wealth, habitat of various ancient castes and tribes and the manufacture of metal utensils and the traditional handicrafts on them are the main features of the district.

#### 4.3 Drainage

Wainganga river is the largest and most important river in Bhandara district and it enters the north-eastern part of the district. She continued. It flows through the southern district of Chandrapur [38, 39, 40]. Tigers, Pangodi, Sur, Gadhvi, Chandan Ajan Bavanidi are tributaries of Wainganga river. The length of the river in Bhandara district is 200 km. is. The main river flowing from Bhandara district is the Wainganga river and due to the special order of flowing the tributaries such as Bawanthadi, Sur, Kanhan, Chulband and Maru etc. the tree lined river system has been created (Figure 4).

#### 4.4 Soil

Soil in Bhandara district has been created from fire and metamorphic rocks. Sandy Red soil has covered 31%

area in total geographical area of Bhandara district. Median Black soil has covered 47% and Lomi Red soil 22% covered the area of district (Figure 5).

#### 4.5 Forest

Bhandara region was known as a "Gondwan" and according to Mahanubhaw literature the term "Zadipatti" is referred to here as the terrain in ancient and medieval time, the region was rich with dense forests, but in last century, the proportion of the world here is very low. There are 20 to 30 feet high mixed plant and low-highly shrubs inhabitant here. For Example, High quality Sagwan, Bija, Halhad, Tiwas, Yen, Khair, Mohagni, Garadi, Dhawda, Tendu, Behada, Kalamb, Bambu, etc. There are 41499 hector. Area are under forest (year 2011), this is 8.96% in total geographical area of district.

#### 4.6 Projects in Bhandara district

Indirasagar Project, Karhada Lake Project, Khamb Lake Project, Chandpur Lake Project, Bahula Dam Project, Balasamudra Project, Itiyadoh Project, Bagh Shirpur Project, Bagh Pujaritola Project, Bagh Kazisarar Project, Gosiakhurd Project. The major projects are the Wagh River Project and the Etidaho Project. Wagheda Project, Sorana Lake, Bodalaksa Lake, Chandpur Lake, Chorakhmara Lake, Khairbanda Lake, Mangad Lake, Sangrampur, Chulband Lake, Belekar Bothali Lake, Kalisarar are the medium scale projects in the district. There are four major divisions of the district in terms of topography Gaimukh and Ambagad mountain ranges Gaikhuri and Pratapgad mountain range Wainganga river basin and Wagh and Pangoli river valleys.

#### 4.7 Pond

There are 580 large and 13,758 small and medium sized lakes in the district. That is why Bhandara district is known as the 'Lake District of Maharashtra'. There are two types of lakes. The first type is the crescent-shaped lakes in the hilly region, especially in the Gaikhuri, Navegaon and Palasgaon mountain ranges. Although these lakes are large in size, their expansion is irregular and the banks of these lakes are made up of dense, rugged hills that collect water on them. The lake has

been constructed by the tribals of Kohli tribe and no planned technique or engineering knowledge has been used in the construction.

#### 4.8 Land use

In 2011, "Medium land holder" (2 to 5 hect.) reached at 22.37% and "Large land holder" (5 to 10 hect.) reached at 9.25%, respectively "Very low land holder" "low land holder" and "Very large land holder" had decried on large scale, in the district. In 1981, 97% of the farmers in the district were forced to cultivate their land by self and in 2001, 99.84% land holder cultivate their agricultural land by self.

In the year 1981, 192400 hect. area was under cultivation, the ratio is 49.94% with geographical area. In 2001 it increased to 54.22 and again in 2011 it increase and reached on 55.13%. Probably the pasture is provided for grazing land for animals by the government in every village. In 1981, the district had 40700 hect. (10.56%) area was under grass. In 2011 it decreased bond come up 4.97%. The area under grazing land decreased by 5.60% from 1981 to 2011. The geographical area (without Gondia district) of Bhandara district was 38530 hect., but in the year of 2001 was 3753500 hect.. Means 7375 hect. Geographical area has become less. During the period 1981 to 2011, there was a significant decline in the forest area, as a result, the net shown area; appears to have increased during the period of last 30 years from 1981 to 2011. The percentage of total area under forest in the district has decreased by 12.25%, especially during 2001 to 2011 periods it was in Bhandara (12.33%), Mohadi (19.89%), Tumsar (13.27%), Lakhani (11.13%) and Lakhandur (16.24%) decreased on large scale. There is a tremendous increase in the forest area in Sakoli taluka (9.31%). Now the implementation of government policy is increasing the forest area. Areas not available for agriculture includes land that is not available to agriculture, there is no such land available for a agriculture such as reservoirs, roads, grasslands village area and other colonies. The area of non cultivable land increased by 2.40% during 1981 to 2011 (Figure 5). In total follow land have included

permanent and current follow land. In the year of 1981, there was 3.17% area under total follow land however; it is 3.52% in 2011 has come up. Net area under cultivation i.e. land under cultivation is meant only during the year, the part of land that was once in use is the net under the crops. Generally the agricultural land using the capacity of Bhandara district has been divided into five parts, i.e. very high (over 90), high (85 to 90), medium (80 to 85), Low (75 to 80) and very low (below 70). In “Medium agricultural land use capacity group” have included Bhandara and Lakhandur taluka in the year of 1981 and only Sakoli taluka in the year of 2011. Other area includes such as the land under various uses but that is not available for agriculture [41, 42, 43, 44]. In 1981 14500 hect. area include in this type of land. In the district during period 1981 to 2011, it increased by 11.23% (Figure 5).

Agribusiness is mainly affected by topography, river, air and weather, fertile land and water resources factor in the region. Agriculture land use is very important, however it use for various causes. In “Low agricultural land using the capacity group” has included Mohadi and Pawani in 1981 and Mohadi and Sakoli taluka in 2011. In “Very low agricultural land using the capacity group” has included Tumsar and Sakoli talukas in 1981 and there are not obtained this type of capacity in 1991, 2001 and 2011 year also. In 1981, there are 197844 total farmers in the Bhandara district, most of them are in “Very low land holder group” (Below 01 hect.) and amount of them is 90944. The maximum number of land holder is in “Small land holder group” (less than 1 hect.) that is 90944 Land holder and ratio is 1.88%.

#### 4.9 Water Resources and Water Irrigation

Show the table 1 there were 4 large & 4 medium projects of irrigation resources in the district and this irrigation capacity was respectively 33659 hect. And 13071 hect, besides this there were 32 irrigation project on state level and 220 on local level, its irrigation capacity was respectively 16245 hect. and 17835 hect. There were 19 lift irrigation projects in the district. The capacity of irrigation of this 19 project is

57962 hect. and Kolhapur type projects are 310 and its capacity is 9897 hect. Thus, including the different types of irrigation sources, there are 589 total irrigation projects in the district and 148849 hect. area is under irrigation by these different types of sources. In short, 60.30% agricultural area out of 100% is under irrigation in 2010-11 in Bhandara district. Bhandara district is known as a “District of Lakes”, but wells and tube wells also are playing important role in irrigation. In the period of 1981 to 2011, total wells reached at 19336 (97.08%) from 9999 (97.63%) total tube wells reached at 182 (0.91%) from 175 (1.71%). After independence, irrigation was given a major place to increase agricultural productivity. Large, medium and small project were started to bring maximum land under irrigation. From the year 1981 to 2011, there is a steady increase in irrigation in Bhandara district. In 1981 there was 66009 hect. area under irrigation. In next ten years, irrigated had area increase by 3829 hect. and reached at 69838 hect. In 2001, it is increased by 53861 hect. and reached at 123669 hect. But in 2011, it increased to a lesser extent by 4496 hect. and reached at 128165 hect. Water supply or irrigation facilities must be available for the growth of agricultural production. On the basis of which the modern seeds, chemical fertilizers, pesticides, etc are strictly used. In pre-planning mans pre-independence period, the large reservoir, Bodalkasa, Chorkhamara, Khairbanda were ready fore the irrigation of agriculture, also “Malgujari” tanks were there in the district, for exam. Nawegaon Bandh, Dhabepawani, Pindkepar, Ekodi, Kosamtondi, Chaprad, Morgaon, Kakodi, Ghatbori, Fulture, Kati, etc. development of wells and tube wells has not been done. Well irrigation is very important, in 1981; the total irrigated area was 66009 hect. of these 7.67% area is under well irrigation in 2011, the total irrigated area was 128165 hect; of these, 19605 hect. (15.30%) area was under well irrigation in the district. The development of tube well irrigation has not been done in the district. In 1981, there was a 6613 hect. (10.02%) area under tube well irrigation and in 2011 it was 25279 hect. (19.72%). Without the irrigation (Table 2)



one can't think the growth of agricultural production, because depending on the rainfall, farming cannot be done on a regular basis for that artificial water supply facilities must be done available. Water supply can only be harvested, if the supply is proper, which lead to crops can use the available water resources to determine the desired amount of water it takes. These water resources are mainly flowing ground water, underground water, atmospheric water and oceans and inland reservoirs are available through this medium. In flowing water through the surface includes rivers, sub-rivers, tanks, lakes, etc. All of this medium water can be supplied to the agriculture, but the proportion of it depends on economical, technical, scientific and other factors. Underground water is the amount water that is poured into the ground surface; the volume of this water depends on internal rocks formation, slope, amount of rainfall, etc. In this region, wells and tub wells have developed and benefitted to agriculture. Ocean and inland reservoirs are huge because of the many rivers that flow through them stocks & sludge come in and store. Therefore, such alkaline water cannot be used for agriculture. In the distribution of water at world level, India is in fifth rank after Brazil, Russia, China and Canada. But in water irrigated area, India is on rank in the world. "An Irrigation is the right amount of artificial water supply, at the right time, for the agricultural crops." Agriculture is such an economic activity which means that the water is the basic factor. Today, irrigation is the soul of green revolution. Generally, the irrigation requirement is uncertain rainfall, needs of different crops, intensive agriculture, increase in productivity, increase in employment, resolving natural imbalance, land for other work, commercialization of agriculture, water transport, fisheries, production of electricity, control water flood, etc. There are three types of irrigation depending on the types of water supply to agricultural farm which is very important for the is flowing irrigation. Store irrigation and lift irrigation. Ground

water irrigation is largely developed in the district. During the 1981 to 2011, in this period, there is a steady increase in ground water irrigation. In 1981, 5433 hect area was irrigated by ground water, it reached at 83279 hect. in the year of 2011. During the period of 1981 to 2011, the irrigated area started increasing. Similarly, there is a huge increase in the following area under cultivation in 1981, there was a near about less than 50% area under irrigation, after 30 years, in 2011, it increased regularly and reach at above 60% in comparison of total cropped area. In 1981, the net area shown was 192400 hect., in this comparison 66009 hect. (34.31%) area was under irrigation and in 2011, net area was increased and reached at 208368 hect., in this comparison 128165 hect. (61.51%) area is an under irrigation [45, 46].

#### 4.10 Population

Bhandara district has a population of 12,00,334 with 979 females per 1000 males. Apart from Marathi, Hindi, Gondi, Powari, Urdu, Sindhi, Gujarati, Holiya, Telugu, Kosthi, Kalari etc. Languages are spoken. The staple food of the people is rice and lime. The meal consists of bread or poli, lakholi varan and vegetables. Flaxseed oil is widely used. Horns are obtained from the lake. In Bhandara district, 771 residential colonies have been developed in total geographical area, 3779.25 sq.km. having 1200334 total population (as of 2011). The density of population is 293.70 people per sq.km. The average literacy rate is 90.74% (191532 people) including men's literacy is 94.38% (100267 people) and female's literacy is 87.06% (91265 people). The agriculture is main economic activity of peoples in Bhandara district, out of the total working population 73% population engaged in this business, 36% are agricultural labours and 37% are farmers. 72.87% people are engaged in primary economic activity in the district. The development of paved roadways have been on large scale also national highway, state highway, district main road, other road are on large scale in the district [47].

Table 1 : Salient Features of Ground Water Exploration (March 2011).

S. No.	Salient Features	Details
1	No. of exploratory wells drilled	EW-19, OW-8
2	Depth range (m.bgl)	55.15 to 222.23
3	Depth Range of zones encountered	24.40 to 154.00
4	Thickness of individual zone (m)	1 to 10
6	SWL range (m.bgl)	3.75 to 12.10
6	Yield range (lps)	2.50 to 8.98
7	No./ % of boreholes with yield more than 3 lps	4/27%
8	Formation	Weathered Granites and Gneisses
9	Transmissivity (m <sup>2</sup> /day)	10.43 to 59.54
10	Storativity	1.5 x 10 <sup>-4</sup> to 8.70 x 10 <sup>-4</sup>

Table 2 : Ground Water Resources

Tehsil	Area Type	Net annual Ground water Availability (ham/yr.)	Annual Ground water Draft (ham/yr.)			Allocation for Domestic & Industrial Requirement Supply up to next 25 years (ham/yr.)	Ground water Availability for Future Irrigation (ham/yr.)	Stage of Ground water Development (%)
			Irrigation	Domestic & Industrial uses	Total			
Bhandara	C	4317	240.00	265.00	504.90			
	NC	4788	825.00	113.10	937.83			
	<b>TOTAL</b>	<b>9105</b>	<b>1065.00</b>	<b>378.10</b>	<b>1442.73</b>	<b>749.00</b>	<b>7320.00</b>	<b>15.85</b>
Mohadi	C	3246.00	855.60	225.51	1081.10			
	NC	2351.00	734.30	124.40	858.70			
	<b>TOTAL</b>	<b>5597.00</b>	<b>1589.90</b>	<b>349.91</b>	<b>1939.80</b>	<b>661.70</b>	<b>3209.00</b>	<b>34.68</b>
Tumsar	C	4233.80	889.77	179.82	1069.50			
	NC	3718.40	1229.32	153.57	1382.80			
	<b>TOTAL</b>	<b>7952.20</b>	<b>2119.09</b>	<b>333.39</b>	<b>2452.30</b>	<b>703.00</b>	<b>5230.00</b>	<b>30.83</b>
Pauni	C	268.00	25.65	94.20	119.80			
	NC	7267.37	3535.99	190.85	3726.89			
	<b>TOTAL</b>	<b>7535.37</b>	<b>3561.64</b>	<b>285.05</b>	<b>3846.69</b>	<b>534.19</b>	<b>3430.36</b>	<b>51.00</b>
Sakoli	C	2187.00	182.23	137.95	320.17			
	NC	4650.00	781.70	98.80	880.5			
	<b>TOTAL</b>	<b>6837.00</b>	<b>964.03</b>	<b>236.75</b>	<b>1200.72</b>	<b>480.20</b>	<b>5428.99</b>	<b>17.57</b>

Lakhandur	C	4224.81	82.06	26.27	108.37			
	NC	3968.35	1781.53	181.36	1962.88			
	<b>TOTAL</b>	<b>8193.16</b>	<b>1863.59</b>	<b>207.63</b>	<b>2071.25</b>	<b>461.00</b>	<b>5889.54</b>	<b>25.27</b>
Lakhani	C	1500.46	64.34	33.22	97.50			
	NC	38889.70	922.60	143.45	1066.00			
	<b>TOTAL</b>	<b>5390.16</b>	<b>986.94</b>	<b>176.67</b>	<b>1163.50</b>	<b>347.20</b>	<b>4014.42</b>	<b>21.60</b>
District Total	C	21517.80	2339.63	961.91	3301.99			
	NC	65632.82	9810.17	1044.68	10815.00			
	<b>TOTAL</b>	<b>87150.62</b>	<b>12149.8</b>	<b>2006.59</b>	<b>14116.99</b>	<b>3936.29</b>	<b>34522.31</b>	<b>28.12</b>

Source: Central Ground Water Board, Bhandara

### Study Area

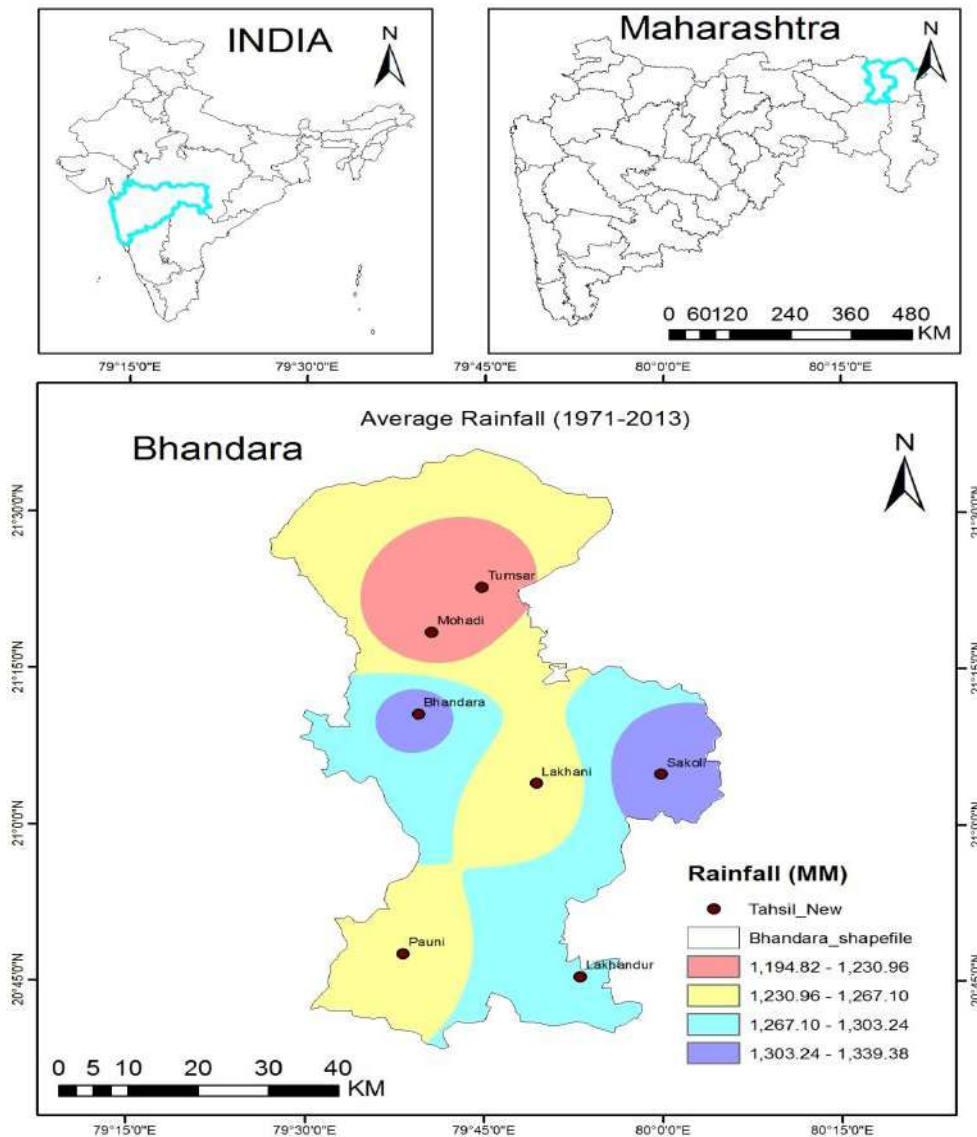


Figure 1: Study area

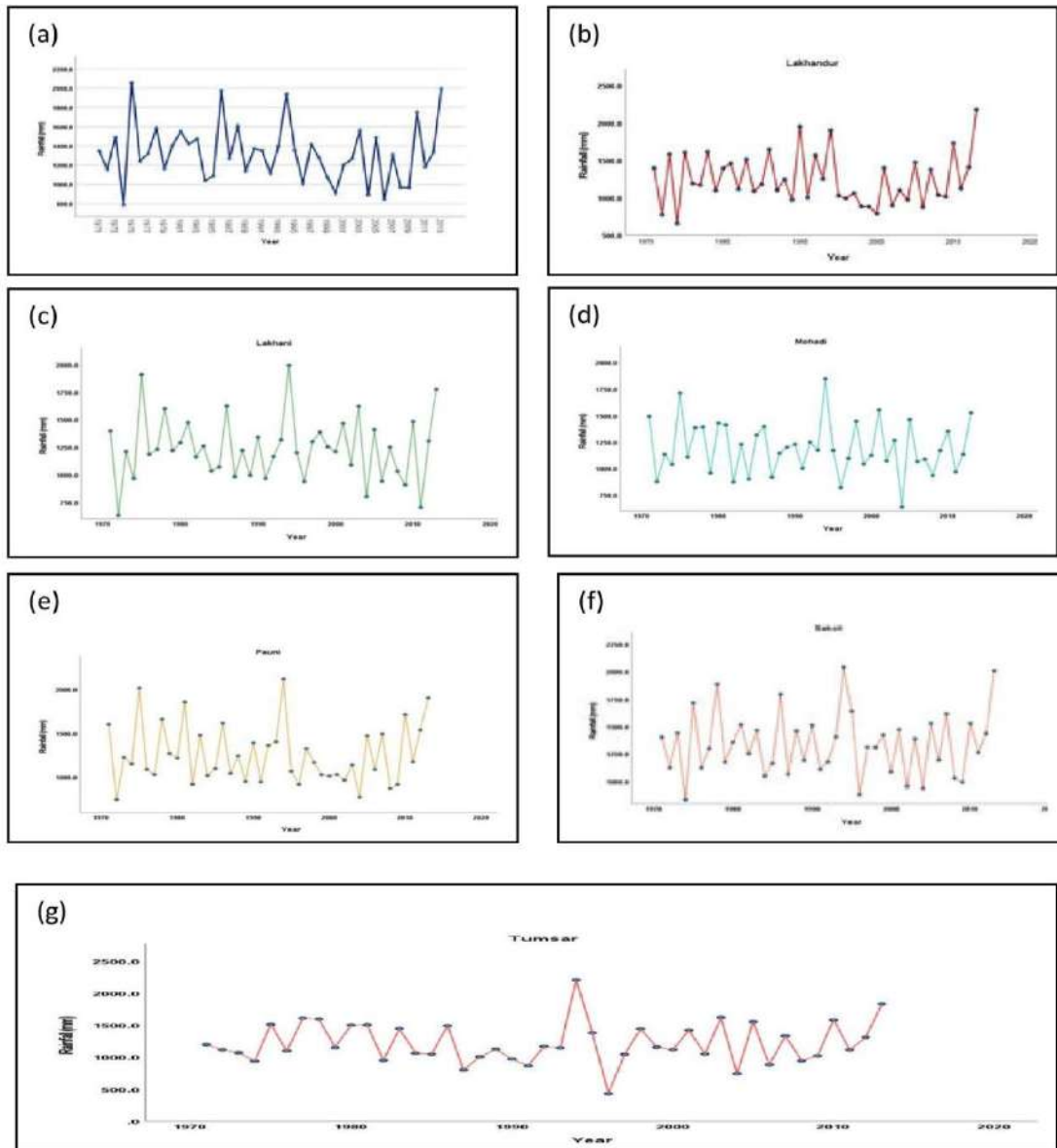


Figure 2: Annual average rainfall trend a) Bhandara, b) Lakhandur, c) Lakhani, d) Mohadi, e) Pauni, f) Sakoli and g) Tumsar stations over the period of 2071-2013.

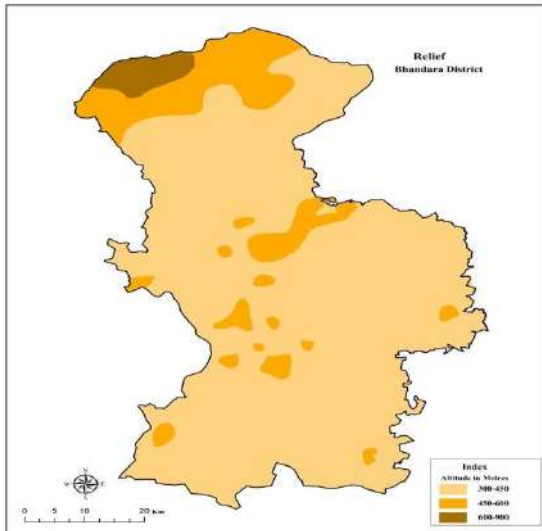


Figure 3 : Relief

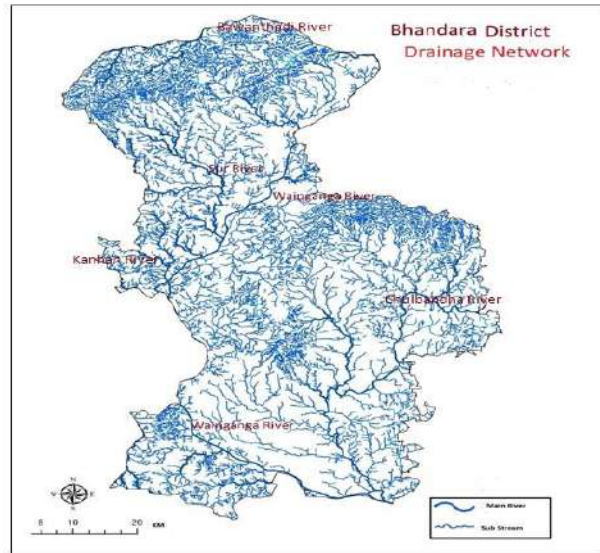


Figure 4: Drainage

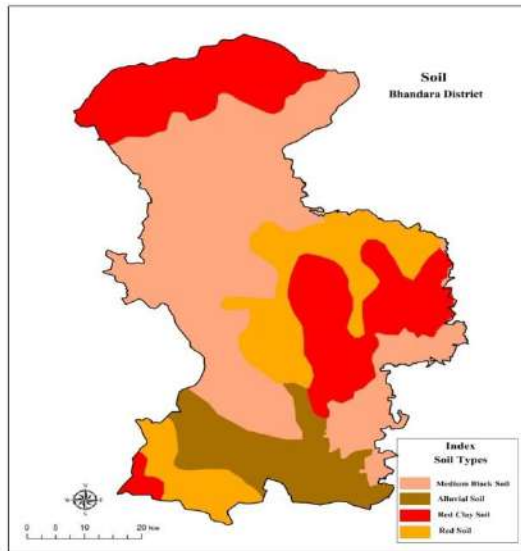


Figure 4: Soil

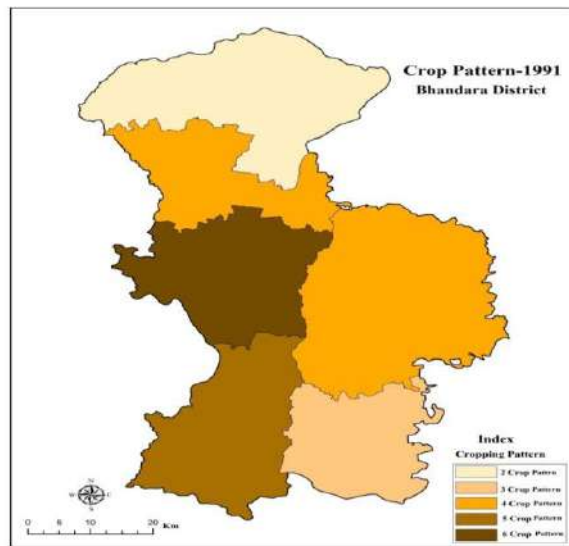


Figure 5: Crop Pattern-1991

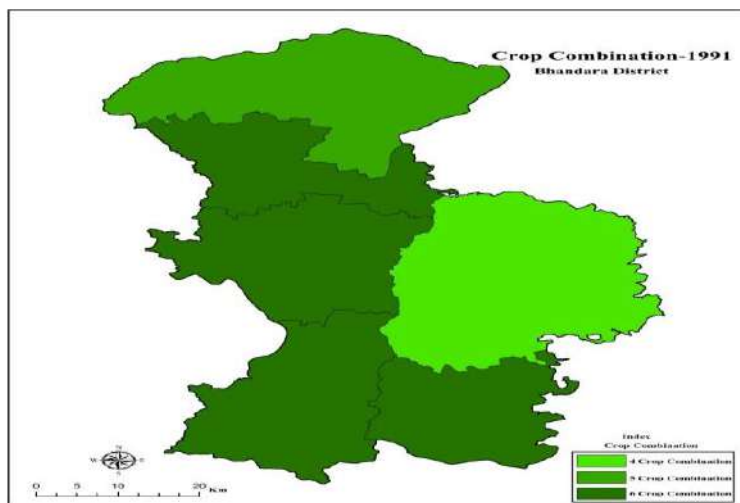


Figure 6: Crop Combination

## V. CONCLUSION

Rice production can largely be sustained in Bhandara District if land and water on which it is primarily based are not degraded. District needs to exploit the benefits of rice science more than anything else. If the successful discoveries of high breed rice can be fully exploited and integrated, District fortune may change positively. There were 19 lift irrigation projects in the district. The capacity of irrigation of this 19 project is 57962 hect. and Kolhapur type projects are 310 and its capacity is 9897 hect. Thus, including the different types of irrigation sources, there are 589 total irrigation projects in the district and 148849 hect. area is under irrigation by these different types of sources. In short, 60.30% agricultural area out of 100% is under irrigation in 2010-11 in Bhandara district. Bhandara district is known as a “District of Lakes”, but wells and tube wells also are playing important role in irrigation. In the period of 1981 to 2011, total wells reached at 19336 (97.08%) from 9999 (97.63%) total tube wells reached at 182 (0.91%) from 175 (1.71%).

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# Web Based Leaf Disease Prediction in Crops and Fertilizer Recommendation System Using Deep Learning Technique

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## ABSTRACT

Agriculture is the considered as the back bone of India. Agriculture is the most important sector in today's life. Many plants are affected by various diseases which naturally drops the yield of the crop production in turn farmers are seriously affected. A web-based tool Flask is used to create an application for routing the web pages and also the designing part involves HTML, CSS and static pages. The Data set contains images of the diseased plants of both vegetables and fruits. These images are trained and tested using Deep learning Model building and the appropriate model is created and saved. This saved model is interlinked with the web page for Prediction and recommendation system. An automated system is introduced in the form of identifying different diseases on plants by checking the symptoms shown on the leaves of the plant. Deep learning techniques are used to identify the diseases and suggest the precautions that can be taken for those diseases. To make the system user friendly a User Interface is created for easy access and usage by the farmers. This application will be very useful for farmers.

**Keywords** : Agriculture, Leaf Disease, Fertilizer Recommendation, Deep Learning, Image Processing

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## I. INTRODUCTION

Agriculture is the most important sector in today's life. The economy of our country is mainly dependent on Agriculture. In today's Agriculture, the farmers experience a major threat and that because of the crops being affected by various diseases which includes bacterial and fungal. The disease on the plant placed a major constraint on the production and a major threat to food security. Hence, early and accurate identification of plant diseases is essential to ensure

high quantity and best quality. In recent years, the number of diseases on plants and the degree of harm caused has increased due to the variation in pathogen varieties, changes in cultivation methods, and inadequate plant protection techniques. Plant pathology can and should contribute in each of these respects--by assessing the immediate and potential dangers to crops from diseases, by forecasting their incidence and severity, by deploying.

## II. LITERATURE SURVEY

The system **Error! Reference source not found.** finds the area of leaf that has been affected and also the disease that attacked the leaf. This is achieved by using Image Processing; there are systems that predict the diseases in the leaf. Our system uses K-Medoid clustering and Random Forest algorithm to produce more accuracy in the detection of disease in the leaf.

A software solution for fast, accurate and automatic detection and classification of plant diseases through Image Processing is presented in **Error! Reference source not found.**

Agriculture fills in as the spine for economy of a nation and is essential. So as to stay aware of good and malady free creation of yields various strategies are being actualized. Steps are being taken in the rustic territories to assist ranchers with best nature of bug sprays and pesticides. In a harvest, ailment generally influences on the leaves by which the yield doesn't get legitimate supplements and because of which its quality and amount additionally gets influenced. In this paper **Error! Reference source not found.**, we are utilizing programming for naturally recognizing the influenced region in a leaf and furnishing with a superior arrangement. For knowing the influenced region of a leaf we are utilizing different picture handling methods. It incorporates a few stages viz. picture procurement, picture prepreparing, division, highlights extraction

Diseases in plants cause decrease in both quality and quantity of agricultural products. The main problem of farmers is the detection of leaf diseases. The leaf disease detection has very important role nowadays. Thus, it is of abundant prominence to diagnose the plant diseases at initial stages so that suitable and timely action can be taken by the farmers to avoid further losses. Early information on crop health and disease detection can encourage the control of diseases through appropriate

administration systems. This technique will improve productivity of crops. This paper **Error! Reference source not found.** presents the technique to detect the leaf disease also compares the benefits and limitations of these potential methods

This paper **Error! Reference source not found.** introduces a compelling technique for estimation of nutrient dimension in soil and suggestion for appropriate fertilizer. The proposed methodologies comprise of four stages: soil analysis, data pre-processing, data analysis and Recommendation. The soil sample is analysed using an IOT based device. This venture is extremely valuable to farmer to pick the right fertilizer toward the start of product cycle and amplify the yield

Agriculture is the main aspect of country development. Many people lead their life from agriculture field, which gives fully related to agricultural products. Plant disease, especially on leaves, is one of the major factors of reductions in both quality and quantity of the food crops. In agricultural aspects, if the plant is affected by leaf disease then it reduces the growth of the agricultural level. Finding the leaf disease **Error! Reference source not found.** is an important role of agriculture preservation. After pre-processing using a median filter, segmentation is done by Guided Active Contour method and finally, the leaf disease is identified by using Support Vector Machine. The disease-based similarity measure is used for fertilizer recommendation.

This paper deals with **Error! Reference source not found.** Leaf disease detection requires huge amount of work, knowledge in the plant diseases, and also require the more processing time. So we can use image processing for identification of leaf disease in MATLAB. Identification of disease follows the steps like loading the image, contrast enhancement, converting RGB to HSI, extracting of features and SVM.

This paper **Error! Reference source not found.** proposes and implements a system to predict crop yield from previous data. This is achieved by applying machine learning algorithms like Support Vector Machine and Random Forest on agriculture data and recommends fertilizer suitable for every particular crop. The paper focuses on creation of a prediction model which may be used for future prediction of crop yield. It presents a brief analysis of crop yield prediction using machine learning techniques

Our proposed system was organized in such a way, to analyse the soil type, diseases in the leaves and finally to recommend the appropriate fertilizer to the farmers, that may be of great help to them. Plant disease, especially on leaves, is one of the major factors that reduce the yield in both quality and quantity of the food crops. Smart analysis and Comprehensive prediction model in agriculture helps the farmer to yield right crop at the right time. The main benefits of the proposed system are as follows: Yield right crop at the right time, Balancing the crop production, control plant disease, Economic growth, and planning to reduce the crop scarcity. Hence to Detect and recognize the plant diseases and to recommend fertilizer it is necessary to provide symptoms in identifying the disease at its earliest. Hence the authors proposed **Error! Reference source not found.** and implemented new fertilizers Recommendation System for crop disease prediction.

This paper **Error! Reference source not found.** provides survey on plant leaf disease detection using image processing techniques. Disease in crops causes significant reduction in quantity and quality of the agricultural product. Identification of symptoms of disease by naked eye is difficult for farmer. Crop protection especially in large farms is done by using computerized image processing technique that can detect diseased leaf using colour information of leaves. This paper **Error! Reference source not found.** provides survey on leaf disease detection technique by using

image processing. India is an agricultural country and most of peoples wherein about 70% depends on agricultural. So leaf disease detection is very important research topic. Number of crops caused by fungi, bacteria etc. To overcomes this by using automatic leaf detection of plant by different image processing technique.

India is a highly populated country and randomly change in the climatic conditions need to secure the world food resources. Framers face serious problems in drought conditions. Type of soil plays a major role in the crop yield. Suggesting the use of fertilizers may help the farmers to make the best decision for their cropping situation. The number of studies Information and Communication Technology (ICT) can be applied for prediction of crop yield by the use of Data Mining, we can also predict the crop yield. By fully analyse the previous data we can suggest the farmer for a better crop for the better yield. This application **Error! Reference source not found.** also provide model which predicts the type of crop disease based on textural similarity of leaves.

### III. HARDWARE / SOFTWARE DESIGNING

#### HARDWARE SPECIFICATION

**Table 3.1** Hardware Specification

Processor	Intel(R) Core(TM) i3-3227U CPU @ 1.90GHz 1.90 GHz
Ram	4 GB.
HDD	100 GB.
Monitor type	15 Inch VGA.
Keyboard	110 Keys Keyboard

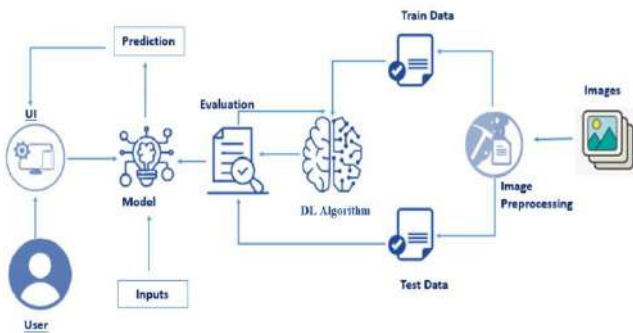
#### SOFTWARE SPECIFICATION

**Table 3.2** Software Specification

Operating system	Windows 10
------------------	------------

Web Browser	Chrome, Mozilla firefox
Open Source Distribution	Anaconda Navigator
Language	Python
Development	Google Colab Jupyter Notebook and Spyder
Packages Required	Numpy, Pandas, Tensor Flow,
JSON	VS Code
Web Application Tool	Flask
Front End Designing	HTML, Java Script and CSS

**IV. THEORETICAL ANALYSIS**



**Figure 4.1 Block Diagram**

**V. EXPERIMENTAL INVESTIGATIONS**

**5.1 DATASETS**

The dataset contains 2 divisions one for identifying the vegetables leaves and the other one for fruit leaves. In this paper with respect to fruit 6 classes are created called as 'Apple\_\_Black\_rot', 'Apple\_\_healthy', 'Corn\_(maize)\_\_Northern\_Leaf\_Blight', 'Corn\_(maize)\_\_healthy', 'Peach\_\_Bacterial\_spot', 'Peach\_\_healthy' out of which 3 divisions represents the diseased dataset and 3 represents the healthy dataset.

Dataset of Fruit is given in the Table 5. 1 with the split of test and train data count

**Table 5.1 Fruit Leaf Test and Train Image Count**

Type of Fruit Leaf	Test Image Count	Train Image count
Apple__Black_rot	181	439
Apple__healthy	445	1200
Corn_(maize)__Northern_Leaf_Blight	301	861
Corn_(maize)__healthy	217	768
Peach__Bacterial_spot	493	1804
Peach__healthy	49	311
Fruit Leaf train and test count	1686	5383
Total Fruit Leaf Count	7069	

Dataset of Vegetable is given in the Table 5.2 with the split of test and train data count.

**Table 5.2 Vegetable Leaf Test and Train Image Count**

Type of Fruit Leaf	Test Image Count	Train Image count
Pepper,_bell__Bacterial_spot	317	997
Pepper,_bell__healthy	448	1478
Potato__Early_blight	300	1000
Potato__Late_blight	52	152
Potato__healthy	290	1000
Tomato__Bacterial_spot	667	2127
Tomato__Late_blight	599	1909
Tomato__Leaf_Mold	322	952
Tomato__Septoria_leaf_spot	421	1771
Vegetable Leaf train and test count	3416	11386
Total Vegetable Leaf Count	14802	

**5.2 WEB APPLICATION FRAMEWORK**

Python uses Flask Framework in this paper which serves as a foundation for developing web applications. Web Server Gateway Interface (WSGI) has been

adopted as a standard for Python web application development. WSGI is a specification for a universal interface between the web server and the web applications.

### Werkzeug

It is a WSGI toolkit, which implements requests, response objects, and other utility functions. This enables building a web framework on top of it. The Flask framework uses Werkzeug as one of its bases.

### jinja2

jinja2 is a popular templating engine for Python. A web templating system combines a template with a certain data source to render dynamic web pages.

The flask folder contains static folder which contains necessary css, image files and javascript files. The template folder contains HTML files.

The server side scripting file app.py helps to perform request response operations and also helps in routing between web pages.

Keras is a simple and powerful Python library for deep learning. Deep learning models takes hours, days to get trained and the trained model is saved and used for prediction purpose. In the model folder two .h5 files are created one for vegetable and other fruits which is trained in the Google colab jupyter notebook and the appropriate models called as vegetable.h5 and fruits.h5 are created and saved for model building. Precautions excel files contain the precautions for all kinds of diseases

The Analysis or the investigation made while working on the solution is depicted as project structure given in the Figure 5.1

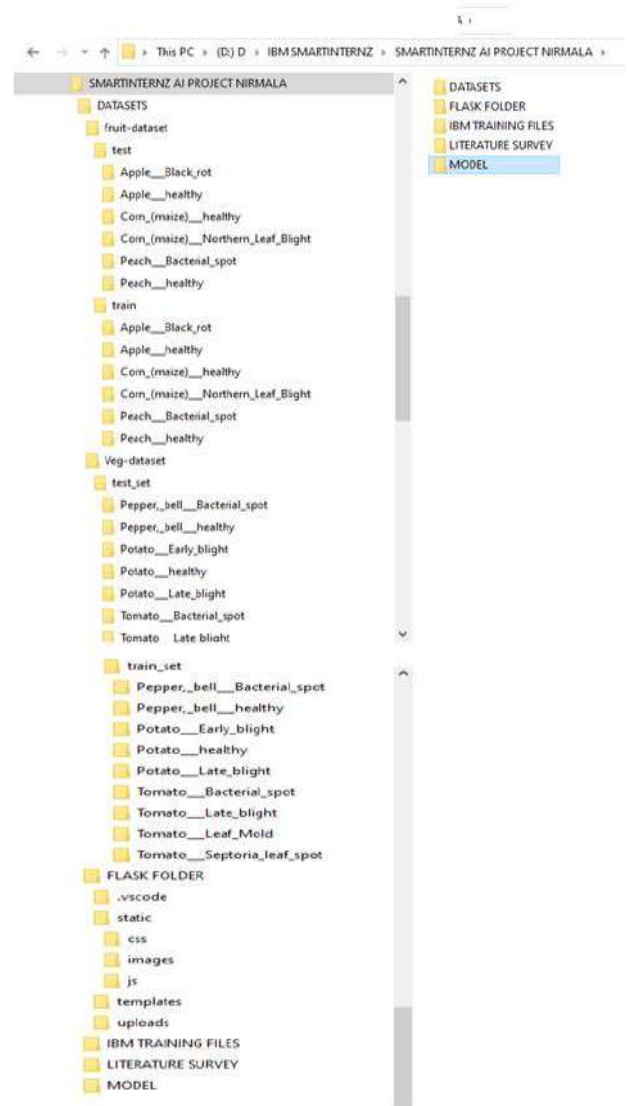


Figure 5.1 Project Structure

## 5.3 RESEARCH STEPS

### Image Preprocessing

Image preprocessing are the steps taken to format images before they are used by model training and testing. The preprocessing steps includes resizing , orienting, color corrections gray, random flips, etc. When working on deep learning network, if the number of images for training model is less then Image Augmentation technique can be applied to expand the size of the data set.

Image augmentation is a technique of applying different transformations to original images which results in multiple transformed copies of the same image. Each copy, however, is different from the other

in certain aspects depending on the augmentation techniques applied like shifting, rotating, flipping, etc. On applying small amount of variations on the original image does not change its target class but only provides a new perspective of capturing the object in real life. This helps us to expand the data set size and is quite often used for building deep learning models.

### Augmentation techniques with Keras

#### ImageDataGenerator class

##### Random Rotations

Image rotation allows the model to perform rotation of the object invariant to the orientation of the object.

##### Random Shifts

It helps to shift the pixels of the image either horizontally or vertically by adding a certain constant value to the pixels

##### Random Flips

ImageDataGenerator class has parameters horizontal\_flip and vertical\_flip for flipping along the vertical or the horizontal axis

##### Random Brightness

It randomly changes the brightness of the image. It is also a very useful augmentation technique because most of the time our object will not be under perfect lighting condition. So, it becomes imperative to train our model on images under different lighting conditions.

##### Random Zoom

The zoom augmentation either randomly zooms in on the image or zooms out of the image

#### Image Pre-processing includes the following main tasks

- Import ImageDataGenerator Library and keras into

the python script

- Configure ImageDataGenerator Class.
  - The Keras deep learning neural network library provides the capability to fit models using image data augmentation via the ImageDataGenerator class
  - ImageDataGenerator class is used to load the images with different modifications like considering the zoomed image, flipping the image and rescaling the images to range of 0 and 1.
  - The ImageDataGenerator accepts the original data, randomly transforms it, and returns only the new, transformed data.
  - `from tensorflow.keras.preprocessing.image import ImageDataGenerator`
  - `train_datagen=ImageDataGenerator(rescale=1./255, zoom_range=0.2, horizontal_flip=True, vertical_flip=False)`
  - `test_datagen=ImageDataGenerator(rescale=1./255)`
- Applying ImageDataGenerator functionality to the train set and test set.

flow from directory helps to read from the specific directory

#target size for all images have to passed as 64 height and 64 width

#The type of object is categorical

#Batch size : in every batch size how many images are passed.

```
x_train=train_datagen.flow_from_directory('/content/drive/mydrive/project/datasets/veg-dataset/train_set',target_size=(128,128),class_mode='categorical',batch_size=8)
```

**Table 5.3** Training and Test Data Details

Description	Number of images	Divided into classes
Number of images in Training set of Fruit_data	5384	6
Number of images in Test set of Fruit_data	1686	6
Number of images in Training set of Veg data	11386	9
Number of images in Test set of veg data	3616	9

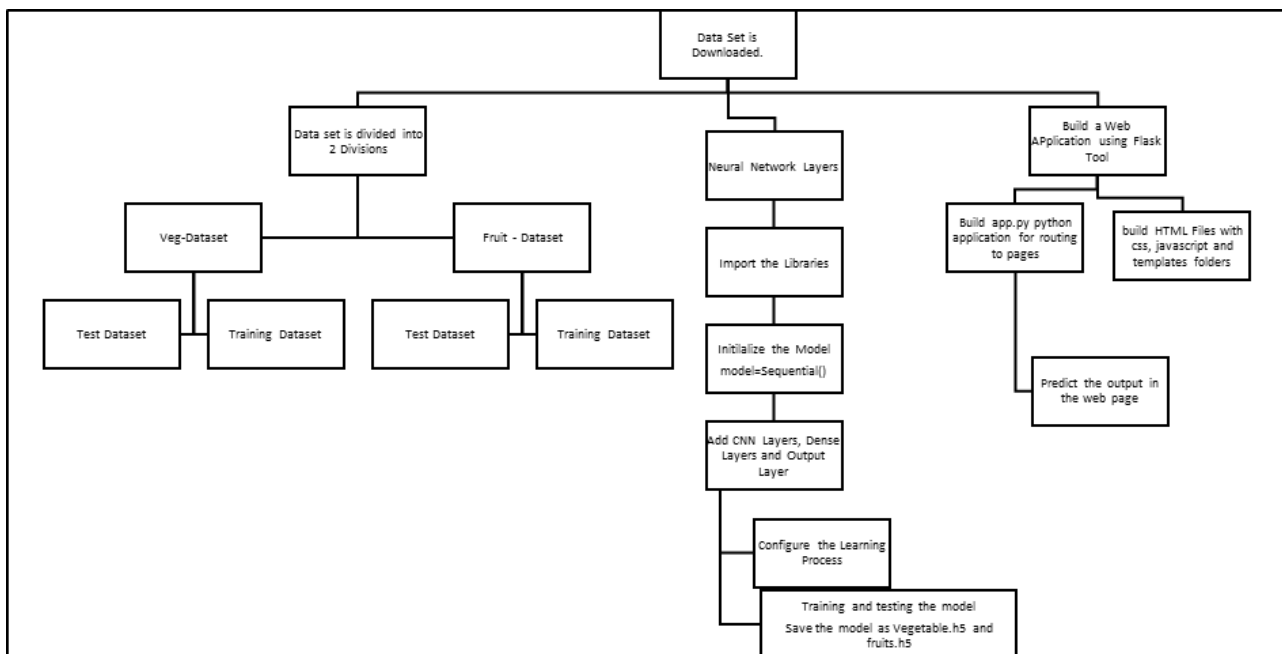
**Model building for Disease Prediction**

The model building Activity includes the following

Descriptions	Vegetable	Fruit
<b>Import the model building Libraries</b>	<pre>from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Dense,Convolution2D,MaxPool2D,Flatten</pre>	<pre>from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Dense,Convolution2D,MaxPool2D,Flatten</pre>
<b>Initializing the model</b>	<code>model=Sequential()</code>	<code>model=Sequential()</code>
<p><b>Adding CNN Layers</b> To create a convolution layer, Convolution2D class is used. It takes a number of feature detectors, feature detector size, expected input shape of the image, and activation function as arguments.</p> <p><b>Max Pooling</b> selects the maximum element from the region of the feature map covered by the filter. Thus, the output after the max-pooling layer would be a feature map containing the most prominent features of the previous feature map.</p> <p>The flatten layer is used to convert n-dimensional arrays to 1-dimensional arrays.</p>	<pre>model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu')) model.add(MaxPool2D(pool_size=(2,2))) model.add(Flatten())</pre>	<pre>model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu')) model.add(MaxPool2D(pool_size=(2,2))) model.add(Flatten())</pre>

<p><b>Adding Hidden Layer</b> This step is to add a dense layer (hidden layer). We flatten the feature map and convert it into a vector or single dimensional array in the Flatten layer.</p>	<pre>model.add(Dense(300,activation='relu')) model.add(Dense(150,activation='relu')) model.add(Dense(75,activation='relu'))</pre>	<pre>model.add(Dense(128,activation='relu')) model.add(Dense(64,activation='relu'))</pre>
<p><b>Adding Output Layer</b> This step is to add a dense layer (output layer) where you will be specifying the number of classes your dependent variable has, activation function, and weight initializer as the arguments.</p>	<pre>model.add(Dense(9,activation='softmax'))</pre>	<pre>model.add(Dense(6,activation='softmax'))</pre>
<p>Configure the Learning Process</p>	<pre>model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])</pre>	<pre>model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])</pre>
<p>Training and testing the model</p>	<pre>model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=20)</pre>	<pre>model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)</pre>
Number of Epochs	20	10
X_train	1424	673
Accuracy	90	95

**5.4 FLOW CHART**



**Figure 5.2 : Flow Chart**



## VI. EXPERIMENTED RESULTS

The Experimented Results was able to give the better prediction. The Web page output and the predicted results are given both for vegetable and fruits.

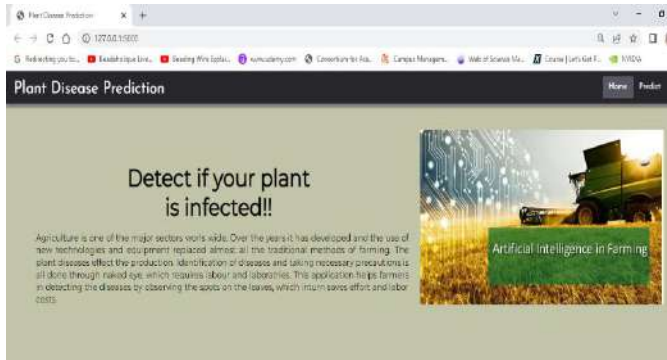


Figure 6. 1 : Home Page

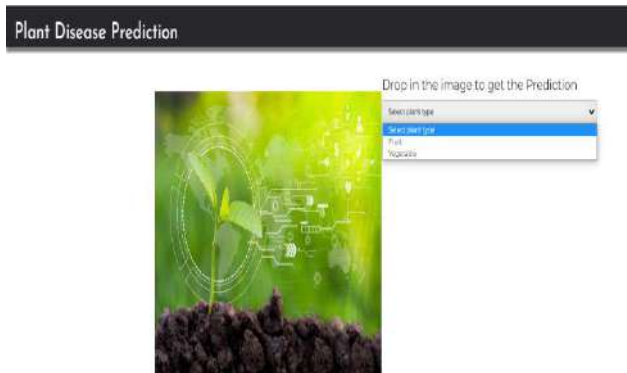


Figure 6. 2 : Choosing Plant Type



Figure 6. 3 : Apple Black\_Rot Prediction



Figure 6. 4 : Apple Healthy Plant Prediction

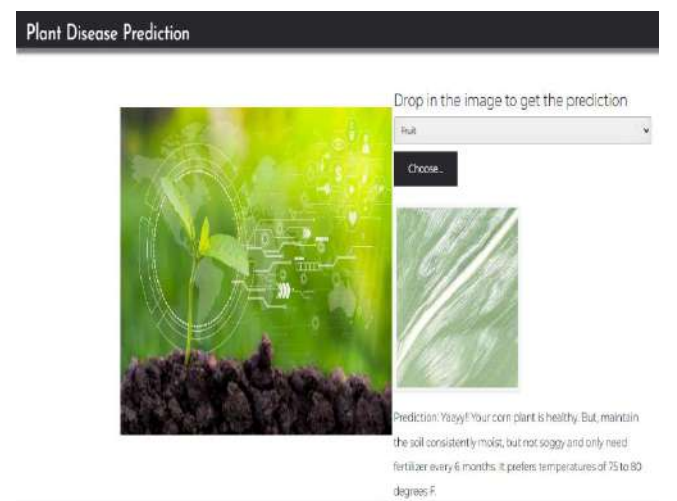


Figure 6. 5: Corn Healthy Plant Prediction

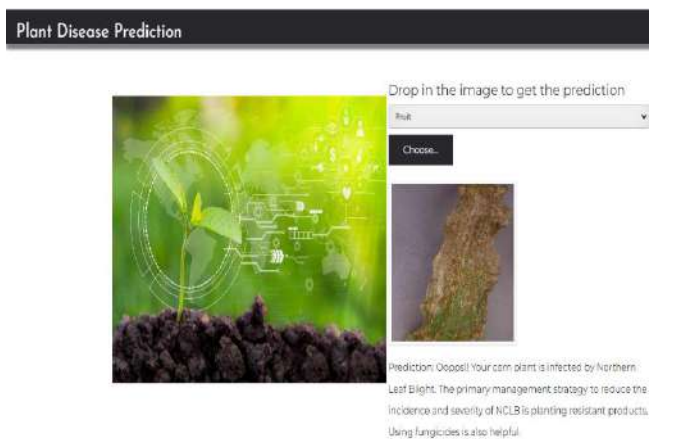


Figure 6. 6 : Corn Infected by Northern Leaf Blight Prediction



Figure 6. 7: Peach Infected by Bacterial Spots Prediction

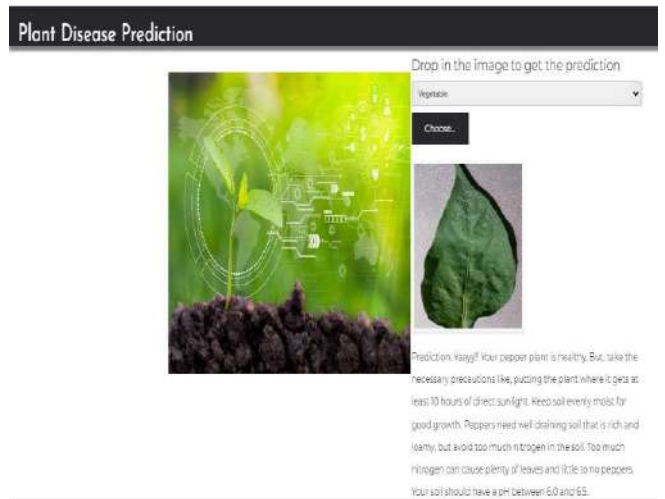


Figure 6. 10: Healthy Pepper Plant Prediction

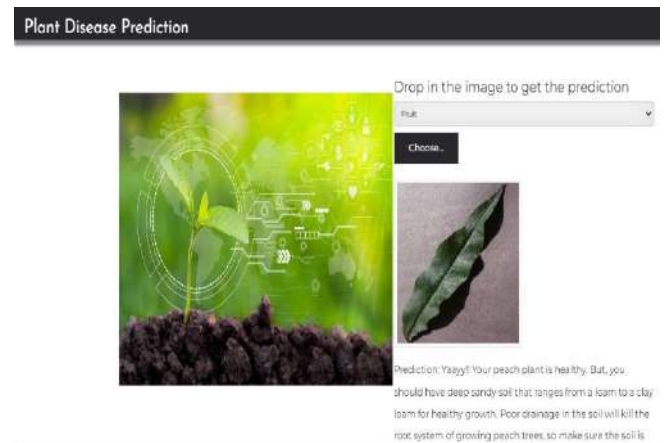


Figure 6. 8: Healthy Peach plant Prediction

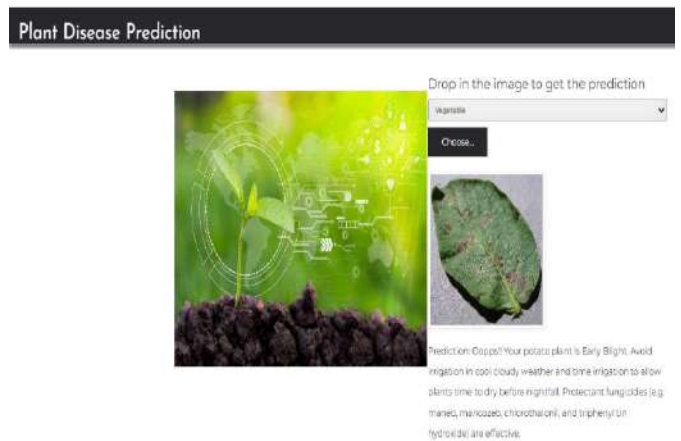


Figure 6. 11: Potato Plant Early Blight Disease Prediction

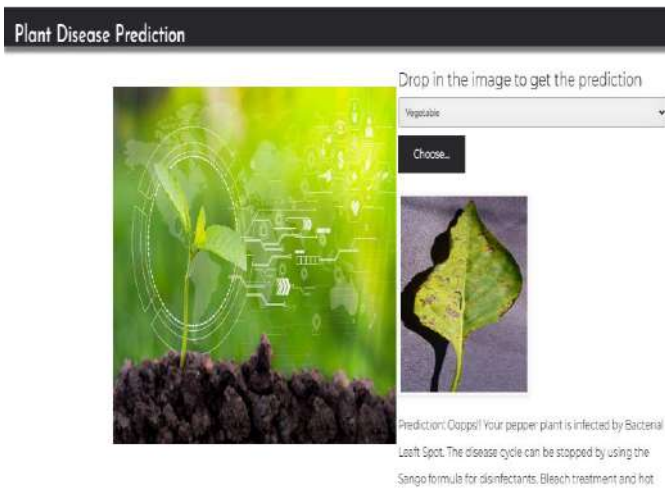


Figure 6. 9: Pepper Plant Affected by Bacterial Leaf Spot Prediction

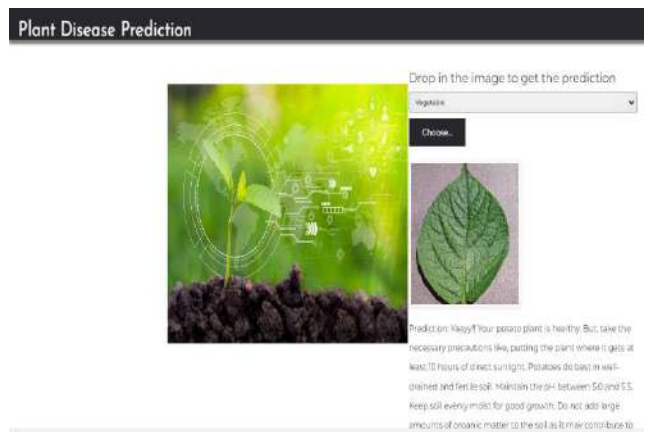


Figure 6. 12 : Potato Healthy Plant Prediction

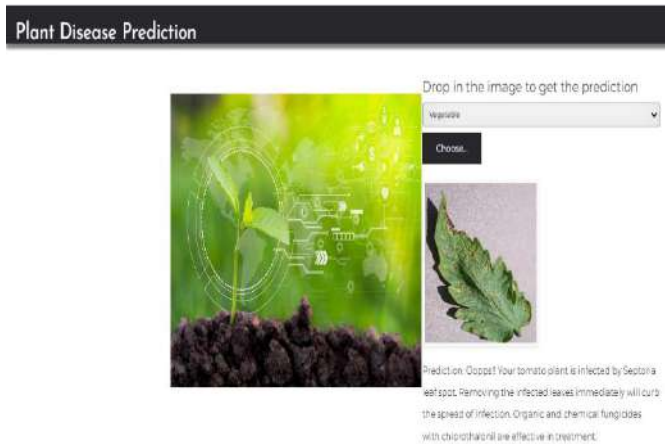


Figure 6. 13 : Tomato Plant infected by Septoria leaf Spot Prediction

## VII. CONCLUSION

The problem of identifying the disease captured through the leaves and also the measures to resolve the disease is also explained in this paper through a web application. The training and testing of varied fruits leaves images and vegetable leaves images are done using ImageObjectGenerator and the various Neural Network layers are added to train the images and also appropriately tested to get the disease predicted and the measures to be followed by the farmers is appropriately outputted in the web page. The ImageDatagenerator requires lower memory usage and saves a lot of memory. The transformed images after applying Augmentation techniques with Keras ImageDataGenerator class only returns the transformed images and does not add it to the original corpus of images. The application is user friendly to the farmers.

## VIII. FUTURE SCOPE

Further extension of this project should be done for all vegetables and fruits using the appropriate diseased and healthy leaves getting trained and tested. In this case the project is limited to only 6 classes with respect to fruits and 9 classes with respect to vegetables. Furthermore, new feature images should be trained

and tested using ANN and the web page design can also be improved for further additions. The problem need to be further extended to support the farmers community to help them to predict the diseased crop and the applicability of required fertilizers to overcome the problem.

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# Power Prediction of Wind Turbine Based on The Presumed Shape of Power Curve

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## ABSTRACT

An accurate model of power plays a crucial role in turbine energy assessment, wind turbine condition monitoring, estimation of wind energy potential, warranty formulations, power forecasting, wind turbine selection, optimization of the operational cost and expansion of windfarm. To achieve all these, algorithms of linear and cubic law models are used to predict the output power of BWC Excel 10 wind turbine. The comparative results show that the considered models can approximate and satisfactorily predicts the output power of wind turbines when compared with fundamental equation of wind turbine that depends on stringent factors like air density, turbine blade parameters, mechanical and control issues etc to yield similar results.

**Keywords :** BWC Excel wind turbine, Cubic law mode, Linear model, Power curve, Renewable energy, Wind energy conversion system

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## I. INTRODUCTION

The increasing need for electrical energy in the modern-day activities, together with the depletion of fossil fuel reserves and increasing concern around the globe over the environmental negativity of rising level of carbon dioxide ( $CO_2$ ), the need to diversify energy sources to enhance energy security, quality and reliability have led to several changes in energy sector and its policies [1, 2]. Renewable energy (RE) resources especially solar and wind are now in the fore front of replacing the conventional synchronous generation. U.S and South Korea efforts to increase the percentage of electricity generation from solar and wind to 20% of the total energy production by 2030 is an indication

that RE generation has come to stay [2, 3]. In the European Union the percentage of RE extended to 32% of electricity generation and 18% of the entire energy consumption in 2018, these shares are intended to rise to 50% of the electricity and 32.5% of the entire energy by 2030 [4]. Among the RE generation, wind power system has become a global and one of the major contributor to achieving a sustainable energy in the modern power systems and for the realization of this project, correct estimation of the power generated is very vital [5, 6]. In wind energy sector, power curve is useful in expressing the performance of turbine and is also a vital input to planning and achieving a reliable and efficient wind farm design [7]. The electrical output of wind turbine at a particular height of the hub

is a function of wind speed, and is usually represented using power curve. The precision of this curve is helpful in turbine energy assessment, wind turbine condition monitoring, estimation of wind energy potential, warranty formulations, power forecasting, and wind turbine selection [2, 8, 9].

Mathematical modelling is an indispensable tool used in sciences and engineering, it prepares a path for an excellent design and cost-effective systems. Proper understanding of all the components part and how they affect or stimulate the operation of the system is a precondition for accurate modelling [10]. This paper presents the deterministic means of predicting wind turbine power output using the algorithms of linear and cubic models. Deterministic forecasting refers to the single-point prediction result, i.e., the expectation of future wind power from the mathematical view [11]. These model uses the cut-in speed, nominal speed, furling speed and the power rating of the turbine for the analysis and does not require much difficult technical details. The traditional way of modelling power output of wind turbine uses the basic equation to determine amount of power present in the wind. However, this is an ideal case and does not always represent the real behaviour of wind turbine. The particular site of turbine, air density, the rotational speed of turbine, wind speed distribution, wind direction, mechanical and control issues, uncertainties in measurements, and turbine blade parameters (e.g angle of attack, pitch angle etc.) are some reasons which may cause empirical power curves differ from theoretical ones [3]. In order to effectively analyse the performance of these models, a commercially available wind turbine, specifically BWC Excel wind turbine actual output power was used to achieve a comparative assessment test.

## II. METHODOLOGY

Deterministic prediction using the concept of linear and cubic law is adopted. This forecasting method refers to the single-point prediction result, i.e., the

expectation of future wind power from the mathematical view [11]. These model uses the cut-in speed, nominal speed, furling speed and the power rating of the turbine for the analysis. For graphical comparative analysis, power curves are plotted.

### Typical Power Curve

A typical hypothetical power curve issued by wind turbine industry and assessed under ideal meteorological and topographical settings of wind turbine is illustrated in Figure 1. There are three major points on the curve which divide the curve into four different regions, each having a different distribution of wind power and wind speed. Point A is the cut-in speed (which is the speed at which turbine first start to rotate to initiate power production), point B is rated speed (speed at which the nominal power of the turbine is reached) and point C is the cut-out speed (at this point wind speed becomes excessively high and the turbine is taken out of operation to avoid defects and damages [12]. The power distribution in these regions are as given in Table 1.

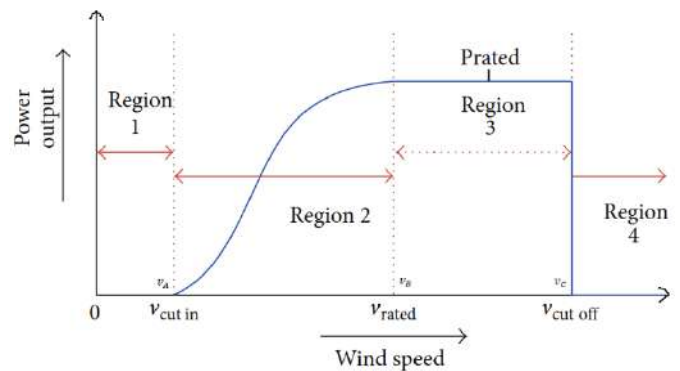


Figure 1 : Typical wind turbine power curve [13]

TABLE I

DISTRIBUTION OF WIND SPEED AND WIND POWER IN THE POWER CURVE

Wind velocity distribution	Electrical power output
$v < v_A$	$P_e = 0$
$v_A \leq v \leq v_B$	$P_e = \frac{1}{2} \rho A v_w^3 C_p(\lambda, \beta) \eta_t \eta_g$

$$v_B \leq v \leq v_C \quad P_e = \text{Rated power}$$

$$v > v_C \quad P_e = 0$$

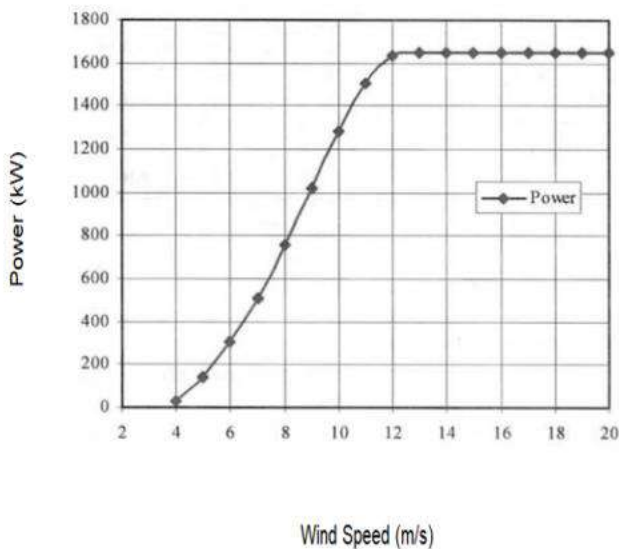
where  $v$  is the mean wind speed,  $v_A$  is the cut-in speed,  $v_B$  is the nominal speed and  $v_C$  is the furling speed (or cut-out speed), all speed parameters are measured in  $m/s$ . Power curves of wind turbines may come in different shapes depending on the design techniques. Figure 2 illustrates the theoretical power curve of two different wind turbines, depicting different shapes.

### Models for characterizing the power output of wind turbine

The models for characterizing wind turbine are generally categorized into two [10];

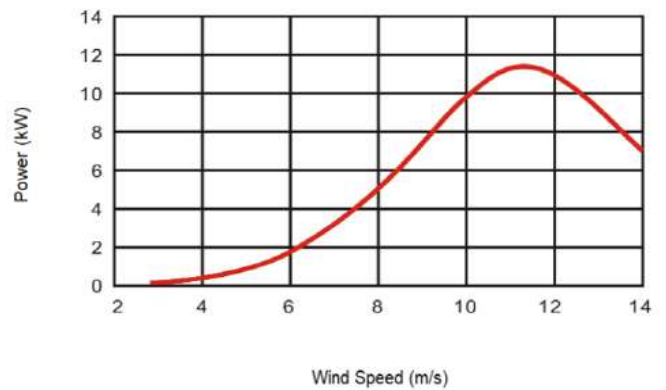
- (i) Models based on fundamental equations of power available in the wind.
- (ii) Models based on the concept of power curve of wind turbine

Power Curve for NM82



(a)

Power Curve for FD8



(b)

Figure 3 : Theoretical power curve for two different wind turbine a) Turbine model NM82, b) Turbine model FD8

*Models based on fundamental equations of power available in the wind*

Simplified functional block diagram of a typical power units of wind power system (WPS) depicted in figure 3. The instantaneous power  $P_w$ (watt) in the wind with mean velocity  $v$  flowing into the rotor blades is given by [14];

$$P_w = d(\text{Kinetic Energy}) = \frac{1}{2} \rho A v^3 \quad (1)$$

The extracted mechanical power ( $P_m$ ) by the wind turbine that flows into the transmission system is given by [15];

$$P_m = C_p P_w \quad (2)$$

Where  $C_p$ , is the power coefficient. The mechanical transmission system (gear train) is a conditioning unit that helps to step up the slow rotational speed of the turbine rotor to a higher speed that is desired to drive the electrical generator and its power output ( $P_t$ ) in Watt is given by;

$$P_t = P_m \eta_t \quad (3)$$

The electrical output power ( $P_e$ ) from the wind generator and power converter is therefore defined as;

$$P_e = P_t \eta_g \quad (4)$$

Where  $\eta_g$ , is the efficiency of the generator. By combining equations (1) to (4), the electrical power

output from the Wind energy conversion systems (WECS) is given as;

$$P_e = \frac{1}{2} \rho A v_w^3 C_p(\lambda, \beta) \eta_o \quad (5)$$

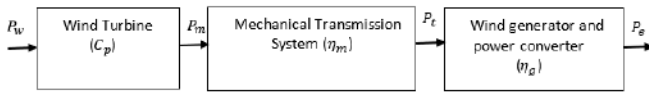


Figure 3: Simplified block diagram of WECS

It was discussed in [16] that wind power output can be determined using equation (5) above. [17] uses an optimization technique to calculate the electrical power generated from WECS by assuming that; (i) electrical and mechanical efficiency of 100% and (ii) the turbine blades were pitched at  $\beta = 0$  which according to Bertz, corresponds to maximum aerodynamic efficiency of 0.593. The resulting equation based on the optimization is given by equation (6).

$$P_e = \frac{1}{2} \rho A v_w^3 \quad (6)$$

It is good to note here that 100% efficiency of electrical and mechanical systems is unrealistic as there would be wear and tear in the moving parts of the gear system and the generator and also the copper and iron losses in the generator cannot be zero. Usually, modelling using the basic equation of power present in the wind is found to be difficult to use and does not suitably represent the behaviour of real wind turbine, it depends on several parameters as discussed earlier. For example, air density is a function of environmental factors like atmospheric moisture content, pressure and temperature which may vary from one wind farm location to another. So, it is often essential to use wind data obtained from a particular site location to get a more precise power curve[8].

#### *Models based on the concept of power curve of wind turbine*

Wind turbine power curve (WTPC) is used to establish input-output relationship between the generated electrical power and the wind speed. A reliable power

curve model is not easy to obtain because of indeterminate relationship between wind velocity and its power output [7, 18]. Deterministic modelling with power curves is much more convenient as it does not require much more detailed information like modelling using the basic equation of power present in the wind. Modelling with power curve can be categorized into two namely;

- (i) Model based on the presumed shape of the power curve
- (ii) Model based on the actual power curve given by the manufacturer.

#### *A. Model based on presumed shape of power curve*

The modelling in this category is assumed to follow the typical power curve shown in figure 1. The power output of wind turbine can be written in piece-wise linear characteristic form as follows [5];

$$P_e = \begin{cases} 0 & v_m < v_A \text{ and } v_m > v_C \\ q(v) & v_A \leq v_m \leq v_B \\ P_r & v_B \leq v_m \leq v_C \end{cases} \quad (7)$$

Quite number of methodologies have been proposed in literatures, ranging from quadratic model, cubic law model, linear model, Weibull parameter-based exponential power curve models to define  $q(v)$ , which represent the power output characteristic of wind turbine during the transient region (i.e between the cut in speed and the nominal speed) [5, 19].  $P_r$  defines the rated power of the wind turbine. This paper, however uses both linear and cubic law models to predict power output of BWC Excel 10 Wind turbine and then compare with the power output specified by the manufacturer.



### Model based on parametric cubic law model

Cubic polynomial model was reported in [20] to estimate electrical power generated from WECS measured in  $\text{KW}/\text{m}^2$  and is expressed as follows;

$$P_{wd} = \begin{cases} 0 & v < v_A \\ \frac{P_{er}}{v_B^3 - v_A^3} v^3 - \frac{v_A^3}{v_B^3 - v_A^3} P_{er} & v_A < v_m < v_B \\ P_{er} & v_B < v_m < v_C \\ 0 & v_m > v_C \end{cases} \quad (8)$$

Electrical power output from the WECS is therefore given as;

$$P_e = P_{wd} \eta_o A \quad (9)$$

### Model based on parametric segmented linear model

This is the most easily employed parametric model which uses piecewise linear approximation to predict the power generated by WECS [10, 19]. The power output  $P_e$ , of wind turbine was proposed according to the equation of a line given as;

$$P_e(v) = \beta v + k \quad (10)$$

where  $\beta$  is the sectional gradient, and  $k$  is a constant in the section. When there is only one section between the cut in speed and the nominal speed, then the equation of a line passing through two points can be used to obtain  $\beta$  and, in that case,  $k = 0$ . Thus,

$$q(v) = P_{er} \frac{v - v_A}{v_B - v_A} \quad (11)$$

Equation (11) is derived on the assumption that only one segment exists between the cut in speed and the nominal speed, in this case, the power output of the wind turbine grows in a linear manner with wind speed and then it stays constant from rated to cut-out speed. The expression that characterizes the linear model is given as;

$$P_e = \begin{cases} 0 & v < v_A \\ P_{er} \frac{v - v_A}{v_B - v_A} & v_A \leq v_m \leq v_B \\ P_{er} & v_B \leq v_m \leq v_C \\ 0 & v_m > v_C \end{cases} \quad (12)$$

## III. RESULT AND DISCUSSIONS

MATLAB codes was developed for both linear model and cubic law model to predict the output power of a commercially available wind turbine (i.e BWC Excel 10 Wind turbine). Table 2 illustrates the comparison of the electrical output power obtained from manufacturer's data sheet [21] with the parametric models under discussion. Figure 4 clearly shows the piecewise linear characterization of the linear model. The turbine starts generating electricity at a cut-in speed of 2.5m/s and follows through this linear transient with positive slope until the nominal speed is reached (14m/s). At 20m/s, the turbine was taken out of operation to prevent damage. Figure 5 is a comparative assessment between the predicted linear model and BWC Excel 10 WT. The curves show that the predicted model is not completely correct in the range of cut in speed to nominal speed as power curve of wind turbine is rarely linear in that region but they are more satisfactory compared with modelling using basic equation of power available in the wind. Figure 6 shows proposed cubic law model while the Figure 7 illustrates the comparative assessment with the actual power output data from the manufacturer. The two responses follow a similar non-linear pattern but with significant errors during the transient state. Between the rated speed to the furling speed of 21m/s, the power generated are closely matched.

More generally, linear model, cubic model and model based on actual data from the manufacturer uses the characteristic equations obtained using the machine reading provided by manufacturer at fixed interval of points but again the behaviour of the machine at different site conditions are not considered. In this category, only cut-in, furling and nominal speeds and the nominal power are employed in generating the model, which are not adequate enough to precisely represent the actual behaviour of wind turbine.

TABLE 2

COMPARATIVE RESULTS OF THE ELECTRICAL POWER GENERATED BASED ON LINEAR MODEL, CUBIC MODEL AND DATA OBTAINED FROM MANUFACTURER'S SPECIFICATION FOR BWC EXCEL 10 WIND TURBINE

Wind speed (m/s)	Electrical power generated (KW)		
	Cubic law model	Linear model power	Actual power output
2.0	0	0	0
2.5	0	0	0.039
3.0	0.052	0.543	0.102
3.5	0.125	1.090	0.229
4.0	0.222	1.6304	0.399
4.5	0.346	2.1739	0.596
5.0	0.501	2.7174	0.848
5.5	0.691	3.2609	1.151
6.0	0.918	3.8043	1.510
6.5	1.187	4.3478	1.938
7.0	1.5	4.8913	2.403
7.5	1.861	5.4348	2.949
8.0	2.274	5.9783	3.602
8.5	2.742	6.5217	4.306
9.0	3.268	7.0652	5.071
9.5	3.856	7.6087	5.96
10.0	4.510	8.1522	6.856
10.5	5.232	8.6957	7.849
11.0	6.026	9.2391	8.863
11.5	6.896	9.7826	9.928
12.0	7.845	10.3261	10.885
12.5	8.877	10.8696	11.619
13.0	10.000	11.413	12.019
13.5	11.200	11.9565	12.276
14.0	12.500	12.500	12.395
14.5	12.500	12.500	12.449
15.0	12.500	12.500	12.495
15.5	12.500	12.500	12.508
16.0	12.500	12.500	12.546
16.5	12.500	12.500	12.555
17.0	12.500	12.500	12.503

17.5	12.500	12.500	12.528
18.0	12.500	12.500	12.442
18.5	12.500	12.500	12.396
19.0	12.500	12.500	12.208
19.5	12.500	12.500	11.878
20.0	12.500	12.500	11.989
20.5	12.500	12.500	11.495
21.0	12.500	0.000	-
21.5	0.000	0.000	-
22.0	0.000	0.000	-
22.5	0.000	0.000	-
23.0	0.000	0.000	-
23.5	0.000	0.000	-
24.0	0.000	0.000	-
24.5	0.000	0.000	-

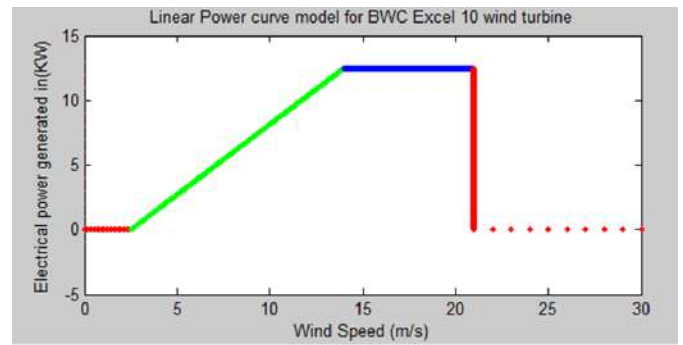


Figure 4: Parametric linear model for BWC Excel Wind turbine

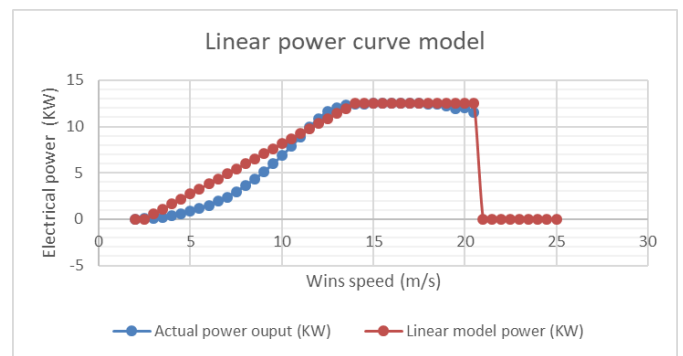


Figure 5: Comparison of actual and proposed linear power curve

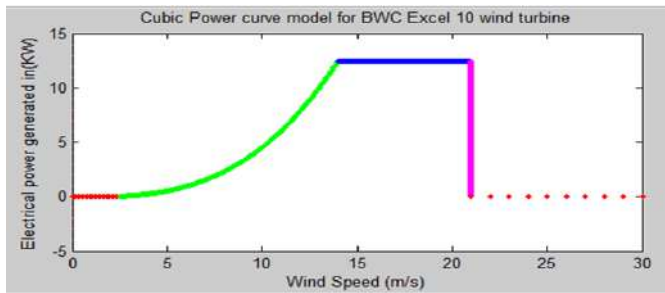


Figure 6: Output simulation results of the proposed cubic model

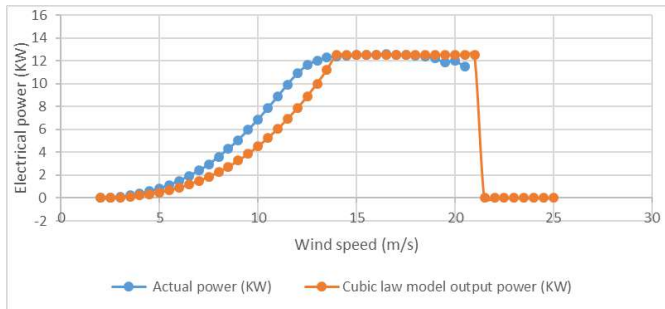


Figure 7: Comparison of actual and proposed cubic power curve

#### IV. CONCLUSION

In this article, comparative assessment of linear segmented parametric model, cubic law model and actual data supplied by the manufacturer of BWC Excel 10 wind turbine have been carried out. The need for power curve in planning and achieving a reliable and efficient wind farm design has also been discussed. The predicted models use only the cut-in speed, nominal speed, furling speed and the power rating of the turbine to predict the electrical power output of wind turbines and does not require additional technical details. The results obtained shows that cubic law model gives a more satisfactory outputs during transient while both models generally shows excellent performance between the rated speed and furling speed.

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# Design and Fabrication of Simple Solar Grass cutter

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## ABSTRACT

In the recent years weed cutter machines are quite common in agriculture field and for lawn maintenance. The grass cutters were operating with IC Engine will use gasoline. The gasoline operated engines will generate harmful emissions which pollute the environment. Also the constant rise in fuel prices and the impact of gas emissions from burned fuel into the atmosphere make it necessary to use the sun's plentiful solar energy as a source of power to operate a grass cutter. Accordingly with the use of abundantly available solar energy it is attempted to make a "Simple Solar Grass Cutter". The fabricated grass cutter involves a solar panel, stainless steel blade, D.C motor, battery, and control switch. The control switch provided on the solar-powered lawnmower closes the circuit and permits current to pass to the motor, which drives the blade. The battery is chargeable and charged continuously by solar energy.

**Keywords:** Solar grass cutter, Solar Panel, Control switch

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## I. INTRODUCTION

Today's pollution is a serious problem for the entire world. Man-made pollution is present in our homes. Gas-powered lawn mowers are guilty of causing pollution because they emit gases. Additionally, it is inefficient due to rising fuel prices. Consequently, solar-powered lawn mowers are introduced. The use of solar energy to drive an electric motor, which in turn moves a blade, is what is referred to as a solar-powered lawn mower. However, those grass cutters which operate with engine are expensive. This design serves as an alternative to the harmful gas-powered lawnmower. Solar energy is a type of renewable energy source that can be either passive or active. Essentially,

solar energy is a free energy source that is simple to use. Then, a solar-powered lawn mower will be manually controlled using this free solar energy. The blades are rotated by a motor for the purpose of cutting the grass. Since no fuel or wire extensions are required for the power supply, the project is pollution-free and environmentally safe. The conditions in India are taken into account in all of the assumptions and decisions made in the design of this project.

### 1.1 Problem Statement

The solar lawn mower is considered after the effectiveness of others felt insufficient due to the following factors:

- 1 Pollution is there due to the use of grass cutter working on IC engine.

- 2 Grass cutters working on electricity are efficient but it also increases electricity consumption.
- 3 More time is required to accomplish the work.
- 4 Human effort required is more.
- 5 There are many safety issues regarding grass cutters such as obstruction in the way of the cutter can cause damage to the blades of the cutter or it can cause the obstructions such as stones to fly and cause harm to the operator.
- 6 There is a probability that it could not be used during rain or in wet conditions.

### 1.2 Objectives

The objectives of this lawn mower are created to solve the problems which existing lawn mowers have, is as follows.

- 1 To design a lawn mower operating on solar energy.
- 2 To reduce operating cost.
- 3 To avoid any damage to operator and the lawn mower itself.
- 4 To keep the environment clean and healthy.
- 5 To cut various type of grasses with precision.

The current technology available in the market are too expensive, they can't be used in domestic applications, so the end product need to be economic in price for it to be used on a large scale.

In India the type of grass usually found are the "Ravenna Grass (*Saccharum Ravennae*)" our main objective is also to cut the grass properly, therefore proper blade design is also necessary for the lawn mower. Elephant grass is also one of the most found grasses in India, they are big in length but have a thin structure, so they must be taken in consideration while designing the lawn mower [4].

### 1.3 Methodology

Solar powered grass cutter has solar panels mounted on it in such a way that we can utilize the solar radiation coming from the sun with high intensity. This solar energy is then converted into electrical energy which

is then stored in rechargeable battery. The battery supply power to D.C motor which drives the blades.

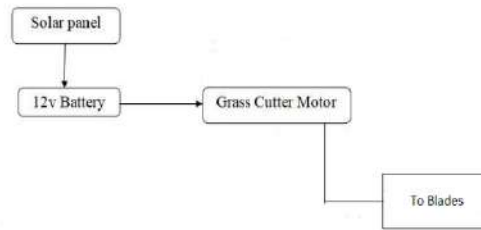


Figure 1: Block diagram of solar grass cutter.

## II. DESIGN OF SLOAR GRASS CUTTER

Solar powered grass cutter has solar panels mounted on it in such a way that we can utilize the solar radiation coming from the sun with high intensity. This solar energy is then converted into electrical energy which is then stored in rechargeable battery. The battery runs the D.C motor so that the blades rotate in clockwise direction in a rated speed. In between the battery and motor a switch is provided to control the operation.

### 2.1 Battery

Normally there are non rechargeable and chargeable batteries. From button-sized cells to massive industrial systems, rechargeable batteries are available in a wide range of dimensions. Rechargeable batteries have a lower overall cost of use and far less environmental impact than their disposable counterparts, which are their key advantages. Although they are initially more expensive than disposable batteries of the same size, their multiple recharge ability reduces their overall cost over time.

Lead-Acid batteries are by far the most economical for larger power applications, as long as weight is of little concern. These batteries have been around since the mid-1800s because they are durable and provide dependable service. The only maintenance requirements are keeping them from discharging too far and there is no memory effect to deal with.



Figure 2: Lead acid battery.

By far the most common application of these batteries are with vehicles for starting engines, as they are heavy enough that the weight is not of much importance. They are also popular in larger energy applications that require constant current, such as golf carts and solar power storage. They are very cheap and available nearly everywhere.

### 2.2 Grass Cutting Blade

The cutting blade is made up of stainless steel to prevent the rusting and for durability. There are three blades fixed over a disc. And the disc is fitted directly to the motor shaft. The cutting blade arrangement is as shown in figure 3.



Figure 3: Stainless steel blade setup.

### 2.3 Motor operating the Cutting Blade

D C Motor is the heart of Simple Grass Cutter. When electric energy is actuated from the control switch the motor starts to rotate in clockwise rotation at a rated speed of 1500 to 2000rpm. In DC Motor electrical energy is being converted into mechanical energy. The principle of working of motor is whenever a current carrying conductor is placed in magnetic field it attains rotational effect. The schematic representation of construction and working principle is shown in figure 4.

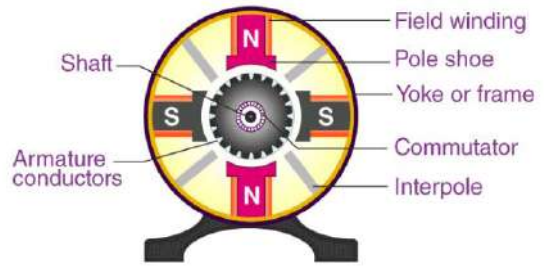


Figure 4: Construction of D C motor.

### 24V 775 DC Motor:

This motor runs at 5000-12000 rpm, this is more preferable compared to 24v DC motor whose rpm goes above 20000 rpm. Current required by the motor is 2.3 amps and weight is 150.00g. This motor has high torque and high power which is required for this project.



Figure 5: DC motor

Power developed by the motor:

$$P = V \cdot I = 24 \cdot 2.3$$

$$P = 55.2 \text{ watts}$$

Torque developed by the Motor:

$$P = 2\pi nT/60$$

$$55.2 = 2 \cdot \pi \cdot 10000 \cdot T/60$$

$$\text{So, } T = 18.97 \text{ N-M.}$$

**Torque developed by the Motor:**

This application requires high torque low speed 12v DC motor. This motor has a rpm of 300. Current required is 0.3amp. Number of motor used are 4 and each motor is for separate wheel, a total of 1.2 amp current will be used.

Power developed by 4 motors:

$$P = V \cdot I = 12 \cdot 1.2$$

$$P = 14.4 \text{ watts}$$

Torque developed by 4 motors:

$$P = 2\pi nT/60$$

$$14.4 = 2 * \pi * 300 * T / 60$$

So,  $T = 0.45 \text{ N-M}$ .

## 2.4 Solar Panel



Figure 6: Solar panel.

A solar panel of size 1 foot  $\times$  1.5 feet is used to generate the electric power required to drive the solar grass cutter blade motor. Solar panel capacity of 12 Volt and 10 Watt poly-crystalline panel is used in our project.

## 2.5 Wheels

The main frame is fitted with four wheels it carries the self weight of the entire assembly. Also it helps to move the grass cutter wherever required to trim the lawn.



Figure 7: Wheel of grass cutter frame.

## 2.6 Switch

The power which is received from the solar panel is stored in the battery. A DC motor is directly connected to the blade. The controlling of the grass cutter blade is achieved by the control switch placed between the battery and blade circuit.



Figure 8: Control switches to on or off the cutting blade operation.

## III. MATERIAL SELECTION AND FABRICATION

Material selection is done on the basis of:

1. Availability of material.
2. Required properties of the material.
3. Weldable material.
4. Cost efficient material.

### 3.1 Material Selection of Blades

The blades of the Lawn Mower is to be made by using Stainless Steel, as the grass which blade will be cutting will not always be dry, so as we cut the wet grass there are chances for corrosion. Stainless Steel is the alloy of iron and carbon with 2% C which has non-corrosive properties. The stainless steel considered for this project is of grade X14CrMoS17, this steel is also known as "ASTM A276 / AISI 430F".

### 3.2 Material Selection of Frame

The frame of the Lawn mower will be made of grey cast iron and will be welded at the joints. Grey cast iron is the alloy of iron and composes of 2-4% carbon with the presence of silicon and manganese. Grey cast iron used in the frame is of grade ASTM A48 CLASS 20. It is more effective because it can be easily machined and manufactured and it is easily available. MIG welding will be preferred for joining all the joints of the Lawn Mower.



Figure 9: Fabricated frame.



### 3.3 Fabrication

In this research fabrication work is the building of solar grass cutter from the scratch. Building each part individually and assembling or welding it together is the major goal of our project. Fabrication is the most significant step following the literature survey and designing. The simple solar grass cutter fabricated is shown below.



Fig. 10 Simple solar grass cutter.

### IV.CONCLUSION

All machines in the modern world are made with the intention of lowering or eliminating the biggest contributors to climate change, greenhouse gas emissions. The problem of environmentally friendly production and low operating costs will be met by this solar-powered lawn mower since fuel is not required. For its intended use, the machine's capacity is sufficient. The device has shown promise as a potential substitute for the gasoline-powered grass cutter.

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# Analysis of Natural Frequency of a Rectangular Beam Using Finite Element Analysis and Artificial Intelligence

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## ABSTRACT

Natural vibrations are the unforced oscillations of an elastic body that occur at the natural frequency. A substantial increase in vibration amplitude occurs when an object vibrates at a frequency that is equal to its natural frequency, which could cause irreparable harm. Therefore, it is essential to comprehend the natural frequency. In order to predict the natural frequency or free vibration characteristics of a rectangular copper beam that is simply supported and cantilevered, machine learning techniques are used to examine the natural frequency of the beam. Here copper material properties is used to predict, where copper has minimal chemical reactivity, is malleable and ductile, and is an excellent conductor of heat and electricity. An artificial neural network and linear regression algorithm model has been developed to estimate relationship between material properties, angular frequency and natural frequencies obtained by Euler Bernoulli method and Ansys 14.5 software as an output layer. Without the need to solve any differential equations or undergo time-consuming experimental procedures, the proposed machine learning algorithms can predict the natural frequencies. The results show that artificial intelligence (AI) can be efficiently adapted to modal analysis problems of beams. The graph behaviour on the natural frequency from AI is also demonstrated.

**Keywords :** Natural frequency, Copper material, Artificial neural network, rectangular beam, Finite Element Analysis and Linear Regression.

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## I. INTRODUCTION

Recently, machine learning has been used in material science to aid in the discovery of novel materials. Sefa Yildirim used the ansys approach to determine the natural frequency of axially and transversely loaded beams for various materials and their characteristics. Investigating the impact of grading direction on the natural frequencies of heterogeneous isotropic beams

and estimating the free vibration characteristics using an artificial neural network approach. The power-law form determines whether to grade the two-dimensional beam in an axial or transverse orientation. For the purpose of estimating the relationship between material properties and model, grading direction, and slenderness ratio as input layers and natural frequencies obtained using the Finite-Element method as output layers, an artificial neural network model has

been developed. The frequencies of the various layers will be computed. Additionally, using artificial intelligence, ANN is used to forecast the frequency of the same material [1]. Ahmed B. Khoshaim et.al [2] Residual stresses (RS) produced in machined components have a substantial impact on the completed items' quality and longevity. Because a variety of cutting parameters and conditions have an effect on RS generation, it is crucial to understand the relationship between RS generation and those features in order to minimise the generated tensile RS. Experimental data on the effects of several parameters, including cutting feed, depth, and speed that generate RS on both circumferential and radial, is gathered. The residual stresses of iron are predicted using ANN. Pengcheng Jiao [3] Visible models with AI capabilities are a practical tool for designing, predicting, and optimising PENG and TENG structures and materials. In this model, the mechanical to electrical performance is predicted using AI-PENG and AI-TENG. Dingqiang Fan, Rui Yu et.al [4] here 80 mixture of concrete is used to predict the performance, Modified andreasen and Anderson and Genetic algorithm based ANN used to predict the ultra high performance of concrete. Dike Li, Lu Qiu [5] An turbine guide vane is modelled and meshed in a CFD Software to estimate the cooling efficiency of it. For the data collected for the turbine vane using CFD will run through ANN to predict the Cooling Efficiency of a turbine vane. In order to pass through a body crack, V. Khalkar and S. Ramachandran[11] used a spring steel cantilever beam with slots that were both rectangular and V-shaped. The static deflection and natural frequency of the spring steel cantilever beam are calculated using the ansys programme for each depth and length of the crack for both v- and rectangular-shaped cracks. discovered how crack affected natural frequency. Copper tubing is currently the best product available for use in plumbing, fire sprinklers, and other applications in buildings. Copper tubing is a fantastic option for natural gas piping systems. Copper and other non-ferrous metals have a long history of being closely

linked to humanity. Copper is a fascinating substance that also possesses a wealth of resources. As a result, it is widely utilised in high-tech domains, emerging industries, and the creation of petrochemicals, machinery, lighting, electronics, and electrical power. In addition to being malleable and ductile, copper has a low chemical reactivity and excels as a heat and electricity conductor. Therefore, machine learning approaches are suggested in this study to estimate the Natural Frequency using the attributes of the copper material.

## II. METHODS AND MATERIAL

Ansys 14.5 software and Euler Bernoulli analytical method is used in this methodology for calculating the natural frequency. Linear Regression and Artificial Neural Network methodology in Artificial Intelligence is used to predict the natural frequency from the data obtained.

Before analyzing the data for the built model, Data should be collected from the Ansys 14.5 software and Analytical method (Euler Bernoulli) for Rectangular simply supported Beam and Cantilever Beam.

A Rectangular beam of width 20mm (0.02m) and height 20mm (0.02m) is considered for the varying length of 1000mm(1m), 2000mm(2m) and 3000mm(3m) for copper material.

The Table 1 consist of copper material property which is taken from [6] as shown below:

Table 1. Copper material Property

Young's Modulus(pa)	Poisson's Ratio	Density (kg/m <sup>3</sup> )
117 x 10 <sup>9</sup>	0.33	8940

### ANSYS

Ansys 14.5 software is used for both the cantilever and simply supported beam. Before building the model, structural and material properties are provided here.

The modelling for the aforementioned dimension is completed with the addition of 2 Node 188-element type, and meshing will follow. Boundary conditions are given for cantilever one side is Constrained, For the simply supported beam boundary conditions are given on the both the sides except ROTZ everything will be constrained. Finally modal analysis and 10 modes will

be given and solution will be taken out from results summary.

Table 2 lists the results from the Ansys 14.5 programme for both cantilever beam and simply supported beam. When five modes are taken into account, the simply supported and cantilever are represented by numbers 1 and 2 in the support columnn.

Table 2. ANSYS values

SL.NO	LENGTH	MODE	SUPPORT	ANGULAR FREQUENCY	FREQUENCY
1	1	1	1	208.39	33.167
2	1	2	1	861.42	137.1
3	1	3	1	2048.88	326.09
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
28	3	3	2	152.57	24.283
29	3	4	2	319.59	50.865
30	3	5	2	578.99	92.15

### 1.1. EULER BERNOULLI

The Euler Bernoulli beam theory, which provides a method for determining the load-carrying and deflection properties of beams, simplifies the linear theory of elasticity. It solely handles the scenario associated with small beam deflections brought on by lateral load.

The equations for free vibration simply supported beam are:

$$\omega_n = \frac{n^2\pi^2}{l^2} \sqrt{\frac{EI}{\rho A}} \text{ (Rad/sec)} \quad (1) \quad f_n = \frac{\omega_n}{2\pi} \text{ (Hz)} \quad (2)$$

The equations for free vibration simply supported beam are:

$$\omega_n = \left(\frac{(2n-1)\pi}{2} + e^n\right)^2 \frac{1}{l^2} \sqrt{\frac{EI}{\rho A}} \text{ (Rad/sec)} \quad (3) \quad f_n = \frac{\omega_n}{2\pi} \text{ (Hz)} \quad (4)$$

Where  $f_n$  = Frequency  $\omega_n$ = angular frequency,  $n$ = no of modes,  $e^n$ = error,  $l$  = length,  $E$  = Modulus of Elasticity,  $I$  = Moment of Inertia,  $\rho$  = Density of material,  $A$ = Area of the material.

Table 3 lists the results from the Euler Bernoulli's analytical approach for both cantilever beams and simply supported beams. When five modes are taken into account, the simply supported and cantilever are represented

by numbers 1 and 2 in the support column. Equations (1) and (2) are used to determine the angular frequency and frequency of a simply supported beam, while equations (3) and (4) are applied to cantilever beams.

Table 3. Euler Bernoulli values

SL.NO	LENGTH	MODE	SUPPORT	ANGULAR FREQUENCY	FREQUENCY
1	1	1	1	206.12	32.806
2	1	2	1	824.54	131.23
3	1	3	1	1855.23	295.27
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
28	3	3	2	143.18	22.789
29	3	4	2	280.57	44.655
30	3	5	2	463.8	73.817

### 1.2. ARTIFICIAL NEURAL NETWORK

Computer architectures known as artificial neural networks (ANN) are based on the biological neural networks seen in animal brains. The core of an ANN is made up of artificial neurons, which are a collection of connected units or nodes that resemble the neurons in a biological brain.

A weighted directed graph, in which the nodes stand in for the artificial neurons, is the best way to depict a synthetic neural network. A directed edge with weight represents the relationship between the inputs and outputs of neurons.

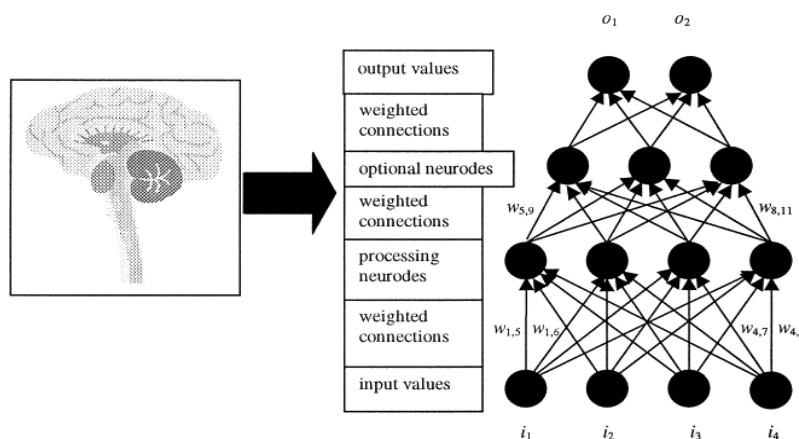


Fig. 1. Artificial Neural Network

### 1.3. LINEAR REGRESSION

By applying linear regression analysis, one variable's value can be used to predict the value of another variable. The dependent variable is the one you must be able to foresee. You must first decide which variable will be the independent one before you can estimate the value of the other variable.

- Validation of model

A model's validation enables evaluation of the trained model's efficacy and correctness. For each machine learning method, real data will be used to build a training set and a test set. The model is validated using the test set after having been trained using the training set of data. For the test data to be predicted in this model, 30% values are used.

### III. RESULTS AND DISCUSSIONS

In this work, the length, support, modes, constant and angular frequency of copper material is considered as the input and the output is Natural Frequency. The network is trained using the methods LR and ANN.

Spyder is used for the aforementioned work.

The model accuracy is predicted using the R-Square value.

$$R\text{-squared} = \text{Explanted Variation} / \text{Overall Variation}$$

It has a value between 0 and 1. Zero means the model made a poor prediction, whereas one means it made a flawless prediction.

#### A. Prediction of Natural Frequency for ANSYS

The R-Squared value achieved using the Python software for ANN and LR Machine learning Techniques is displayed in Table 4. It demonstrates that LR and ANN produce superior outcomes with an R-Squared value of 1. It suggests that both methods are effectively employed.

Table 4. R-Squared value for ANSYS Natural Frequency

Technique	LR	ANN
R-Squared	1	1

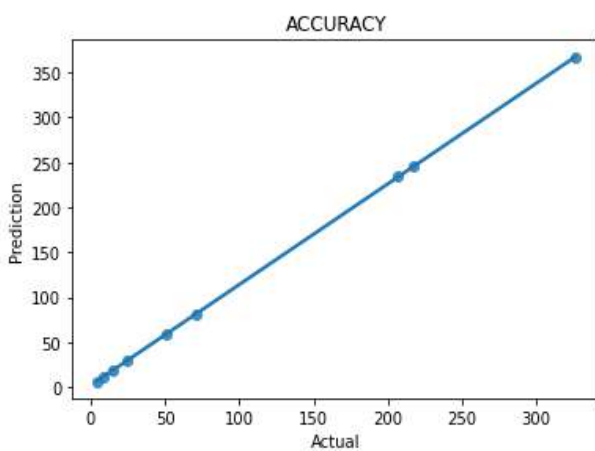


Fig. 2. Actual vs prediction Frequency using ANN

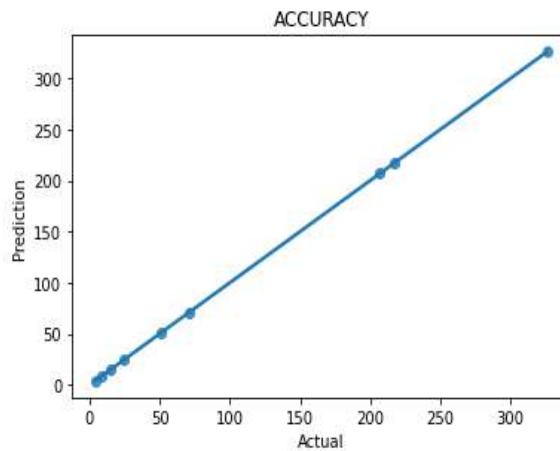


Fig. 3. Actual vs prediction Frequency using LR

For the Natural Frequencies for both techniques, Figure 2-3 shows the Actual versus Prediction Values graphs (LR and ANN). The fitting region, which was identified using linear regression and an artificial neural network, covers almost all of the data points in Figures 2 and 3, and it is equal to 1. The ANN & LR plot has a better match, as shown by the graph above. In terms of fitting points to regression lines for the ANSYS Natural Frequency, the ANN & LNN approach definitely performs better. Because of this, Ansys Natural Frequency of Copper predictions made using the ANN & LR approach are better and more accurate. R-Squared has showing 1 for both the algorithms which means 100% accuracy in the actual versus prediction plot obtained.

**B. Prediction of Natural Frequency for Euler Bernoulli**

The R-Squared value achieved using the Python software for ANN and LR Machine learning Techniques is displayed in Table 5. It demonstrates that LR and ANN produce superior outcomes with an R-Squared value of 1. It suggests that both methods are effectively employed.

Table 5. R-Squared value for Euler Bernoulli Natural Frequency

Technique	LR	ANN
R-Squared	1	1

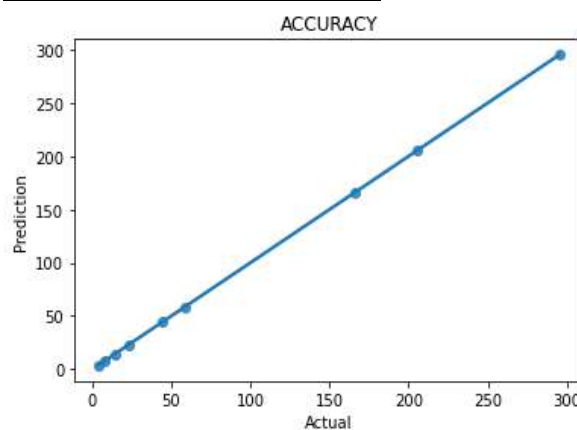
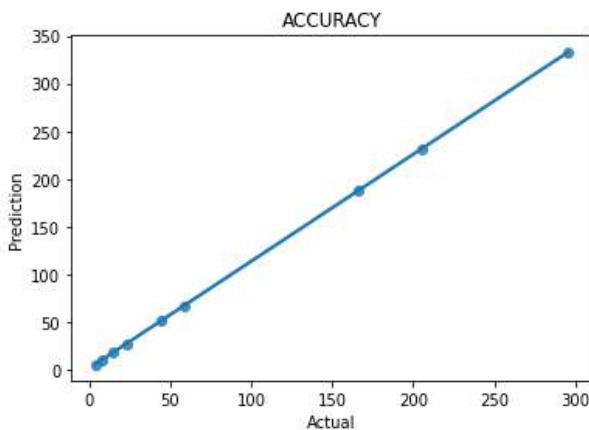


Fig. 4. Actual vs prediction Frequency using ANN

Fig. 5. Actual vs prediction Frequency using LR

For the Natural Frequencies for both techniques, Figure 4-5 shows the Actual versus Prediction Values graphs (LR and ANN). The fitting region, which was identified using linear regression and an artificial neural network, covers almost all of the data points in Figures 2 and 3, and it is equal to 1. The ANN & LR plot has a better match, as shown by the graph above. In terms of fitting points to regression lines for the ANSYS Natural Frequency, the ANN & LNN approach definitely performs better. Because of this, Ansys Natural Frequency of Copper predictions made using the ANN & LR approach are better and more accurate. R-Squared has showing 1 for both the algorithms which means 100% accuracy in the actual versus prediction plot obtained.

**C. Prediction of Natural Frequency for Euler Lagrange**

The R-Squared value achieved using the Python software for ANN and LR Machine learning Techniques is displayed in Table 6. It demonstrates that LR and ANN produce superior outcomes with an R-Squared value of 1. It suggests that both methods are effectively employed.

Table 6. R-Squared value for Euler Lagrange Natural Frequency

Technique	LR	ANN
R-Squared	1	1

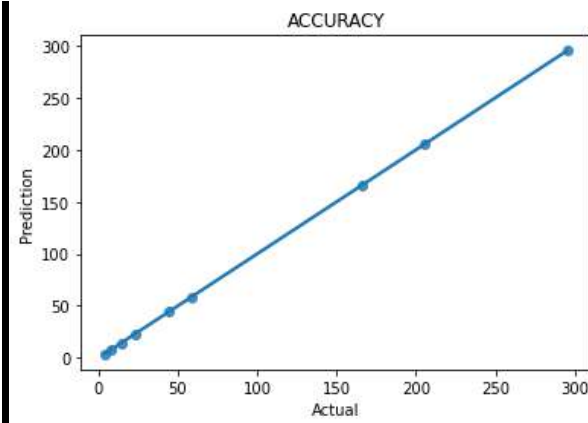
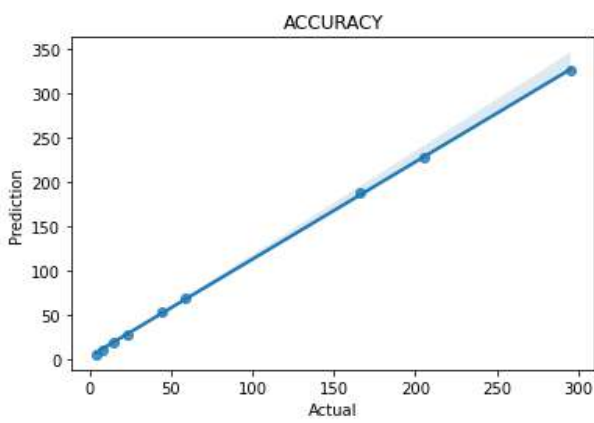


Fig. 6. Actual vs prediction Frequency using ANN Fig. 7. Actual vs prediction Frequency using LR

For the Natural Frequencies for both techniques, Figure 6-7 shows the Actual versus Prediction Values graphs (LR and ANN). The fitting region, which was identified using linear regression and an artificial neural network, covers almost all of the data points in Figures 2 and 3, and it is equal to 1. The ANN & LR plot has a better match, as shown by the graph above. In terms of fitting points to regression lines for the ANSYS Natural Frequency, the ANN & LNN approach definitely performs better. Because of this, Ansys Natural Frequency of Copper predictions made using the ANN & LR approach are better and more accurate. R-Squared has showing 1 for both the algorithms which means 100% accuracy in the actual versus prediction plot obtained.

Table 7. Performance Comparison Table

PERFORMANCE	ANSYS		EULER BERNOULLI	
	ANN	LR	ANN	LR
R-SQUARED	100	100	100	100

Table 7 displays performance comparisons for all the factors.

#### IV.CONCLUSION

The Natural Frequency is estimated in this study using two machine learning methods: LR and ANN. For cantilever and simply supported beams, copper material properties are utilized to calculate frequencies using boundary conditions. The data was gathered using the Euler-Bernoulli analytical method and Ansys 14.5 software for both the beams. The analytical approach and the ansys software are used to produce

the training and testing data sets for the machine learning algorithms. Using the ANN and LR algorithms, Natural Frequency values can be predicted with greater accuracy. In addition to being outlier-sensitive, linear regression only works well with linear connections. Based on data from the Ansys software and analytical techniques (Euler Bernoulli), it can be seen that LR and ANN produce better and more accurate values when compared to plots of actual vs. predicted values. Similar techniques can be used in



future study to identify distinctive materials in other composites by utilizing various machine learning techniques. Machine learning is useful in other fields of material science as well.

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# Rotor Dynamic Analysis of Multi-Disc System with Viscoelastic Support

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## ABSTRACT

The detailed study of rotor dynamic aspects of a rotating system is very much essential before the start of manufacturing process. In different types of rotating machines like compressor, turbine, turbo-pumps and so on the different types of bearings and support system have been used to obtain desired performance. A detailed analysis on critical speed estimation and frequency response of the system has been carried out in this work. To avoid resonant condition at operating speeds, modal analysis of such systems is much important in the initial stages of design. Full rotor dynamics analysis during operating conditions is also mandatory to investigate the dynamic behaviour of the rotating structures. In this work modal analysis, critical speed and harmonic analysis of frequency response of high speed multi disc system supported with viscoelastic support has been carried out using 3D finite element analysis software named Ansys workbench. The critical speed and mode shapes of the multi disc system supported with viscoelastic support are obtained through Campbell diagram in order to investigate the dynamic behaviour of the rotating system. The effect of change of critical speed due to change in stiffness values of the support is been studied. Further, harmonic analysis is been carried out in order to determine the frequency response of the system.

Keywords: Rotor Dynamic, Critical Speed, Campbell Diagram, Natural Frequencies, Unbalanced Response.

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## I. INTRODUCTION

Rotodynamic is an area of applied mechanics that focuses on the behavior and diagnostics of rotating system. It also known as rotor dynamics, it is frequently used to analyze the behavior of various types of constructions including computer hard drives, steam turbines and jet engines. The use of foil journal

bearing for high speed rotor systems is a growing popularity [15]. Due to shaft's high flexibility, it is prime important to do the dynamic modelling and also the vibrational analysis for design and operations of multistage rotating system [12]. Multi-disc systems are widely used around the domain as a dependable, flexible and efficient power generation option. This adds to the workhorse that has been unparalleled in

aircraft engines for eras. The more progressive the technology, the lower the vibration of the turbine, thus increasing rated power, reducing weight and improving efficiency. This requires the use of progressive materials, so a deeper understanding of rotor dynamics analysis becomes essential. In this paper a viscoelastic support has been given around the bearing to study how the viscoelastic support around the bearing will make changes in the performance of the multi-disc system about the critical speeds which are obtained from the Campbell diagram and also the frequency response of the multi-disc system with viscoelastic support. Amor Zapanta [1] Viscoelastic material characterization was carried out using Dynamic Mechanical Analyzer (DMA). A rectangular curved specimen for the mold compound material characterization was used, at the test temperature range from 300 C to 3000 C with 100 C increment and a frequency sweep from 0.1 Hz to 100 Hz with 5 points per decade spaced accordingly to a log scale. DMA output showed that the relationship between the storage modulus and temperature for all the frequencies applied, they see that the modulus becomes lower at higher temperature as heat softens the mold material. Jing Wang, Yongfeng Yang [2] A rotor system having dual disc with uncertain parameters was analyzed with Chebyshev convex method of non-probabilistic type, for the dual disc rotor system the dynamic equations was derived with the help of finite element method and Chebyshev convex method was used to get the uncertain transient response. The dual disc rotor experiment findings confirmed the precision and effectiveness of the Chebyshev convex approach, their future work will be on optimization of Chebyshev convex method, that will provide effective help to rotor dynamics designer. Qinwu Xu [3] To enhance the current model, they created a material that is non-linear viscoelastic with mathematical and physical exponential. Here the non-linear strain hardening is taken into account as the relaxation modulus transient from the glassy stage to the rubbery stage through a time-dependent viscosity

in a continuous spectrum. The model is numerically stable and does not slow down computational speed. I I Ivanov [4] They provided the proper strategy, which combines the usage of non-linear support models with rotor finite element models. The hertz contact theory was used to determine the non-linear exponential dependencies of forces on displacement that were used to simulate rolling bearing. Mehmet Parlak [5] A compact steam turbine rotor was subjected to rotor dynamic analysis and by applying a finite element approach based on dynort software, critical speed, modal shapes and Campbell diagram of the system were derived. Vasanth Kumar S [6] He used rotor bearing system of small gas turbine to study the dynamic analysis, an equivalent mass model was designed to carry out the study of rotor bearing to examine the response in an effective way. He used various bearing stiffness values in order to find critical speed, stability limit and unbalanced response of a rotor bearing system. He explains how we can use bearing stiffness and control the vibration parameters. Number of stages of the multi disc system is specified in the design program by considering the factors specified for working condition and overall efficiency and size of the system. As the steps in the system increases, there will be increase in the efficiency because the heat loss of each step is optimized in the next step, but still the weight, cost and size of the system increases.

## II. METHODS AND MATERIAL

Design of a multi-disc system is a difficult task although the working principal is same as that of single stage systems. The analysis is carried out for multi-disc system, in this study we can carry out the model analysis and unbalanced response. There are no systems which are vibrations free, this is due to the external and internal forces, the primary aim is to bring the vibration levels within the acceptable limits. The standard procedure followed in the designing of these rotor system is to perform the finite element analysis

on various rotor configuration for the fabrication. For this work the commercially available finite element package, ANSYS Workbench is used.

### 2.1 Finite Element Method

A finite element method can be done using computers to predict the effects of a wider range of physical structures. FEM software is a very standard tool used by engineers and physicists because it can accurately flexibly and practically apply the laws of physics to real world scenarios. FEM is a scientific technique used to imprecise answers to differential equations, which can now be answered by the computer multiple times. Differential equations are important and exists for many technical problems since they characterized the linguistic in which the laws of physical are conveyed. They combine alterations in internal variables such as displacement, temperature and pressure with the geometry, physical properties of things, and external influences that act on them.

### 2.2 Catia V5 Software

Catia is a computer assisted drawing software developed by French company Dassault Systems. Catia is an aggressive application that helps you to create difficult design. The purpose of Catia process shoes how to calculate a part or assembly in Catia and how to create a simple drawing of that part or assembly. Using Catia software, 3D parts from 2D sketching are possible, sheet metal parts, composite materials can be designed with minimal errors.

### 2.3 ANSYS Workbench Software

ANSYS Workbench is a well-known analysis software. This consist of pre-processing and post-processing steps. It takes CAD model to carry out the finite element analysis steps for structural, thermal and electromagnetic problems. Ansys workbench consist of several steps to be followed like importing a geometry, meshing the geometry, applying the boundary conditions and extracting the results and reviewing the analysis in the software.

Initially the model from the Catia software should be saved in stp file format, then the stp file should be imported in the Ansys workbench software. The imported model is meshed first by providing the material properties and then various constraints and application of different types of loads by providing all these in Ansys software we are going to extract the results.

## III. Multi-Disc System Model

A multi-disc rotor bearing system is shown in the Fig. 2 and same system with three disc is taken for the purpose of analysis. The rotor bearing system supported with viscoelastic support is made of axial turbine, bearing and shaft. The material properties are taken from the reference [6], the material properties are shown in Table 1.

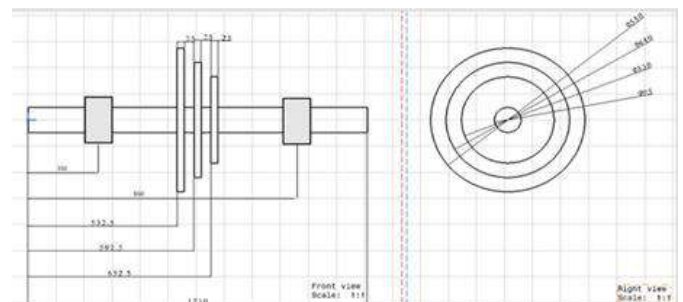


Fig. 1. 2-Dimensional view of Multi-Disc System.

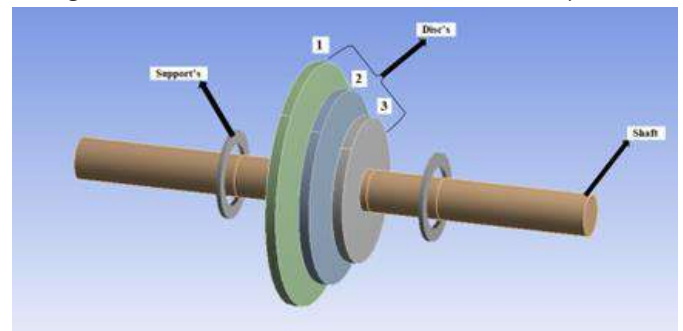


Fig. 2. Components of Multi-Disc System with Viscoelastic Support.

Table 1. Material Properties of Multi-Disc System.

Component	Material	Young's Modulus (GPa)	Poisson's Ratio	Density (Kg/m <sup>3</sup> )
Disc's	CM-247	209	0.3	8500
Shaft	C-15	235	0.24	7850

Each component is being modelled by Catia V5 software and all the components are being assembled for further analysis. The Ansys workbench software is used to do the analysis after assembling the model is imported in the Ansys workbench. In the analysis we have considered two cases, Case 1 is the assembly with only bearing support and the other one is Case 2 is the assembly with bearing support along with the viscoelastic support, for these two cases the analysis is done. After proper meshing and proper application of the boundary condition's the results are extracted along with the frequency response curve.

#### IV. ROTOR DYNAMIC ANALYSIS

Rotor dynamic is a sub division of applied mechanics, which helps to study the behavior changes of rotating system. Rotor dynamic study is done for analyzing the turbines, jet engines, auto engines and so on. Rotor dynamic analysis is concentrated on rotational velocity and the supports to the system. There will be vibrations in the system due to the unbalance present in the rotor, when these vibrations exceed the limit, the component fails. Depending on the types of bearing and support used the magnitude of these vibrations varies. The maximum vibration takes place when the system's natural frequency will be equal to frequency of rotation and that speed value is called as critical speed. The first critical speed is the lowest speed on which the resonance occurs. Likewise, within the operating speed a single system can have many critical speeds. To avoid working near critical speeds of the system it is important to analyze the unbalanced forces which produces high vibrations. Neglecting these aspects might results in loss or wear of machine component and even the loss of equipment and also the catastrophic failure of the component can occur.

The equation of motion in its generalized matrix form is written as:

$$[\mathbf{M}]\ddot{\mathbf{u}} + \mathbf{\Omega}[(\mathbf{C} + \mathbf{G})]\dot{\mathbf{u}} + [\mathbf{K}]\mathbf{u} = \mathbf{f}(\mathbf{t}) \quad (1)$$

Where:

- $[\mathbf{M}]$  is the Mass matrix.
- $[\mathbf{C}]$  is the Damping coefficient in matrix form.
- $[\mathbf{G}]$  is the Gyroscopic matrix.
- $[\mathbf{K}]$  is the Stiffness matrix.
- $\mathbf{U}$  is the Generalized coordinates of the rotor.
- $\mathbf{f}(\mathbf{t})$  is the unbalanced forces.
- $\mathbf{\Omega}$  is the spin speed.

The above equation (1)'s generalized solution involves complex eigen vectors which are spin speed dependent. To understand these solutions, one depends on the Campbell diagram, the Campbell diagram is the diagram which gives all the necessary information's like critical speed, whirl direction and stability values.

Fourier Transformation is used to write the solution vector  $\mathbf{u}$  to solve the equation (1).

$$\begin{aligned} \mathbf{u} &= \mathbf{U}e^{j\omega t} \\ \dot{\mathbf{u}} &= j\omega\mathbf{U}e^{j\omega t} \\ \ddot{\mathbf{u}} &= -\omega^2\mathbf{U}e^{j\omega t} \end{aligned}$$

Substituting the above in equation (1) and reducing it to standard form we get,

$$[\omega^2[\mathbf{I}] - \mathbf{A}]\mathbf{U} = \mathbf{0} \quad (2)$$

Where  $\mathbf{A} = [\mathbf{M} - j\mathbf{G}]^{-1}[\mathbf{K}]$ . The critical speed is calculated using the above equation (2).

The critical speed is defined either backward or forward whirl subjected to the rotation mode generated with respect to the axis of rotation. The critical speed map is then extracted using this data in the form of Campbell diagram.

#### V. FE Analysis of Multi-Disc System

We have used equivalent mass representation for all the disc's, each of these components is designed

modelled by means of Catia software and all the component are assembled for the further study as shown in the Fig 3. The assembled model is then imported in Ansys workbench. After proper meshing as shown in Fig 4 and application of boundary condition results are extracted for both the cases as mentioned above. The extracted results contain critical speed values and its frequencies with their whirl direction.

For the model there were totally 4544 elements and 24580 nodes were created with an edge length of 17.50 mm

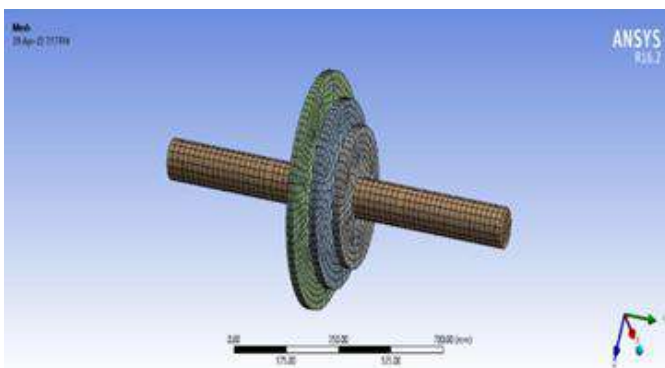


Fig. 3. Multi-Disc Model in Catia Software.

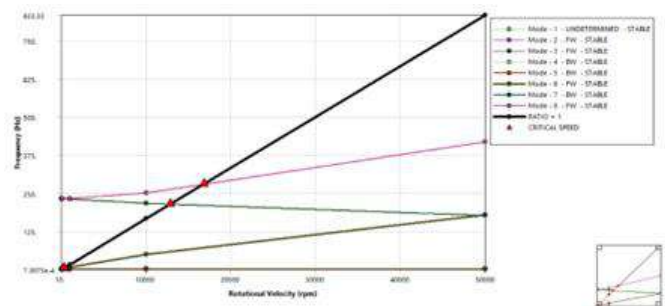


Fig. 4. Meshed Model in Ansys Workbench

After meshing the model, the model is analyzed by applying all the operational boundary condition, along with suitable bearing stiffness values. For rotor dynamic analysis the Coriolis effect is turned on so that the campbell diagram can be extracted. After that the frequency response are extracted for both the cases as mentioned above.

5.1. Case 1: Multi-Disc System Supported with only Bearing

The modal analysis for the multi-disc system supported with only bearing is carried out with the bearing

stiffness of 50 N/mm. The application of constraints is shown as in the Fig. 5(a) and the output containing Campbell diagram is shown as in the Fig. 5(b) which includes critical speeds, whirl direction and mode stability as shown in Table 2.

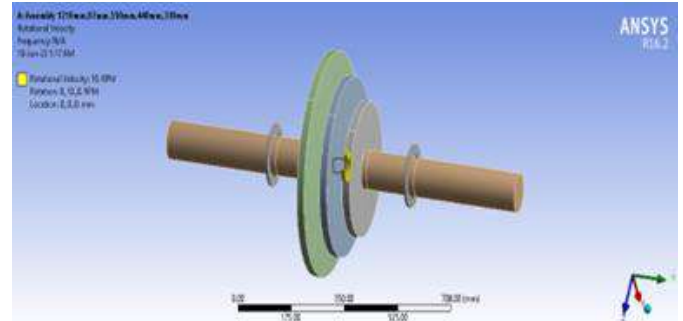


Fig. 5(a). Constrained Model.

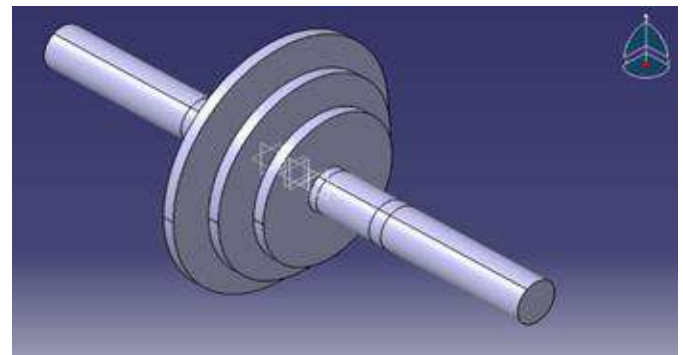


Fig 5(b). Campbell Diagram for Multi-Disc System with only Bearing Support.

Table 2. Critical speed and Stability

Mode	Whirl Direction	Mode Stability	Critical Speed
1	UNDETERMINED	STABLE	NONE
2	FW	STABLE	NONE
3	FW	STABLE	234.58 rpm
4	BW	STABLE	240.17 rpm
5	BW	STABLE	234.86 rpm
6	FW	STABLE	319.02 rpm
7	BW	STABLE	12860 rpm
8	FW	STABLE	16845 rpm

The harmonic analysis is also carried out on this case to extract the frequency response of the system for the unbalanced mass of 0.01 Kg with rotating radius of 2

mm i.e., Unbalanced force of  $2 \times 10^{-2}$  Kg-mm, these unbalanced forces are given on all the three discs as shown in the Fig 6. After applying the unbalanced mass at a radius, the analysis is done and the frequency response of each disc is extracted as shown in the Fig. 7, Fig. 8, Fig. 9.

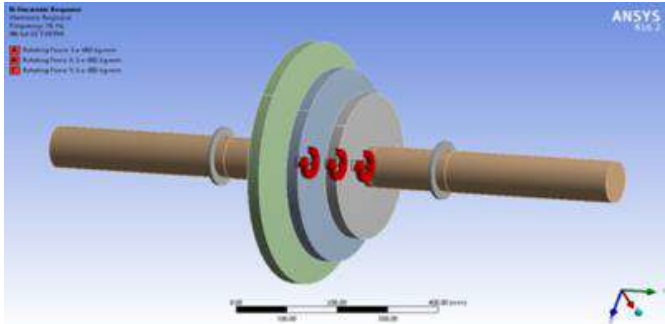


Fig. 6. System with Unbalanced Force with only Bearing Support.

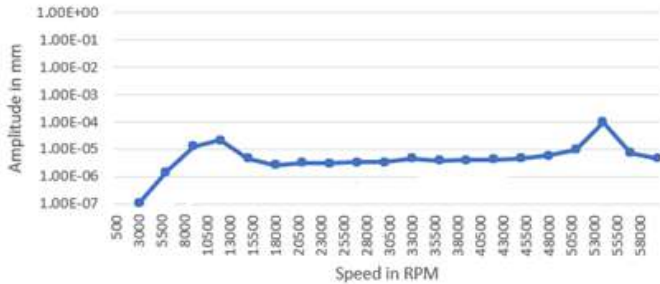


Fig. 7. Frequency Response of Disc 1 for only Bearing Support.

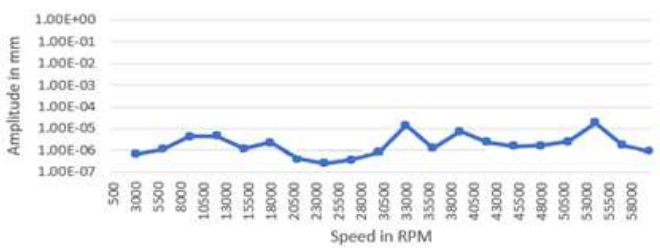


Fig. 8. Frequency Response of Disc 2 for only Bearing Support.

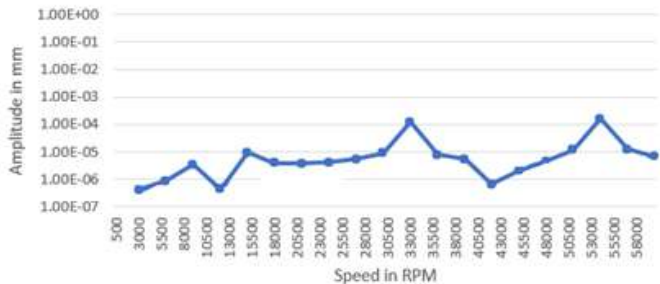


Fig. 9. Frequency Response of Disc 3 for only Bearing Support

### 5.1 Case 2: Multi-Disc System Support with Bearing along with Viscoelastic Support

The modal analysis for the multi-disc system supported with bearing along with the viscoelastic support is carried out with the equivalent stiffness of 49.2362 N/mm. The application of constraints is shown as in the Fig. 14(a) and the output containing Campbell diagram is shown as in the Fig. 14(b) which includes critical speeds, whirl direction and mode stability as shown in the Table 4.

The calculation of equivalent stiffness by considering the bearing stiffness is as shown below

- $Pressure = \frac{Force}{Area}$  in  $N/mm^2$  (3)

Force = 50N

Area = Length of Arc  $\times$  Width

$$Area = 2 \times \pi \times radius \times \left(\frac{\theta}{360}\right) \times Width$$

$$Area = 2 \times \pi \times 85 \times \left(\frac{70}{360}\right) \times 30$$

$$Area = 3115.4127 \text{ mm}^2$$

$$Pressure = \frac{50}{3115.4127}$$

$$Pressure = 0.01604 \text{ N/mm}^2.$$

- Bearing Stiffness,  $K_b = 50 \text{ N/mm}$ .
- Viscoelastic Support Stiffness,  $K_s = \frac{Pressure}{Deflection}$  (4)

The deflection of the viscoelastic support is found by analyzing the viscoelastic support in the Ansys workbench software.

#### 5.2.1 Viscoelastic Support Analysis

The viscoelastic Support is given around the bearing. The model of viscoelastic support is done using Catia software and analyzed in Ansys workbench. The inner diameter of the viscoelastic support will be the external diameter of bearing which is 170 mm and also the outer diameter of the viscoelastic support is taken from design data handbook which is 310 mm. The 2D representation of the quarter part of viscoelastic support is as shown in the Fig 10. And the Catia model is as shown in the Fig 11 and the material properties given for the viscoelastic support is as shown in the Table 3 (a) and (b).



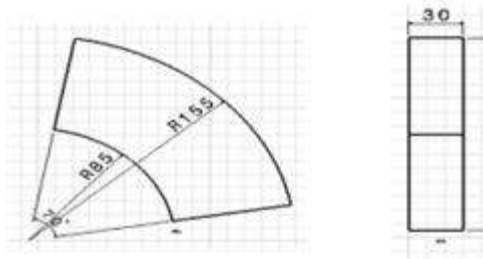


Fig. 10. 2-Dimensional View of Quarter Part of Viscoelastic Support

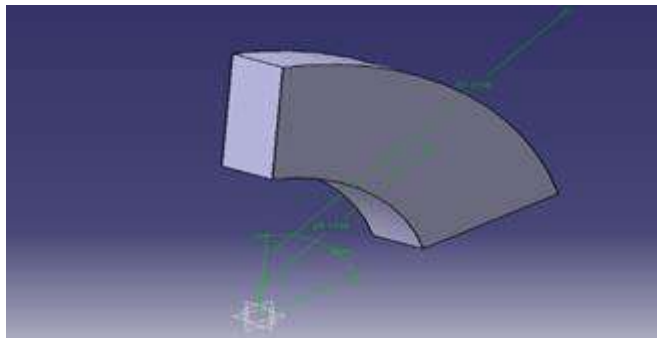


Fig. 11. Viscoelastic Support Model in Catia Software.

Table 3(a). Material Properties for Viscoelastic Support.

Component	Young's Modulus (GPa)	Poisson's Ratio	Density (Kg/m <sup>3</sup> )
Viscoelastic Support	200	0.3	2300

Table 3(b). Prony Shear Relaxation Table for Viscoelastic Support.

Index	Relative Moduli	Relaxation Time in s
1	0.5	1
2	0.2	10
3	0.2	100

The fixed support is applied on the outer surface of the viscoelastic support and a pressure of 0.001604 N/mm<sup>2</sup>

is applied in the internal surface of viscoelastic support the same has been shown as in the Fig. 12. After applying the boundary condition. The total deformation is extracted which is needed to calculate the viscoelastic support stiffness.

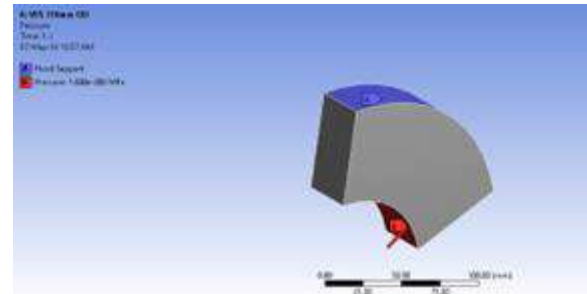


Fig. 12. Constrained Viscoelastic Support Model

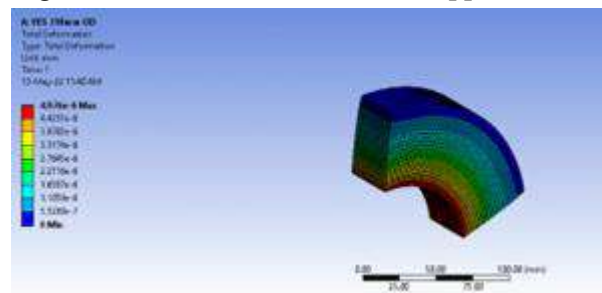


Fig. 13. Total Deformation of Viscoelastic Support.

The total deformation obtained for the viscoelastic support is obtained as  $4.976 \times 10^{-6}$ . The further calculation of the stiffness of viscoelastic support and for the calculation of equivalent stiffness we are considering the bearing stiffness along with the viscoelastic support stiffness and with having the equation (4) we can write the viscoelastic support stiffness as shown below.

- From equation (4), Viscoelastic Support Stiffness,  $K_s = \frac{\text{Pressure}}{\text{Deflection}}$
- $K_s = \frac{0.01604}{4.976 \times 10^{-6}} \Rightarrow K_s = 3223.4726 \text{ N/mm.}$
- Equivalent stiffness,  $K_e = \frac{K_b \times K_s}{K_b + K_s} \quad (5)$

$$K_e = \frac{50 \times 3223.4726}{50 + 3223.4726} \Rightarrow K_e = 49.2362 \text{ N/mm.}$$

The multi-disc system support with bearing along with the viscoelastic support subjected to constraints is as shown in in the Fig 14 (a) and the output containing

the Campbell diagram shown as in the Fig. 14(b) and the whirl direction, critical speeds, mode stability is shown in the Table 4.

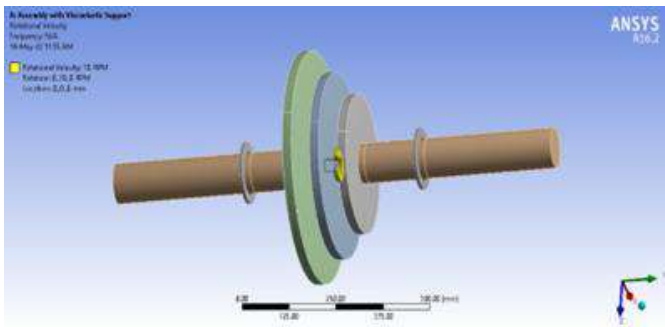


Fig. 14(a). Constrained Model.

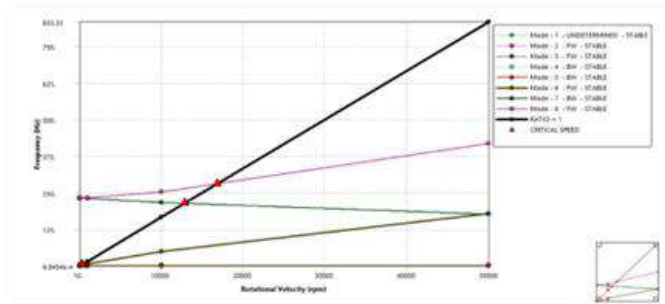


Fig. 14(b). Campbell Diagram for Multi-Disc System with Bearing and Viscoelastic Support.

Table 4. Critical speed and Stability.

Mode	Whirl Direction	Mode Stability	Critical Speed
1	UNDETERMINED	STABLE	NONE
2	FW	STABLE	NONE
3	FW	STABLE	232.82 rpm
4	BW	STABLE	238.40 rpm
5	BW	STABLE	233.41 rpm
6	FW	STABLE	317.14 rpm
7	BW	STABLE	12860 rpm
8	FW	STABLE	16840 rpm

The harmonic analysis is also carried out on this case to extract the frequency response of the system for the unbalanced mass of 0.01 Kg with a rotating radius of 2mm i.e., Unbalanced force of  $2 \times 10^{-2}$  Kg-mm, After applying the unbalanced mass at a radius on all discs, the analysis is done and the frequency response of each disc is extracted as shown in the Fig 16, Fig 17, Fig 18. Fig. 15. System with Unbalanced Forces with Bearing and Viscoelastic Support.

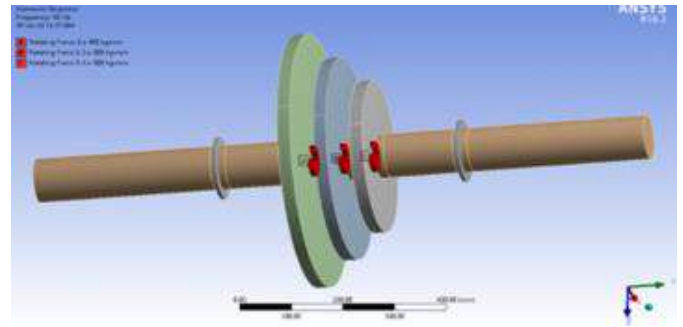


Fig. 16. Frequency Response of Disc 1 for Bearing Support along with Viscoelastic Support.

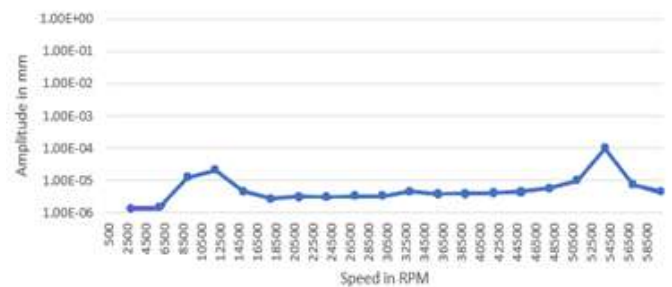


Fig. 17. Frequency Response of Disc 2 for Bearing Support along with Viscoelastic Support.

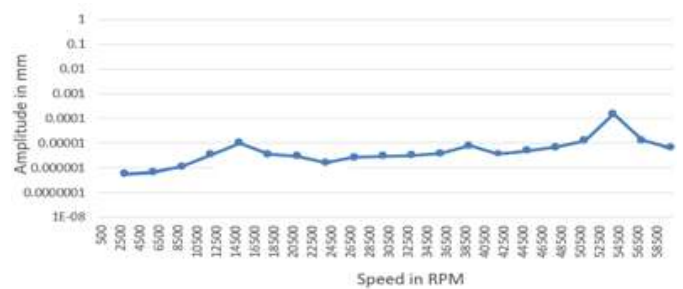


Fig. 18. Frequency Response of Disc 3 for Bearing Support along with Viscoelastic Support.

## VI. RESULTS AND DISCUSSION

The analysis carried out for two cases one is the multi-disc system supported with only bearing another one is the multi-disc system with bearing support along

with viscoelastic support. The analysis carried out so far are done to see the changes in the critical speeds, mode stability and frequency response so that the suitable support stiffness can be proposed. Based on the response obtained, system with viscoelastic support configuration was proposed to be analyzed for an equivalent stiffness value of 49.2362 N/mm. From this we have obtained all the modes as stable along with their critical speeds and also the frequency response of each disc is obtained and compared between the two cases.

Table 5. Comparison of Critical Speed for Stiffness 50 N/mm and 49.2362 N/mm.

Mode	Mode Stability	Critical Speed for Stiffness 50 N/mm	Critical Speed for Stiffness 49.2362 N/mm
1	STABLE	NONE	NONE
2	STABLE	NONE	NONE
3	STABLE	234.58 rpm	232.82 rpm
4	STABLE	240.17 rpm	238.40 rpm
5	STABLE	234.86 rpm	233.41 rpm
6	STABLE	319.02 rpm	317.14 rpm
7	STABLE	12860 rpm	12860 rpm
8	STABLE	16845 rpm	16840 rpm

The summary of the above comparison Table 5 is, first we analyzed the system with only bearing support with a stiffness of 50 N/mm after that we analyzed the system with bearing along with the viscoelastic support with an equivalent stiffness of 49.2362 N/mm. On comparing the above two analysis the critical speed of the system reduced slightly by providing a viscoelastic support compared to the system with only bearing support.

The harmonic analysis is also done to know the frequency response for the two cases, the frequency response comparison of each disc is as shown in the Fig 19, Fig 20, Fig 21 and discussed the same.

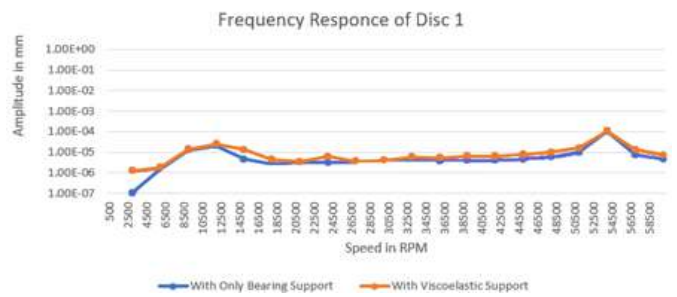


Fig. 19. Comparison of Frequency Response of Disc 1.

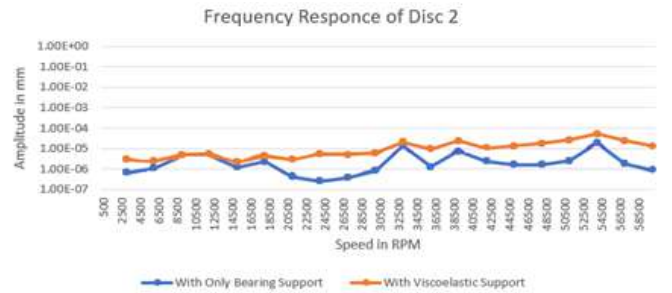


Fig. 20. Comparison of Frequency Response of Disc 2.

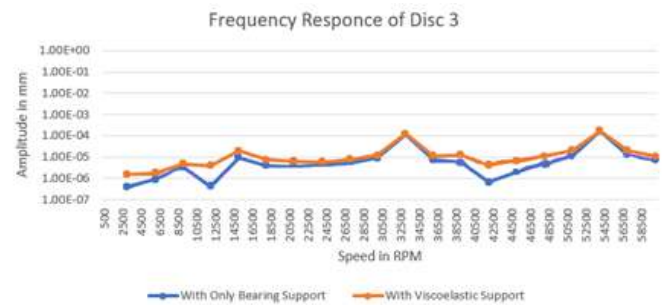


Fig. 21. Comparison of Frequency Response of Disc 3.

The summary of the above three comparison graphs is, the three graphs says that the amplitude variation in the system with only bearing support is quite greater than the amplitude variation in the system with bearing along with the viscoelastic support, so from the above three comparison graphs we can say that frequency response of the multi-disc system model with bearing along with the viscoelastic support is greater than the frequency response of the system with only bearing support. Therefore, the multi-disc system with viscoelastic support is proposed to be analyzed.

## VII. CONCLUSION

In this paper, the multi-disc system is used to study the model and harmonic analysis of the system in two conditions one is multi-disc system with only bearing support and the other one is multi-disc system with

bearing along with viscoelastic support for these two conditions the analysis was done. Based on the above analysis results, following conclusions are drawn.

- The analysis of critical speed helped us to study the parameters responsible for changing the rotor dynamic performance of the system.
- Through Ansys workbench software FE analysis can be employed for the effective analysis of critical speed and frequency response of the rotor dynamic system.
- The stability of the multi-disc system mainly relies upon the stiffness of the bearing used and also on the stiffness of the viscoelastic support used.
- Harmonic analysis shows that any vibrations in the system will lead to the failure of the component or the entire system. The source of this vibration will be due to the unbalanced mass present on the rotor system. These vibrations are reduced by adding or by reducing masses at specific location.
- The additional viscoelastic support configuration to the multi-disc system with bearings helps in reducing the overall unbalanced response and provides a better frequency response.

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# Performance Analysis of Ejector Expansion Refrigeration System on The Basis of Area Ratio

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## ABSTRACT

Vapour compression refrigeration system is the conventional way existing for the refrigeration these days. Although to overcome the loses in conventional method there are several ways to improve the performance of vapour compression refrigeration cycle. This paper provides an alternative method of increasing the performance by varying the area ratio of the ejector. As Ejector is the most simple and economical replacement of throttling valve. A Simulation model is developed and parametric study of ejector is done. It was found that there will be increase in performance as area ratio is changed. This cycle is named as Ejector expansion Refrigeration System.

**Keywords :** VCR Cycle, Refrigeration System, Coefficient of Performance

## I. INTRODUCTION

These days world is experiencing electricity crises on a high note. The Demand for electricity in world has been growing at an average rate of around 8% annually over the last years. The electricity consumption in the field of refrigeration is about 23% of the total energy consumption. In order to reduce this demand a high energy efficiency systems should be adopted. The most common and widely used system in refrigeration industry is vapour compression refrigeration system. There are several ways of enhancing the performance of a vapour compression refrigeration system. One of the way is using ejector as expansion device. In conventional VCR Cycle, the expansion is done by a throttle valve or by capillary tube.

Throttling is one of the thermodynamic losses processes in VCR cycles but it is most loss prone irreversible proves in a conventional vapour compression refrigeration cycle. In order to reduce this loss, various devices and technique have been attempted to use instead of the conventional devices. Ejector is a device that uses a high pressure fluid to pump a low pressure fluid to a higher pressure at a diffuse outlet. Its low cost, no moving parts and ability to handle two phase flow without damage make it attractive for being the expansion device in the refrigeration system.

## II. LITERATURE REVIEW

Nehdi E et al. gives the use of an ejector as an expansion device by replacing the throttling valve in the vapour compression refrigeration cycle and by varying the geometrical parameters there is a increase of COP by 22%.

Sandeep Kashyap et al found that the use of ejector in vapour compression system for the improvement of COP has great influence as the COP of ejector refrigeration cycle depends on ejector geometry, operation condition and property of working fluid. Comparative analysis were made on ejector refrigeration cycles with working fluid R410a and R134a in same ejector geometry and same operating condition using one dimension modal. On based of study COP of ejector refrigeration cycle depends on ejector geometry, operation condition and property of working fluid. COP of system increased as boiler temperature increased while Cop is decreased when Compression ratio and condenser temperature increased. For different ejector ratio the performance of system are different but ejector ratio  $\phi = 7.84$  at 353K have higher COP comparative other ejector ratio. All area ratio and operating temperature the performance R134a is better than R410a.

Reddick , Christopher et al aim of the work is to experimentally study the possibility of improving the energy efficiency of a vapour compression refrigeration system where a two-phase ejector replaces the expansion valve. A test bench using refrigerant R134a was designed and built which functions in both the conventional mode and in ejector mode. The primary nozzle of the ejector was equipped with a double throat, having an adjustable area for the first throat and a fixed area for the second throat. Experimental results showed an improvement of 11% in the coefficient of performance (COP) in ejector mode as compared with the conventional mode.

Giorgio Besagni et al gives an comprehensive literature review on ejector refrigeration systems and working fluids. It deeply analyzes ejector technology and behaviour, refrigerant properties and their influence over ejector performance and all of the ejector refrigeration technologies, with a focus on past, present and future trends.

Vu V. Nguyen et al presents an experimental study of the influence of a variable geometry ejector (VGE) design on the performance of a small-scale, 1.5 kW nominal capacity solar heat driven ejector air conditioning system under real-life working conditions. Under variable operating conditions (e.g. solar radiation, ambient temperature) fixed geometry ejector performs poorly, therefore the objective of the present work was to prove the benefit of the VGE concept. In the experimentally tested VGE the area ratio through a movable spindle (SP) and the nozzle exit position (NXP) can be adjusted in order to respond to the operating conditions. The results showed very stable operation of the cooling cycle during the experiments. Both NXP, SP had considerable influences on the cooling cycle performance.

Hafiz Ali Muhammad et al develops a single mathematical correlation that can predict the ejector performance with reasonable accuracy. The proposed correlation relates the entrainment ratio and the pressure rise across the ejector to the area ratio and the mass flow rate of the primary flow.

Hassan S. Jawad et al presents a paper where an ejector was designed and manufactured from brass metal as part of a cooling system operating with steam the type of the primary nozzle is converge diverge. The ejector was manufactured from a number of interconnected parts to give the final shape. The performance of the ejector was analyzed theoretically using the equations of continuity, momentum and energy, and through operating conditions change and the examination, it was found that the mixing ratio increases with the

increase of the primary pressure, the mixing ratio decreases with increasing suction pressure and the mixing ratio increases to a certain value and then decreases with increasing discharge pressure.

### III. MODELLING

The layout of the ejector expansion vapour compression refrigeration cycle is shown in fig 1 and the corresponding p-h diagram is shown in fig 2 . The primary flow from the condenser and the secondary flow from the evaporator are expanding through primary and secondary nozzles, respectively to mixing chamber pressure, mixing at constant pressure. The mixed flow is discharged through the diffuser of the ejector and then separated in forms of vapour and liquid so that this ratio matched with the inlet ratio of primary and secondary flows. Then the liquid circulates through the expansion valve and evaporator whereas the vapour circulates through the compressor and the condenser. This cycle is very efficient and widely accepted with various simulations and optimization been performed.

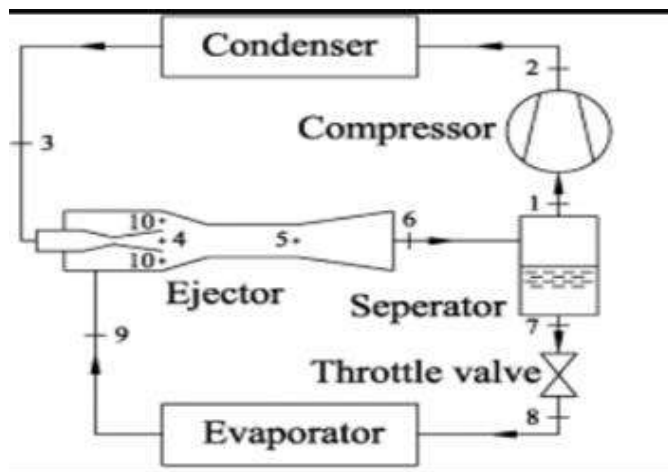


Figure 1 Schematic of the EERS

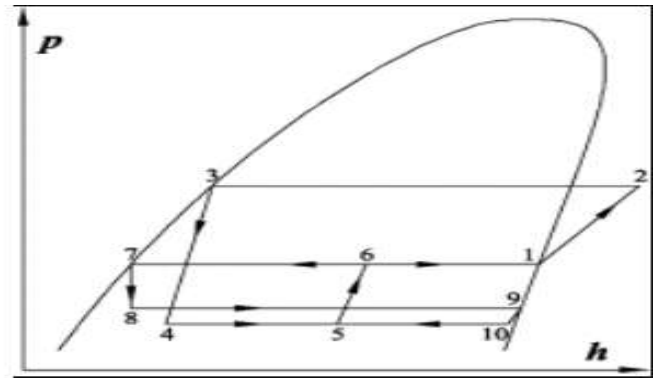


Figure 2 P-h Diagram

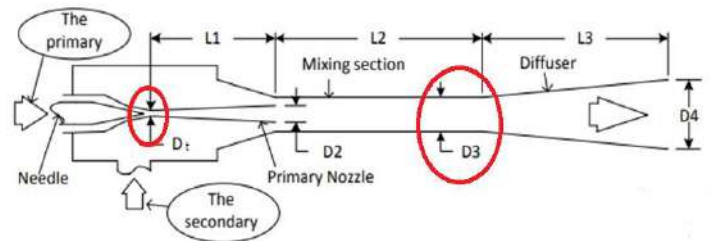


Figure 3 : Schematic of Ejector

#### Components of ejector and their functions

- 1) **Motive Nozzle or Primary Nozzle** : A Nozzle in which high pressure side refrigerant flowing from the condenser is converted into a kinetic energy so that refrigerant is expanded iso entropically.
- 2) **Secondary Nozzle** : A high speed motive stream from the motive nozzle entrains/sucked low pressure stream from the evaporator up to expanded pressure.
- 3) **Mixing Chamber** : Both Primary and secondary streams exchange momentum, kinetic and internal energies in the mixing chamber and become one stream with almost uniform pressure and speed.
- 4) **Diffuser**: The stream converts its kinetic energy in to internal energy in the diffuser to reach a pressure higher than the suction stream inlet pressure.

Parameters used in modified EERS CYCLE which significantly influence the system performance:-

- a) **Entrainment Ratio ( $\omega$ )** : It is the ratio of secondary mass flow rate of refrigeration coming out from the evaporator( Vapour) to the primary mass flow rate of refrigerant coming out from the condenser(liquid).



## V. CONCLUSION

This paper provides an performance evaluation on the basis of geometrical parameter of ejector i.e, area ratio. Proposed modification in EERS is better than conventional system as it will increase the refrigerant effect and decreases the work input. Mixing chamber is a innovative way to enhance the performance. This model will definitely help in increasing COP of Ejector Expansion Refrigeration system.

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$$(\omega) = \frac{ms}{mp}$$

**b) Pressure Lift Ratio( $\Psi$ ):** It is the ratio of diffuser exit pressure ( $P_6$ ) to secondary inlet pressure ( $P_9$ ).

$$\Psi = P_6/P_9$$

**c) Area Ratio ( $\Phi$ ):** It is ration of mixing chamber area ( $A_3$ ) to throat area ( $A_t$ ).

$$\text{Area Ratio } (\Phi) = A_3/A_t$$

**d)Secondary Nozzle Pressure Drop( $\mathcal{E}$ ) :** It is the amount of vapour refrigerant pressure drop that takes place in secondary nozzle coming out from the outlet of the heat exchanger.

$$\mathcal{E} = P_9 - P_{10 \text{ ejector}}$$

## IV. RESULTS AND DISCUSSION

Ejector is analysed and keeping the throat diameter( $A_3$ ) constant and varying the mixing section diameter( $A_t$ ), we get different entrainment ratio. Based on that readings plot is made. Simulation model is used to get the optimal design of the ejector. Entrainment ratio directly influence the performance of refrigeration as mixing is getting better by increasing the mixing area. Modified EER cycle gives better performance as compared to conventional VCR Cycle. Entrainment ratio is directly proportional to coefficient of performance.

### PLOT OF ENTRAINMENT RATIO V/s AREA RATIO

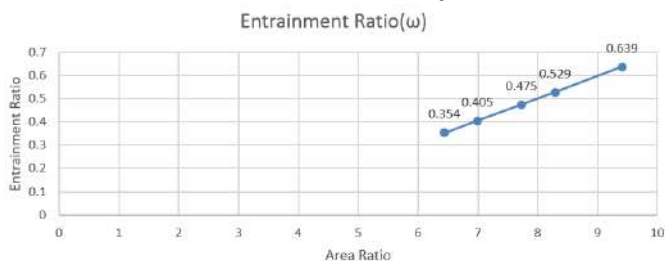


Figure 4 Entrainment Ratio v/s Area Ratio

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# A Survey on Road Accident Prediction Techniques Based on Various Methodologies

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## ABSTRACT

Since traffic accidents are a leading source of injury and death globally, there has been a lot of focus on developing more accurate methods of analysis and prediction in order to pinpoint the causes of these tragedies. Predicting traffic accidents is an effort to meet the problem of creating a safer transportation environment in order to save lives. The purpose of this study is to survey the current landscape of research into the use of convolutional neural networks, long short-term memory networks, and other deep learning architectures for the prediction of traffic accidents. In addition, the most popular data sources for predicting traffic accidents are compiled here and analyzed. Additionally, a categorization is recommended based on factors including its source and features, such as open data, measuring methods, onboard equipment, and social media data. In this section, we list and evaluate the many algorithms used to forecast traffic accidents, taking into account the data types for which each is most suitable, the accuracy of the findings, and the clarity with which they can be interpreted and studied. In order to further analyze the findings, the authors found that the best results were achieved by combining two or more analytic approaches. Many authors agree that using geospatial data, information from traffic volume, traffic statistics, video, sound, text, and sentiment from social media may improve the precision and accuracy of the analysis and predictions; this is one of the next challenges in road traffic forecasting.

Keywords - Traffic accident prediction, Road accident forecasting, Data analysis, Traffic engineering, Machine learning

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## I. INTRODUCTION

### A. Overview

Many countries have paid little attention to reducing the severity of road traffic accidents (RTAs), despite the fact that they kill thousands of people and destroy millions of dollars' worth of property every day. The fact remains, however, that it is a leading global killer and destroyer of property. The severity of the impact on human life and property may be mitigated by finding and fixing the root causes of road traffic

accidents. Road Adverse events of severe magnitude are not random occurrences, but rather follow predictable patterns that allow for their mitigation. Ergo, mishaps are "observable, measurable, and preventable occurrences" [20]. "Fatalities are not fated; accidents are not random; disease is not arbitrary; it is caused" [33] is how the workers' health association defines accidents. Every day, people were injured or killed in traffic accidents in Addis Ababa, Ethiopia's capital. In a matter of seconds, human lives may be lost

and property can be destroyed. It's a major killer in this nation, and it's one of the scariest things about it.

The severity of road traffic accidents has been a focus of study over the last two decades. Road accident severity categorization based models have been the subject of several intriguing research methodologies. The authors analyzed data in a conventional statistical manner to construct their models. These methods are useful for learning about and figuring out what contributes to road accidents. Due to the availability of large datasets, machine learning has surpassed traditional statistical methods for model prediction in recent years [41]. The causes of severe road traffic accidents have been the subject of several academic works [7, 9, 36, 37, 40, 43, 45] from a variety of nations. Studies aiming to forecast the severity of traffic accidents are still in their early stages of development. A mixed machine learning strategy was used to enhance classification accuracy in the prior work. This gap in the market is something we want to solve by developing a hybrid machine learning technique for road accident categorization, which will increase the efficiency and precision of our forecasts. The prior research focuses primarily on the efficiency of a Machine Learning-based categorization strategy. In contrast, there is a lack of research comparing deep learning algorithms with state-of-the-art Hybrid Machine Learning methods. Accurate predictions may often be improved by using the most appropriate method. Therefore, the most important causes of road accidents may be isolated with the aid of the best paradigm. Additionally, prior identification and concern for target-specific contributing elements was lacking. In order to forecast the severity of traffic accidents, the researchers utilized a combination of clustering and classification techniques. In this paper, we present a novel hybrid approach based on K-means clustering and random forest for predicting the severity of traffic accidents at a given location. The effectiveness of the created model was evaluated by comparing the suggested method to that of separate classifiers. Measures of accuracy, precision, specificity, and recall are employed to contrast the novel method with traditional approaches. There are a few stages to the new method: There are five main steps: (I) cleaning the data by removing unwanted noise and filling in

missing data using the mean for numerical variables and the mode for the categorical variable, (II) dividing the data into a training and test dataset, (III) developing a novel feature through clustering, (IV) training classifiers, and (V) finally assessing the effectiveness of each classifier. The suggested method was further evaluated in comparison to state-of-the-art classification methods by using a deep neural network. The results of the study demonstrated that the suggested method outperformed the competition in terms of classification accuracy and overall performance.

- Accuracy: represent the rate of instances correctly classified over the total number of instances. The ideal value for accuracy is 1.00 (100% classification accuracy).
- Precision or confidence: defined as the proportion of predicted positive cases that are correctly predicted or labeled as real positives.
- Recall: calculated as the proportion of real positive cases that are accurately predicted positive.
- F-measure: weighted average of the precision and recall.
- Mean absolute error: also known as average prediction error, is the average of the difference between predicted and actual value in all the test cases. A low mean absolute error (MAE) indicates good predictive accuracy.
- Mean squared error: determined as the average of the squared differences between each computed value and its corresponding correct value.
- Root mean squared error (RMSE): RMSE is calculated as the square root of the MSE and is used as a measure of differences between valued predicted and the real values. A lower value of RMSE is an indicative of a higher prediction precision.

Traditional statistical model-based strategies were employed to forecast accident fatalities and severity in the field of road safety. Several standard statistical studies have been employed, including the mixed logit modeling technique [23, 26], the ordered Probit model [54], and the logit model [11]. The standard statistical approach was shown by some research to be more effective than other studies in distinguishing between independent and dependent accident variables [31].

However, traditional statistical methods cannot handle multidimensional data sets [16]. Many recent research have used the ML technique as a means of overcoming the shortcomings of conventional statistical models on account of its superiority in terms of prediction, efficiency, and depth of information. In the last ten years, ML has been used in a variety of fields, including building and construction [48], workplace accidents [41], farming [22], education [53] and sentiment analysis [50] and finance and insurance [46].

To construct an accident severity model, K-means, Support Vector Machines, K-Nearest Neighbors (KNN), Decision Tree (DT), Artificial Neural Network (ANN), Convolution Neural Network (CNN), and Logistic Regression (LR) are among the most effective clustering and classification techniques. Based on data gathered in California between 2004 and 2010, Kwon et al. [28] used Nave Bayes (NB) and Decision Tree (DT). Using binary regression, the authors found that although both the Nave Bayes and the Decision Tree models performed well, the former was more attuned to the presence of risk variables.

Using support vector machines and multilayer perceptrons, Sharma et al. [44] evaluated data on traffic accidents. The authors also relied heavily on only two independent variables (alcohol and speed) in their analysis. In the end, the SVM with the RBF kernel outperformed the MLP (64%) with a higher level of accuracy (94%). According to the results, driving too fast while under the influence of alcohol is the leading cause of collisions.

In order to assess classifiers and determine the most important causes of motorcycle accidents, Wahab and Jiang [51] used MLP, PART, and SimpleCART on the crash events in Ghana dataset. The authors employed Weka tools for data comparison and analysis, and they used InfoGainAttributeEval to identify the most significant factor in motorbike accidents in Ghana. In this regard, the simpleCART model outperformed competing classification methods.

**II. DATA SOURCES**

Road accident analysis and prediction data sources including government data, open data, measurement technologies, vehicle onboard equipment and social media.

Government data	Data sets that are generated, collected, preserved, stored and made available to the public by government entities or those that are delegated to exercise functions of control, execution or reporting of information concerning road accidents
Open data	Open data catalogs are maintained by government agencies and are available to all public without restriction. The data must comply all legislation regarding privacy and confidentiality
Onboard equipment	Onboard equipment refers to all devices installed on a vehicle that can store or transmit data concerning the vehicle variables and driver conditions
Measurement technologies	Measurement technologies include all kind of equipment that is part of the road infrastructure, such as radar, cameras, or equipment embedded on the road itself, i.e., loop detectors
Social media	Social media can be considered the newest developed data source in traffic and road accident related studies, and currently the most used data source comes from Waze, Inrix, Google Maps and Twitter streams

**III. MEASUREMENT TECHNOLOGIES**

Instruments like radar, cameras, and even hardware permanently installed in the road (like loop detectors) are all considered measurement technologies.

Many investigations have made advantage of readily accessible technologies like the loop detector, video surveillance, microwave, and laser radar. Road junction data have also been collected using Bluetooth detectors and adaptive signal control databases. Since the variables in a loop detector record are limited to

vehicle type, vehicle speed, record time, and loop-specific information like localization and status, this data is not high-dimensional. When compared to other types of road infrastructure like cameras and radars, loop detector arrays are very cheap and may be installed along a major highway or expressway. However, loop detectors are not very trustworthy because to their susceptibility to failure in extreme temperatures, vibrations, and pavement fluctuations.

**IV. ONBOARD EQUIPMENT**

Any device put in a vehicle for the purpose of storing or transmitting information on vehicle variables and driving circumstances is considered onboard equipment. GPS units, cameras aimed at documenting road conditions or the driver's state of consciousness (Zheng et al., 2014), accelerometers, vehicle condition recorders that log data like speed, abrupt braking, lane changes, and impact or collision direction and acceleration may all be present. Using the PreScan platform to simulate traffic accidents is a novel strategy described by Xiong et al. (2017), who used a sophisticated system known as the chain road traffic incident.

**V. ROAD ACCIDENT ANALYTIC METHODS**

By using analytic methods, researchers seek to characterize the information and variables of the road accident, in order to discover hidden patterns, profile behaviors, generate rules and inferences. These patterns are useful to profile drivers or drivers' behavior on the road, to delimitate unsafe areas for driving, to generate classification rules related to road accident data, to perform selection of variables to be fetched in real-time model of accidents and to select relevant variables to be used to train other methods, such as artificial neural networks and deep learning algorithms.

On the aspect of the algorithms and computational methods reported by the authors employed to analyze road accident data, as summarized in Table 2, the most used are: i) clustering algorithms (Cao et al., 2015; Kumar and Toshniwal, 2015a; Moriya et al., 2018); ii) decision trees and classifiers (Castro and Kim, 2016; Gutierrez-Osorio and Pedraza, 2019; Scott-Parker and Oviedo-Trespalacios, 2017; Taamneh et al., 2017); iii) association rules (Ait-Mlouk et al., 2017; Ait-Mlouk and Agouti, 2019; Kumar and Toshniwal, 2015b) and

iv) natural language processing algorithms (D'Andrea et al., 2015; Gu et al., 2016; Salas et al., 2018).

Representative studies and methods on road accident data analysis.

Author	Research problem-computational method	Data source	Result
Cao et al. (2015)	Correlate abrupt braking events in real time-batch clustering, fuzzy C-means and real time clustering	Data from driving events for seven vehicles by the DAP platform from Ford Motor Company	Correlations that indicate potentially dangerous places for driving, according to the time of day
Kaplan and Prato (2013)	Determine the variables that influence the severity of road accidents between cyclist and drivers (latent class clustering)	Data reported in Denmark (2007–2011), accidents involving cyclist and drivers	13 clusters showing specific patterns of urban and rural road accidents; obtaining a high classification accuracy, with all the clusters being correctly assigned for more than 80 percent of the observations

			ons, and reporting an entropy criterion of 0.86			facial expression	decelerati on
Depaire et al. (2008)	Find patterns of severity of injuries resulting from road accidents in a heterogeneous data set (latent class clustering)	Accident data reported by the Belgian road police (1997–1999), 29 variables and 4028 accident records	7 clusters showing a high level of accidents for motorcyclist and cyclists under 19 years old	Kumar and Toshniwal (2015a)	Determinate the variables that influence the event of road accidents (cluster K-means, association rules model)	11,574 traffic events on the roads of Dehradun (India) (2009–2014)	6-cluster model as input to a model of association rules. Severity of accident, type of road, lighting and surrounding area affect the aggregation of the clusters
De Oña et al. (2013)	Identify the key factors that affect the severity of injuries caused by a rural road accident (latent class clustering, Bayesian networks)	3229 traffic accidents reported by the police in rural roads of Granada (Spain), occurred between 2005 and 2008	Results depends strongly on the initial data set analyzed and the techniques used	Taamneh et al. (2017)	Determination of the most important variables for severity prediction of traffic accident (J48 decision tree, rule induction PART, Naive Bayes)	5973 traffic accident records occurred in Abu Dhabi between 2008 and 2018	Age, gender, nationality, year of the accident affect the severity of the accident
Zheng et al. (2014)	Determinate the variables that identify a driving style or driver with high risk of vehicular collision (cluster K-means)	31 vehicles with a GPS for 60 days, driving recorders and cameras to capture the road and driver's	3 clusters for road accident risk levels, a correlation between driving events and maximum	Beshah et al. (2011)	Understand the interaction between the different actors that intervene in a road accident (CART and random forest)	14,254 traffic accidents with 48 attributes (May 2005–September 2008) Ethiopia	CART and RF behave similarly but RF has lower failure rates to predict the probability of someone

			emerging unscathed from a road accident
Ahmed and Abdel-Aty (2012)	Prediction of traffic accidents in real time with information provided by an automatic vehicle identification (AVI) (random forest)	Real-time data on speed, average speed and traffic volume obtained from AVI along 125 km highway at Orlando (FL) 2008	The model is sensitive to the distance between each tag to AVI, nor statistically or predictive significant values were obtained

	operating characteristic (ROC) curve	
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Regarding road accident forecasting, as shown in Table 5, deep learning architectures, usually employed in the fields of signal and image processing, shows promising results to identify, analyze and forecast traffic accidents. The drawback of deep learning algorithms is their elevated computational requirements and the need of extensive data sets that can be subject to the possibility of produce over fitting models. The model proposed by (Ren et al., 2017) can be considered a baseline model for predicting traffic accident risk, since it incorporates big traffic accident data, as called by the authors, and proposed a novel deep learning architecture based on LSTM to predict the risk with accurate results. It can be remarked the novel approach proposed to model the data, using an encoding matrix that represents the spatial-temporal frequency of traffic accidents. Furthermore, the encoding matrix was developed using a heat map, which allowed visually highlighting the space-time zones with the highest road accident frequency values.

**VI. ROAD ACCIDENT FORECAST METHODS**

Representative results on road accident forecast methods.

Road accident analytic method	Metric	Best result
Clustering algorithms	Bayesian information criterion (BIC), Akaike information criterion (AIC)	Moriya et al. (2018) with minimum values of AIC and BIC at 3 clusters
Classification algorithms and decision trees	Accuracy, precision, recall and F-measure, using receiver operating characteristic (ROC) curve	Tiwari et al. (2017), with an accuracy of 0.8235
Natural language processing	Accuracy, precision, recall and F-measure, using receiver	D'Andrea et al. (2015) reported and accuracy value of 0.9575

Representative metrics and results on road accident forecast.

Road accident forecasting method	Metric	Best result
Bayesian networks	Accuracy, precision, recall and F-measure, using receiver operating characteristic (ROC) curve	Castro and Kim (2016), accuracy is 0.8159, precision is 0.7239, recall value is 0.7239, F-measure is 0.723
Genetic algorithms and evolutionary computing	Accuracy, precision, recall and F-measure	Hasheminejad (2017), precision is 0.885, recall is 0.889, accuracy is 0.8820, F-measure is 0.8875



Support vector machines	Accuracy, precision, recall and F-measure	Xiong et al. (2017), accuracy is 0.8730
Artificial neural networks	Accuracy measure correlation, R-squared, MSE and RMSE	Alkheder et al. (2017), accuracy is 0.7460
Deep learning	Mean absolute error (MAE), mean relative error (MRE), mean squared error (MSE) and root mean squared error (RMSE)	Ren et al. (2017), MAE is 0.014, MSE is 0.001, RMSE is 0.0340

## VII. CONCLUSIONS AND FUTURE WORK

The researches reviewed, were limited by the lack of incorporation of other relevant factors and variables, such as traffic flow, human mobility and special events that can affect traffic and accident risk, i.e., massive events. Furthermore, in order to provide an effective forecast and analysis, the models output was coarse-grained, using data that comprise in spatial variables, road segments or city grids, and in temporal terms, day, or hours, that cannot be disaggregated. The results lacking predictions and analysis that can provide road segment level results and temporal analysis that cannot be drill down to minutes.

Considering the analytic methods for road accident analysis, the classification algorithms and decision trees are widely employed by their interpretability, but, in the other hand, they do not offer results with such high levels of precision and accuracy compared to other methods. Because of this, it can be considered that the approach proposed by Tiwari et al. (2017), as shown in Table 4, is valuable, since their research obtain better results by using clustering algorithms to preprocess the data set, in this particular case, hierarchical clustering and K-modes clustering were evaluated. The results obtained improved the performance of the classifiers methods. Regarding the natural language processing of social media information related to traffic accidents, the work by D'Andrea et al. (2015) was innovative and a baseline model to other authors, since their model was

compared against other algorithms, such as Naive Bayes classifier, C4.5 decision tree, K-nearest neighbor (KNN) and PART classifier, and their model was put to test in task of classification of real-time twitter streams, with successful results.

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# Solutions to complete state management for road traffic infrastructure investment in BOT form

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## ABSTRACT

This article recommends resolutions to improve the state management of road transport infrastructure investment in the form of BOT (Building - Operate - Transfer) in Vietnam, on the basis of Vietnam's practice and international experience. Accordingly, the group of authors solves 05 basic issues affecting the state management of PPP (Public - Private - Partnership) projects in Vietnam, including: State management's regulatory documents; State management model, content and management method; Personnels participating in PPP; Financial instruments and management; Investment environment. The authors used qualitative and quantitative research methods to identify factors affecting state management and eliminate duplicate factors and factors with small impacts. Through the multivariable regression equation, there is the general formula  $Y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n$  as the basis for the solution system. The conclusions drawn from the study help the state management to get a comprehensive view of the BOT projects that have been implemented in the past time to make adjustments and gradually improve the investment model in the form of PPP in general and BOT in particular.

**Keywords :** BOT (Building - Operate - Transfer); Road transport infrastructure; PPP model; PPP (Public - Private - Partnership); State management.

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## I. INTRODUCTION

Climate change is the change of the current and future atmospheric, hydrological, biosphere, and lithosphere system due to natural and man-made causes. The main causes of the earth's climate change are increased activities that generate greenhouse gas emissions, overexploitation of sinks and reservoirs of greenhouse

gases such as biomass, forests, other terrestrial, coastal and marine ecosystems.

The term "PPP" stands for the English phrase of Public - Private - Partnership. There are many different interpretations of the public-private partnership. The most commonly understood is an agreement expressed through a contract between a competent state management agency and an investor/project enterprise

to implement the construction, operation, maintenance and/or management of infrastructure, etc. where ultimate responsibility for service provision of the state partner is reserved [1].

BOT stands for Building - Operate - Transfer. Accordingly, BOT is specifically defined as follows: a contract signed between a competent state agency and an investor/ project enterprise for the construction of infrastructure works. After completing the project, the investor/ project enterprise is entitled to do business for a certain period of time; at the end of the term, the investor/ project enterprise transfers the project to the state agency [2].

State management of PPP in road transport infrastructure investment is conducted by an organized system and by the laws of the State in order to mobilize and use the most effective resources of investors/enterprises participating in the transport PPP projects, with the aim of completing the road transport infrastructure investment, putting it into operation and use as quickly as possible to meet the increasing development requirements of the economy [3].

In Vietnam, there have been many authors conducting research on the state management of project investment in road transport infrastructure investment, some of which can be mentioned.

The Ministry of Transport (2009) in a study of PPP in construction of road transport infrastructure analyzed and evaluated the legal framework, regulations and policies for the road industry and proposed to support PPP in the road sector. Accordingly, the Ministry proposed the policy framework, legislation, model and capacity of the state management [4].

Ta Van Khoai (2009) in his research on state management of investment projects, analyzed the state management functions according to the management process, including: planning for investment projects; forming the legal framework for management of investment projects; promulgating and organizing the implementation of mechanisms and policies on management of investment projects; organization

model for management and personnels; and inspecting, controlling investment projects [5].

Dinh Kien (2010) when analyzing the causes leading to the failure of the investment projects to build the BOT infrastructure in the form of BOT, commented that: the project management capacity of the competent state management agencies was still weak; legal system, policies were not really complete and effective. Therefore, he proposed solutions on planning and policies, laws and regulations on PPP form [6].

Bui Thi Hoang Lan (2010) focuses on the application of the PPP model in Vietnam, including preliminary assessments of state management of PPP projects and some recommendations to improve PPP project management capacity and develop road traffic infrastructure [7].

Dang Thi Ha (2013) examined the shortcomings when applying the PPP method to mobilize capital from non-state areas for highway projects in Vietnam and stated that the policies were not specific; lacking of detailed written instructions. The legal document system has not covered all situations arising in reality, lacking of coordination among state management agencies [8].

Nguyen Thi Ngoc Huyen (2013) analyzed the state management of PPP in the construction of special traffic infrastructure, including: strategy development, planning, organizing the implementation of policies and regulations, implementing legal framework, management apparatus and personnels; investment monitoring and evaluation [9].

Nguyen Thi Hong Minh (2016) analyzed the current state management of PPP investment projects in Vietnam's special traffic system and offered a number of solutions including: completing the development plan of PPP projects; finalizing policies and laws for PPP projects; completing the state management apparatus for PPP projects; completing monitoring and evaluation of PPP projects [3].

In general, domestic studies have mentioned and addressed some aspects of state management of road PPP projects in Vietnam. However, these studies have

some limitations: (i) Only mentioning one or some specific aspects, there are almost no systematic studies on theory and assessment of the state management of the PPP project; (ii) The perception of scientists and policy makers on PPP is not consistent. S

Sometimes, they identified PPP as socialization of public services, or limited to the form of BOT, BTO, BT between the state and the private enterprises. They have not studied other forms of PPP such as the conditions for applying the form of M&O; (iii) There is a lack of research on strategies, plans, policies and laws of the state for PPPs in order to ensure effective control on the basis of transparency, legality and investment attractiveness.

International research related to PPP investment in general and PPP investment in infrastructure in particular is has been quite diverse. International studies often provide guidelines for PPP investment, while others provide information on the pros and cons of this investment approach, as well as the risks involved in the overall projects.

Hwang, T. and Chen, C. (2004), "Future Development of the Competitive Framework, Netherlands: International Kluwer Law", the authors identified the State represented by the policy makers must understand the expectations of private investors as well as barriers to PPP in order to be able to develop and complete the policy framework, support the private sector, and ensure the efficiency of state management in public sector. In PPP projects, the Government should be actively involved throughout the project life cycle to ensure the project meets its objectives [10].

Koch, C. and Buser, M. (2006) published in the International Journal of Project Management the research named "Emerging Meta Governance as an Institutional Framework for Public Private Partnerships in Denmark" and argued that targets in PPP contracts vary widely among different public authorities (Central and Local). Through PPP projects, the State will strengthen management capacity, innovate service quality, increase efficiency of

investment projects, optimize risk transfer/sharing capability, and ensure value for investment capital. [11].

Nyagwachi, J.N. and Smallwood, J.J. (2006), "PPP projects in South Africa: a systematic model for planning and implementation" at the Construction Industry Development Board Conference. The study found that a complete legal framework is necessary but not enough to guarantee the success of PPP projects. The authors pointed out that although a fairly complete legal framework has been built, PPP projects in the field of road traffic infrastructure in South Africa still failed due to: inadequate support policies; weak project management capacity of state agencies; and inadequate awareness of PPP both in the private and public sectors [12].

Yescombe (2007) "Principles of Public Private Partnership in Policy and Finance". The State is the decisive force in the development of PPP, responsible for creating an environment for PPP including policy framework, legal framework, unify legal provisions, bidding procedures, funding sources and financial instruments, arbitration, dispute settlement, monitoring and evaluation [13].

Cuttaree (2008) in his study "Success and Failure of PPP Projects" identified the success factors of PPP in Chile and Mexico in post-crisis conditions including: sufficient PPP project planning; appropriate legal framework; strong State management; effective macroeconomic management; ability to make payment of users; competitive and transparent bidding [14].

Generally, in the world, there have been many studies on PPP which have been implemented in many countries and considered as one of the capital mobilization channels for national infrastructure construction. The main scientific works are general policy analysis and legal framework recommendations. There have not been any studies on the limitations of legal PPP investment control in countries. Therefore, in the current context, Vietnam is expected to consider and learn the influencing factors and success

conditions for PPP projects, thereby gaining experience in PPP project implementation.

## II. PRACTICES ON STATE MANAGEMENT FOR PPP INVESTMENT PROJECTS OF ROAD TRAFFIC INFRASTRUCTURE IN VIETNAM

In order to implement PPP projects of road traffic infrastructure with high efficiency, the role of state management is very important, to ensure the project objectives. In recent years, in order to assess the shortcomings of state management in PPP projects in general and BOT projects in particular, in Vietnam, the authors address the shortcomings and limitations through a number of methods and specific projects.

### A. Hanoi - Hai Phong highway project

Hanoi - Hai Phong highway project with route length of 105,837 km, its starting point is at the roundabout and ring road 3 in Thach Ban ward (Long Bien, Hanoi), the ending point is at Dinh Vu port, Hai An district (Hai Phong).

The route has a road surface width of 32.5 m to 35 m with six lanes and a design speed of up to 120 km/h, two emergency lanes, a hard median strip in the middle, a green strip on both sides with some collection lines where necessary.

This project had some limitations, including the following points:

Large increase in total investment. The project was started in 2008, with a total initial investment of 24,500 billion VND, then adjusted to 45,000 billion VND (an increase of 45%). The reason was due to changes in basic design, inflation of raw material prices such as: cement price increased by 49%, diesel oil increased by 67%, asphalt price increased by 113%... compared to the approved price in January, 2008, resulting in a longer schedule and increased costs [15]. This shows that the role of state management was weak, especially in project approval and appraisal, risk management, contract management and responsibility of related parties, ...

Electronic toll collection (ETC) after 7 years of exploitation, not yet completed [16]. This shows that the State management has not fully anticipated the risks in the process of exploitation and operation to ensure transparency in the return of capital, which may lead to consequences such as tax evasion, loss of state budget, causing suspicion in public opinion.

### B. Ho Chi Minh City - Trung Luong highway project

Ho Chi Minh City highway project - Trung Luong with route length of 61.9 km. Its starting point is at the intersection of Cho Dem - Binh Chanh - TP. Ho Chi Minh City, the ending point is the intersection of Than Cuu Nghia - Chau Thanh district - Tien Giang province. The route was invested to build an A-standard highway, grade 120 corresponding to Vtk=120Km/h, phase 1 was built with 4 lanes and 2 emergency slanes (4 x 3.75m + 2 x 3.0m) with a width of the roadbed from 25 to 26 m.

This project had some limitations, including the following points:

The environmental impact assessment has not been strictly controlled by the appraising agency. This led to the result that the rice plants along the highway developed abnormally, unevenly flowering due to the high-pressure lights illuminating continuously at night, causing failure of crops. The lighting system was repaired, which wasted investment funds [16]. It proved that the appraising agency has not fulfilled its responsibility in environmental impact assessment before approving the project and the state management did not make any responsibility handling.

The planning was not efficient, leading to a lack of regional linkages. The routes intersecting with the highway to Ben Luc district are incomplete when the project was put into operation. Then, it was supplemented. Currently, the project has to be postponed because the construction contractor violated the law [16]. We can see that the project appraisal was not well conducted.

The operation - management (O&M) was incomplete. This led to a loss of state capital (VND 725 billion of

tax amount, in addition to incorrect determination of vehicle traffic due to the absence of ETC) [16]. The state management has not done well in the project transfer contract and control the toll collection activities.

### C. Trung Luong - My Thuan project

Trung Luong - My Thuan highway project (phase 1), route length of 51.5 km. The starting point is at Than Cuu Nghia intersection, the ending point is intersecting with National Highway 30 at An Thai Trung intersection.

The entire route has a road surface width of 17m with four lanes (4x3.5) and a median strip, no emergency lanes, a design speed of 80 km/h.

This project had some limitations, including the following points:

The construction lasted for a long time. The project was started in November 2009, and expected that, according to the contract, it will be put into operation and exploitation by 2012. After 13 years of construction, the project was only tested on January 25, 2022, and officially put into operation on April 30, 2022 (with a delay of 130 months) [16]. The reason for the delay is due to the slow response of the State management on site clearance; the coordination between central, local agencies and investors is not effective; plus the changes of state management from central to local levels also impact the project duration. The decentralization between state management and business management is not clear, the directing and controlling role of state management is not satisfactory. Maximum speed is 80 km/h, not suitable for highways [16]. This shows that the appraisal process is not good because the maximum allowed speed of highways in Vietnam is usually from 100 to 120 km/h. Therefore, calling this project "highway" is not appropriate in practice, this case can only be called "toll road". The appraisal agency has not complied with the mandatory standards on highway design and they did not have experience as well as traffic safety knowledge of the

design agency and the appraisal of the State management is not good.

There is no emergency lane, causing unsafety and congestions. With a design width of 17 m, including 4 lanes of 3.5 m wide and median, no emergency lanes. So, in the case of a vehicle having a breakdown or traffic accident, there is no exit, causing traffic congestion and great economic losses. Report of the Department of Transport of Tien Giang province in February 2022, in 10 days (from January 28, 2022 to February 6, 2022) there were 04 traffic accidents, killing 1 person, damaging 10 vehicles (05 cars, 02 trucks and 03 passenger cars) [17]. From April 30, 2022 to June 9, 2022, through the trial toll collection, there were 225 breakdowns of broken cars and traffic accidents, causing many hours of congestion, and the rescue work was also slow due to lack of traffic connection points for rescue vehicles to enter.

Investor capacity is not guaranteed. The project has changed investors twice. The first time (in 2015) - the investor is a consortium of Tuan Loc investors. The second time (in 2019) - Deo Ca Group [16]. This proves that the project preparation, bid review, investor selection of the State management... do not meet the requirements. This is entirely the responsibility of the State authority in selecting investors.

### D. BOT project of Cai Lay

The Cai Lay BOT project belongs to the investment project to build the National Highway 1 bypass and strengthen the National Highway 1 road surface, the section passing Cai Lay town. The route length is 38 km, in which the length of the National Highway 1 bypass section passing through Cai Lay town is more than 12 km and the length of the old National Highway 1 route is more than 26 km. The project collects fees from August 1, 2018.

This project had some limitations, including the following points:

Unreasonable position. During the toll collection process, many vehicle owners caused trouble, causing congestion at the station for a long time, affecting

security and social order. As a result, the BOT project had to temporarily stop collecting fees [15]. The main reason is that the toll station is placed improperly and must be adjusted (Cai Lay toll station is located on National Highway 1 to collect tolls for all vehicles traveling on National Highway 1 route and bypass). This does not make sense because vehicles that do not take the bypass still have to pay the fees. Thus, the appraisal for selecting location is not good, lacking of transparency and the control role of the state management is weak during the project implementation. The state management has not carefully consider the social environment impact for the form of PPP investment project.

Toll collection policy has many problems: Cai Lay BOT station collects fees from VND35,000 to VND180,000/turn for cars of all kinds, not considering exemption or reduction for citizens living near the station, citizens not travelling the entire route. After that, it must be adjusted to exempt 100% of the fee for the above-mentioned people [16]. The state management has not fully anticipated the social impact; State management in some areas also has different ways of understanding, affecting the investment environment under the PPP method.

#### **E. My Thuan - Can Tho Project**

My Thuan - Can Tho highway project with route length of 23 km. The starting point is at Km107+363.08, located in Tan Hoa Ward, Vinh Long City, Vinh Long, the ending point is at Cha Va intersection (with National Highway 1, coinciding with the beginning point of Can Tho bridge project), in Thuan An commune, Binh Minh Town, Vinh Long. The project is constructed with 6 lanes, the width of the roadbed is 32.25m, the design speed is 100km/h. Phase 1 with 4 lanes, roadbed width of 17m, bridge width of 17.5m and the design speed is 80km/h.

This project had some limitations, including the following points:

Public investment is much lower than PPP investment. The total project investment in the PPP phase is VND

5,408 billion (approved by the Ministry of Transport in 2017). However, in April 2020, the project was adjusted to the form of public investment. At this time, the total investment decreased to VND 4,758 billion (a decrease of VND 650 billion) [16]. It proves that the control of the BOT project preparation stage has been abandoned and the appraisal is not good.

#### **F. The Eastern North-South Highway Project in the 2021-2025 period**

The Eastern North-South highway construction project (period 2021-2025), includes 12 component projects with a route length of 729 km, of which 08 projects are public investment (route length of 505 km) and 04 projects implemented by BOT form (224km in length). The project implements a phased investment according to the scale of 4 lanes with 17m of road surface (without 2 emergency lanes), the design speed is 120 Km/h.

The project failed to attract investors by BOT method, specifically: 04 projects that failed to attract investors had to switch to public investment [16]. This proves that the ability to attract PPP investment is not good. Although there is a Law on PPP investment (Law 64 takes effect on January 1, 2021 and Decree 35/2021/ND-CP dated March 29, 2021), the state management needs to re-evaluate and determine the cause (weak investor capacity, legal corridor problems). From the analysis results of the above PPP investment projects, it shows that the role of state management of PPP projects in general and BOT projects in particular is still limited and inadequate. It can be concluded that there are still many issues to be considered, such as:

First, the regulatory system of state management is not timely and not suitable with reality.

Second, the management model and method have not been able to separate the roles of state management and business management, causing overlap and confusion when implementing PPP projects.

Third, the project appraisal still has many problems, there is no specific responsibilities of relevant parties.



Fourth, in terms of the risk management of the State authorities and investors, all the risks throughout the PPP project are not fully anticipated, leading to many projects delaying progress and increasing costs.

Fifth, personnels involved in PPP projects are lacking of expertise and management skills.

Sixth, State management lacks effective financial tools to support investors.

Seventh, the transparency in investment and fee collection has not yet been ensured.

Eighth, legal factors have not been strong enough to attract investment.

Ninth, there are not investors with actual capabilities to implement PPP projects.

Through analyzing the shortcomings and limitations of the PPP investment projects mentioned above. It has been shown that the main factors affecting the role of state management, leading to inefficient PPP investment projects, causing losses, and increasing investment costs. In addition, there are a number of other factors affecting the role of state management such as: capacity of investors/enterprises; sense of responsibility; natural - economic - social conditions, etc. affecting the state management function for PPP projects.

In order to verify the factors affecting the state management of the above-mentioned investment projects of road traffic infrastructure in Vietnam, the article studies international experiences on state management of road traffic infrastructure investments, then notes down some lessons for similar cases in Vietnam.

### III. INTERNATIONAL EXPERIENCE ON STATE MANAGEMENT OF THE ROAD TRAFFIC

## INFRASTRUCTURE IN THE FORM OF PPP INVESTMENTS AND LESSONS LEARNED FOR VIETNAM

### A. International experience on state management of the road traffic infrastructure in the form of PPP investments

#### 1. The U.K. [3], [19]

To successfully implement the PPP project, the British Government has done well the following activities:

- Policy and law on PPP projects:

+ Ensuring the stability of PPP legislation. For example, PPP contracts are usually 25-60 years in term of duration. This will attract private investors and commercial banks can trust and offer long-term loans.

+ Ensure policy flexibility, as shown in the follow-up of "Private Funding Initiative" by the private funding system 2 (PF2). Accordingly, PF2 has provided 1 billion USD in investment capital for 46 schools and hospitals. Projects that demonstrate high value will receive a funding commitment in the form of credits for a private finance initiative.

- State management: The British Government's Ministry of Economy and Finance established the British Partnership which functions as a center for knowledge development and expansion of the Government's PPP projects, connecting with each Government agency in each PPP project. At the same time, it is responsible for consulting on the national PPP policy and strategy and specific PPP projects. For example, it supports bidding process to select investors; the partner organization operates thanks to the fees collected from the services they provide: preparation of sample documents and instructions for the project under the PPP method, etc.

- From the viewpoint of PPP implementation: Projects that cannot be completed by the private sector or that the private sector does not participate directly, then the government will perform those projects. The State encourages the form of contracting to the private sector all facilities of the project. Then the State rents

it back, so the facilities still belongs to private sector and they are leased by the State.

## 2. Korea [3], [8]

The Korean government has also taken a number of measures to ensure the success of the PPP projects, including:

**Policies and laws for PPP projects:** Korea especially encourages the private sector to invest in building traffic infrastructure. Investors can benefit from many tax reductions, including VAT exemption. The government guarantees the project revenue (which can be up to 90%) so the revenue risk is mostly transferred to the government side. Although the basic principle for fee collection is the “the beneficiary makes payment for infrastructure”. Simplified bidding procedures facilitate the selection of contractors by state agencies and participation in bidding by private investors.

**Legal framework on PPP projects:** fully promulgated by the Government to regulate the behavior of parties involved in the PPP projects, including the PPP Act in the field of infrastructure, the Decree and regulations detailed guidance on the implementation of PPP investment. The system of legal documents is highly flexible and timely adjusted to create a framework for the implementation of PPP projects. Especially, the PPP Act in the field of infrastructure from 1998 to 2010 was adjusted 48 times. In addition, the PPP legislation in the infrastructure sector of Korea is compatible with relevant laws such as: Road Toll Law, State Property Law, Local Finance Law, National Land Use and Planning Law, the Law on Urban Development, etc.

**State management in PPP projects:** Establish a separate “PPP management agency” to manage PPP projects. In particular, clear decentralization of management for PPP in the road sector, large projects decided by the Committee on private investment in the infrastructure sector at the central level, small projects are decided by localities.

## 3. Philippines [18], [19]

**Mechanism:** The government allows to implement a project proposed by a private investor, which will be tested through the market mechanism by inviting other interested investors to offer on the basis of competition among interested investors.

**State management in PPP projects:** The Government established the Investment Coordination Committee (ICC) which is the highest decision-making body for PPP projects. This is an interdisciplinary committee, the member of which are the Ministers and chaired by the President of the Philippines. Supporting the ICC is the National Economic Development Authority (NEDA) with the function of drafting and submitting policies on the form of PPP, including the investor selection process. NEDA is also the agency to coordinate among ministries and branches related to specific PPP projects, coordinate with the Ministry of Finance to ensure the State's participation in the project finance. In addition, the Philippine government also established a BOT Center under the Ministry of Industry and Trade, with the function of consulting for agencies implementing PPP projects.

## 4. Indonesia [3], [18]

Indonesia has mobilized private sector investment for infrastructure development since the 1990s. However, there are still reasons why PPP in Indonesia has not been as successful as expected due to:

- Lack of strong commitment and strong political support
- Lack of coordination between agencies.

### B. Lessons learned for Vietnam

Through practice, after many years of applying the PPP investment method along with studying the experiences of countries around the world, some lessons can be drawn for Vietnam as follows:

Firstly, the promulgation of the law and legal framework is much slower than in the implementation of the projects in practice.

Second, the system of sub-law documents: from the research results in the above countries, it shows that to

ensure the success of PPP projects, the system of sub-law documents must be fully and timely promulgated. It is to ensure that the project is implemented smoothly, without interruption and affecting progress, quality, cost, etc.

Third, state management model and management method: it is necessary to separate the role of state management from the role of business management by establishing a focal point on PPP (for example, as in the United Kingdom, Korea...). Thereby, there are clear responsibilities of state management agencies, PPP agencies and project investors/ enterprises.

Fourth, personnel involved in PPP projects: it is necessary to consider training and improving professional competences for 02 basic personnel groups: state management and project investors/ enterprises.

Fifth, risk management: subjective and objective risk management needs to be identified and developed by the State Management into a specific management and response procedure. At the same time, a reasonable separation of risks among the State and project investors/enterprises based on the principle of "Equality – Minimizing risks".

Sixth, financial instruments and management. The State must develop an effective system of financial instruments to support investors, similar to the case of UK's "Private Funding Initiative".

Seventh, investment environment: The State needs to create favorable conditions to attract project investors/enterprises through policies such as VAT exemption and reduction, revenue guarantee (Example: in Korea, United Kingdom, etc.).

#### IV. RESEARCH METHODOLOGY

##### A. Research model and hypotheses

From the analysis results (Section 3) and (Section 4) above, it is shown that there are many factors affecting the effectiveness of state management for the PPP projects of road traffic infrastructure. In Vietnam, from the perspective of state management, it can be

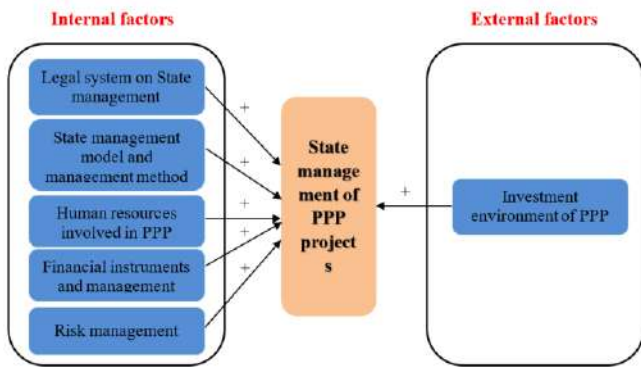
summarized into groups of factors affecting the state management, including:

- Group 1: Legal system on State management (sub-law document system).
- Group 2: State management model and management method.
- Group 3: Human resources involved in PPP projects.
- Group 4: Financial instruments and management.
- Group 5: Risk management.
- Group 6: Investment environment of PPP projects.
- Group 7: The capacity of the State management and the project investors/enterprises.
- Group 8: Natural - economic - social conditions.

Through primary and secondary survey methods and combining with expert consultation, in order to remove duplicate factors and groups of factors with small influence, the original 08 groups of factors are shortened to 06 groups of factors that affect the state management of the PPP project in Vietnam, specifically:

Eliminating Group 7: C The capacity of the State management and the project investors/enterprises and Group 8: Natural - economic - social conditions because these groups of factors are controlled by Group 2: State management model and management method; Group 3: Human resources involved in PPP projects and Group 5: Risk management". When the State management performs well its role in perfecting the state management model and method, high efficiency can be ensured. At the same time, combining with the enhanced awareness and ethical qualification of human resources participating in PPP, and well-controlled risk activities, those group of factors will be eliminated.

Accordingly, 06 groups of factors proposed for research are divided into 02 groups, including: Group of internal factors and external factors, (Figure 1) shows the model of factors affecting the state management of PPP projects.



**Figure 1.** Model of factors affecting the effectiveness of state management of PPP projects

Source: Authors

“+”: Represents groups of factors according to the proposed hypothesis, which have a positive impact on the effectiveness of state management for PPP projects.

**B. Questionnaire, scale**

**1. Questionnaire**

The questionnaire was built on the following basis: Referring to previous studies on factors affecting state management locally and internationally.

Practical implementation of BOT transport infrastructure projects in Vietnam in recent times.

International experience in implementing road transport infrastructure of PPP projects.

Consultation from experts with experience in the field of traffic project management in general and BOT project management in particular.

The official questionnaire includes 42 observed variables (Table I), including: Legal system on State management (6 variables); State management model and management method (9 variables); Human resources involved in PPP (6 variables); Financial instruments and management (9 variables); Risk management (7 variables); Investment environment of PPP (5 variables).

TABLE I. GROUPS OF FACTORS AFFECTING STATE MANAGEMENT IN PPP

Factors	Code
<b>1. Legal system on State management</b>	<b>HTVB</b>
Completing the system of sub-law documents, in order to create a favorable environment for project investors/enterprises to implement PPP projects	HTVB1
The system of promulgated sub-law documents is incomplete (clearly defining roles, tasks, responsibilities, etc.) of state management agencies from central to local levels.	HTVB2
The system of sub-law documents does not have provisions on the "time period" that need to be adjusted.	HTVB3
Completing the regulations on responsibilities for the Sector Council when participating in the drafting of sub-law documents, ensuring practicality, international integration, scientific and technological development, etc.	HTVB4
The review work of experts and social criticism before the promulgation of legal documents is not well organized	HTVB5
Legal documents in PPP investment, including BOT, need to clarify the attractiveness, expressed in specific incentives.	HTVB6
<b>2. State management model and management method</b>	<b>QLNN</b>
State management model for investment projects in form of PPP, currently not suitable for practice in Vietnam	QLNN1
The state management model for PPP investment projects has not yet separated the	QLNN2

role of state management and the role of business management, causing overlapping and lack of transparency.	
State management model for investment projects in PPP form has a low degree of specialization because it still retains the part-time model of state management.	QLNN3
The state management for PPP investment projects is not clear in terms of structure, functions and tasks from central to local levels.	QLNN4
State management model for PPP investment projects is not ensured to be flexible, suitable for management subjects as project investors/enterprises.	QLNN5
Lack of a mechanism to check, evaluate and control project investors/enterprises' capacity in terms of technical, financial, management, etc. especially the financial capacity to be implemented throughout the project.	QLNN6
The responsibility of the PPP project appraisal agency has not met the requirements, causing the total investment to change many times, the quality of is not guaranteed, lacking of materials, etc.	QLNN7
The coordination between State agencies and bodies (Ministry of Planning and Investment, Ministry of Transport, People's Committees of provinces/cities...) is not good. There are still overlaps in tasks.	QLNN8
The supervision role of the community for PPP projects in has not been developed into a movement and built into a process, leading to a lack of critical information on state management.	QLNN9
<b>3. Human resources involved in PPP</b>	<b>CNQL</b>
The awareness of state management officials about the roles, tasks and responsibilities in the process of implementing PPP investment projects is not high.	CNQL1
Ethical quality of state management staff is not good, leading to lack of enthusiasm, not ensuring fairness in the project implementation.	CNQL2
Professional management capabilities of state management staff for PPP investment projects is still weak and inadequate	CNQL3
Training state management officials in implementing PPP projects has not been seriously carried out.	CNQL4
Policies for state management officials in PPP project investment are not satisfactory.	CNQL5
The capacity of managers of project investors/enterprises is not guaranteed in terms of quantity and quality	CNQL6
<b>Financial instruments and management</b>	<b>QLTC</b>
Medium-term capital sources for PPP investment projects need to be planned in order to have a plan to balance capital sources.	QLTC1
Create an open legal corridor for credit institutions to finance projects	QLTC2
Supporting investors in mobilizing and effectively using investment capital	QLTC3
State guarantee for PPP projects such as loan guarantee, revenue guarantee, etc.	QLTC4
Check and monitor the disbursement process for the project	QLTC5
Investment promotion activities need to be focused, to widely promote to domestic and foreign investors, to attract investment in PPP projects.	QLTC6
Lack of effective solutions for project investors/enterprises to access capital sources with low interest rate and long grace period	QLTC7
Monitoring the financial capacity of investors during the project implementation phase is of little concern	QLTC8
Controlling the toll collection by state management agencies is not effective.	QLTC9

Inefficient management caused great losses to the State budget	
<b>Risk management</b>	<b>QLRR</b>
The PPP project contract has not identified an accurate, complete and specific list of risks from a comprehensive point of view	QLRR1
Lack of transparency of contract terms, making it difficult to monitor and evaluate project investors/enterprises	QLRR2
The reasonable allocation of risks between the State and investors and service users has not been carefully calculated on the basis of consensus between the parties.	QLRR3
A reasonable risk management process has not been established for the stages during PPP project implementation	QLRR4
Lack of process to control contracts signed between competent state agencies and investors, leading to disputes, prolongation and delay in putting works into operation.	QLRR5
The development of the road transport system causes a decrease in the revenue of investment routes in the form of BOT	QLRR6
Lack of periodic assessment of the quality of works during exploitation, the sustainability of the project and the impact of the project on the socio-economic aspects.	QLRR7
<b>Investment environment of PPP</b>	<b>MTĐT</b>
The level of socio-economic development of the country requires state management to improve its management capacity to meet the requirements in Vietnam.	MTĐT1
State management lacks a mechanism to control the micro-management apparatus for project investors/enterprises during PPP project implementation.	MTĐT2
Lack of project investors/enterprises with actual finance capacity, leading to difficulties in selecting project investors/enterprises to implement PPP projects.	MTĐT3
The level of development and capacity of project investors/enterprises has not kept pace with the development of science-technology and international integration.	MTĐT4
Project investors/enterprises set profit target higher than socio-economic targets.	MTĐT5

*Source: Authors*

### The scale

A Likert scale of 1 to 5 is used to measure these variables, where:

- (1) Not affected; (2) Very little influence; (3) Medium; (4) High influence; (5) Very high influence.

### The order of processing survey results

In order to build a multivariate regression equation showing the influence of factors on state management of the PPP (BOT) road infrastructure projects in Vietnam, the authors conducted a survey to subjects who had experience in the field of BOT road infrastructure, project management, service users for BOT projects, etc.

Data were collected through the distribution of 250 questionnaires. After collecting, there are 250 valid

questionnaires. The encrypted data is processed using SPSS24 software. Procedure includes:

Step 1: Evaluate the reliability of the scale through Cronbach's Alpha coefficient.

In order to measure the internal consistency of variables in the same group, thereby eliminating the intrinsic inconsistency of variables in the same group.

Step 2: Exploratory factor analysis

In order to reduce a set of many interdependent measurement variables into a smaller set of variables, to be more meaningful but still contain most of the information content of the original set of variables.

Step 3: Analyze Pearson correlation

Check the close linear correlation between the dependent variables and the independent variables and

early identify the problem of multicollinearity when the independent variables are also strongly correlated with each other.

**Step 4: Multivariate regression analysis**

In order to assess the degree of influence of groups of variables on state management on investment projects of road traffic infrastructure in Vietnam, at the time of the survey.

Through the process of processing with SPSS24 software, following the above steps, the results of multivariable regression analysis (Table 2), show the groups of factors affecting the state management of the urban central system in Vietnam.

TABLE II. RESULTS OF MULTIVARIABLE REGRESSION ANALYSIS

Model		Coefficients <sup>a</sup>						
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.094	.172		.543	.588		
	QLNN	.256	.035	.321	7.395	.000	.720	1.389
	HTVB	.278	.038	.325	7.408	.000	.691	1.447
	CNQL	.184	.034	.297	5.472	.000	.707	1.414
	QLTC	.146	.031	.201	4.771	.000	.678	1.475
	<b>QLRR</b>	<b>.032</b>	<b>.031</b>	<b>.045</b>	<b>1.016</b>	<b>.310</b>	<b>.696</b>	<b>1.437</b>
	MTĐT	.023	.037	.015	1.620	.000	.640	1.562

Multivariate regression results (Table II) show that:

- Eliminate QLRR factor group because it is not significant in the model. The test sig (t = 1.016) is greater than 0.05 and this group belongs to “Group 3: Human resources involved in PPP”. This shows that the research results are consistent with the practice of implementing PPP projects. Because people participating in PPP are fully aware of the form of PPP, the control of risks is subjective and objective will be efficient.
- The group factors of QLNN, HTVB, CNQL, QLTC, MTĐT all have an impact on the dependent variable. Sig t-test of each independent variable is less than 0.05.
- VIF coefficients of independent variables are all less than 10, no multicollinearity occurs.

So, the multivariable regression equation of the remaining 5 variables (according to the standardized Beta coefficient) is represented by formula (1) as follows:

$$QLNN=0.325*HTVB+0.321*QLNN+0.297*CNQL+0.201*QLTC +0.015*MTĐT \tag{1}$$

In which:

1. HTVB: Legal system on State management.
2. QLNN: State management model and management method
3. CNQL: Human resources involved in PPP
4. QLTC: Financial instruments and management
5. MTĐT: Investment environment of PPP

**V. PROPOSING SOLUTIONS**

From domestic and foreign studies on state management of PPP form; practical PPP investment methods in Vietnam and international experience; combined with re-testing through the above regression equation, the authors propose a system of solutions, in order to complete the state management of BOT investment projects of road traffic infrastructure in Vietnam.

**A. Completing the legal documents on state management**

The system of sub-law documents should ensure "Legality - Validity - Feasibility - Role and control function of state management" for PPP projects.

- Develop a separate set of legal documents for PPP projects (including adjustments to existing legal documents), on the basis of ensuring the following principles:

- + Clearly define roles, tasks, responsibilities, etc. of state management agencies from central to local levels.
- + Ensuring "Practical - International integration - The development of science and technology".
- + Regulations and responsibilities of the project appraisal council.
- + Provisions on the "Permissible adjustment period" for sub-law documents.
- + The role of experts and social critics before promulgating legal documents.

- Develop risk management process, risk responsibility and risk sharing mechanism, especially financial risk to ensure harmonization of interests between the State, society and investors. In particular, the risks of construction materials, site clearance, natural disasters, epidemics, etc. need to be developed into a specific handling process and specified in separate clauses in the contract, between the State management agencies and investors.

- Promulgating management sanctions and forms of handling violations to eliminate self-interested acts of group interests, causing bad consequences for the implementation of PPP projects.

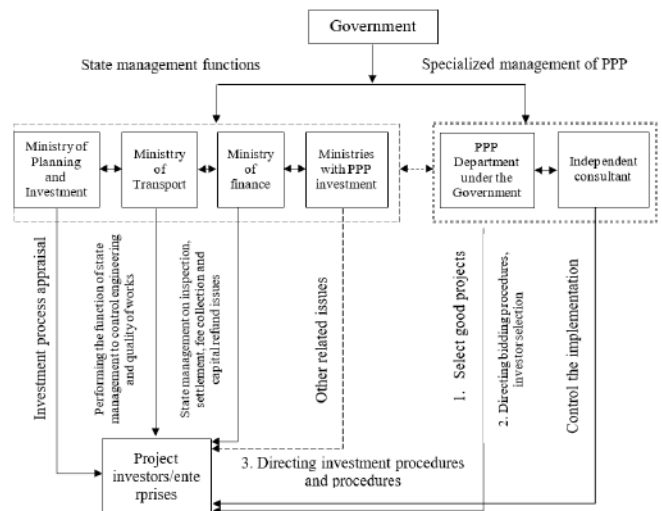
**B. Completing the state management model and management method**

The current management model is not effective because the investment costs of BOT projects are too high compared to similar public investment projects. This is shown through the examples in Section 3.1, causing many reactions about fairness, project transparency and group benefits, etc. The authors propose a management model BOT investment

projects of road traffic infrastructure in Vietnam, on the basis of compliance with the following basic principles:

- Separation of state management role and business management role in PPP projects.
- Ensuring the "Effectiveness - Efficiency - Sustainability" of state management for PPP projects.
- The state management model is decentralized by industry and by locality. And, in order to unify all activities with the right objectives, there must be a specialized agency (specialized in PPP). Ensure perfection in the direction of increasing decentralization and specialization. On the basis of clearly defining roles, functions and responsibilities between state management agencies and professional management agencies.
- Ensure "Publicity - Fairness - Transparency" to attract investment from domestic and foreign private investors.

State management model in PPP:



**Figure 2.** Model of management and control of investment in road infrastructure projects in the form of PPP in Vietnam [20]

Advantages of the model:

- Separation of state management and business management ensures fairness between the State and investors, minimizing group interests in investment.
- Mechanism for inspection and control of PPP projects ensures compliance with the law, clearly



defining responsibilities and obligations for monitoring and evaluation between competent state management agencies and project investors/enterprises, on the basis of reducing costs, reducing time and increasing quality, transparency and fairness for PPP projects.

- Mechanism to check, inspect and control the capacity of project investors/enterprises to implement PPP projects, especially the financial capacity is guaranteed. To ensure that investors mobilize enough capital to implement the project in accordance with the set goals and plans.

- Enhancing the community's supervisory role for the PPP project, in order to make the PPP project implementation process transparent, on the basis of ensuring the rights and responsibilities of investors and society.

- Coordination mechanism for implementation between agencies and levels (Ministry of Planning and Investment, Ministry of Transport, other ministries related to PPP investment, People's Committees of provinces/cities...), based on the assignment of responsibilities and how to coordinate in the entire process of project preparation and implementation.

Efficiency and science of the model:

With the model (Figure 2), for road traffic infrastructure PPP projects, the State needs to have a specialized agency to ensure the depth of business management and the ability to attract investment, establishing "The PPP Board" directly under the Government and has the same functions and powers as ministries and branches.

- The PPP Board has the functions of performing good project selection (investment urgency, socio-economic efficiency); Directing the process of project formulation and appraisal, organizing bidding to select qualified and experienced investors on the basis of transparency, fairness, increased competitiveness, and increased investment attraction; Directing throughout investment procedures. At the same time, the PPP Board signs contracts with independent consulting units,

controlling the entire project implementation process of the investor, in order to increase transparency.

- The Ministry of Planning and Investment is responsible for appraising the investment process.

- The Ministry of Transport performs the function of state management to control technical processes to ensure the quality of the works and the progress of the project.

- The Ministry of Finance shall perform the state management of payment, settlement, financial issues related to investment, collection of payback fees and other costs related to the project.

- Other ministries and sectors related to PPP investment in road transport infrastructure will coordinate with the PPP Board to resolve related issues. Thus, with the model (Figure 2), it is clear that the important role of the "PPP Board" is directly under the Government (instead of the Ministry of Planning and Investment as before). At that time, the PPP Board only specializes in managing PPP projects. Particularly, the state management function will belong to the ministries and branches with PPP investment, in order to increase the publicity, transparency and fairness of the project. Therefore, creating a basis for attracting investment, achieving project efficiency, and contributing to the development of the project, socio-economic development of the country, avoiding conflicts compared to the projects implemented in the previous period.

For projects under localities, the guiding role belongs to the Provincial People's Committee, while other actors (Departments, branches) are similar to Figure 2.

### **C. Improve professional qualifications and awareness of human resources participating in PPP**

With the model (Figure 2), individuals and departments are involved with responsibilities in state management process for PPP projects. So, to perform the model well, it is necessary to have competent PPP human resources to complete the tasks. Therefore, it is necessary to train people to participate in PPP from

both perspectives: the management staff of the State Administration and of the project investors/enterprises.

### **1. Management staff (economic management, technical management) of the State Management**

- Members of the state management apparatus participating in PPP investment must have a deep understanding of PPP, know how to apply and decide in accordance with each content and characteristics of each type of PPP investment.

- Officials of the State management agency must have the capacity, responsibility and experience to control the investment, negotiation and signing of PPP contracts.

- PPP managers need to be trained and updated regularly, in order to improve their professional capacity on PPP. On the following aspects:

+ Capacity to synthesize and consult.

+ Competence in appraisal and financial management.

+ Capacity to monitor and manage PPP contracts.

- Organize recruitment for civil servants and public employees based on the principle of "Competition - Publicity - Transparency", in order to select officials with ethical qualities, qualifications about investment and PPP projects.

- Expanding international cooperation to improve project management capacity by PPP method.

- For large-scale projects, consider hiring consultants with expertise in PPP or experts to assist the state in analyzing and evaluating PPP projects in order to limit risks.

### **2. Management staff of project investors/enterprises**

The management team of the project investors/enterprises needs to ensure that their quantity and quality match the project requirements.

Organize short-term and long-term training courses on PPP project implementation experience (The State needs to stipulate that PPP certificates are required for organizations and individuals of project investors/enterprises when participating in PPP investment projects).

Building a unified system of PPP project management apparatus of investors, on the basis of clearly defining the roles and responsibilities of the departments and individuals controlling the project (design unit, investor supervision, construction, equipment supply, etc.)

### **D. Building financial instruments and controlling PPP project finance**

Due to the lack of public investment capital, countries, including some developed countries, use the public-private partnership (PPP) method. However, some countries succeeded, and some countries failed due to the lack of a legal framework, processes, standards or lack of financial support tools [21]. When investors have to mobilize short-term capital up to 80% through banks, but the State has no tools to support the implementation. Therefore, the authors propose solutions to build financial tools and control finance as per the following contents:

#### **1. For the state:**

- Perfect the financial and budgetary mechanism for PPP projects. It is possible to study and arrange centralized budget sources at the central level exclusively for PPP projects and allocate to localities in each period, in accordance with the public investment plan and the medium and long-term financial plan, to serve the project preparation (site clearance, change of production structure, etc.)

- Proposing the investor's loan interest rate for the prioritized project (lower than the average rate of commercial banks), proposing state capital to participate in the project by many sources (Concentrated budget, or fund to cover the financial shortfall), it is possible to establish a PPP Bank as a dedicated bank.

- Develop a mechanism to mobilize capital from investors. There can be many options to mobilize capital such as ODA capital, preferential capital sources of the State.

- Develop regulations on payment methods and conditions for project investors/enterprises with the State's capital.
- Research on O&M investment form, in order to reduce interest expense, increase investor's ability to quickly recover capital and minimize force majeure risks.
- Research and supplement regulations on ETC method and appropriate service prices.
- Building risk sharing tools for projects such as guaranteeing revenue, foreign currency conversion, planning changes, etc.
- Enhancing the role of the State Audit in controlling capital sources, taking measures to support or make adjustment.

## 2. For project investors/enterprises

Establishing organizations to raise idle capital of small businesses and investors in various fields on a transparent basis to raise capital.

### E. Improving the investment environment for PPP projects

Investment environment here is understood as objective and subjective environment. The environmental factors are calculated and forecasted in advance, it will reduce risks for the project. Managers have preventive or countermeasures to ensure the safety of the project, speeding up progress, reducing costs, etc. to quickly put the project into operation, contributing to economic development.

#### 1. Objective environment

- Risks caused by political and economic instability in the world and in the country (war, riots, crises, etc.)
- The fluctuations of nature (weather, unusual rain and flood, earthquake, climate change,...) have an impact on the project.
- Response plans must be developed to increase prevention and proactively handle plans.

#### 2. Subjective environment

- The State needs to create a healthy, equal and non-discriminatory competitive environment for all economic sectors.
- Complete support mechanisms and policies to attract investors to participate in PPP projects such as exemption and reduction of value-added taxes, corporate income tax, etc.
- Building the Government's website on PPP investment, creating a public investment environment and transparent information about PPP.
- Develop a management process for PPP projects, ensuring to encourage innovation and responsibility of PPP project implementation parties.
- Promulgate regulations on organizational structure of project investors/enterprises to implement PPP projects. On the basis of ensuring the number of personnel, the organizational structure, in accordance with the scale and technical requirements of the project.
- Develop processes for public evaluation and selection of qualified project investors/enterprises for project implementation.
- Simplify administrative procedures for PPP projects, in order to shorten the project implementation time, thereby reducing risks for project investors/enterprises, and increasing project efficiency.

## VI. DISCUSSION

Within the collected research samples, the authors, through qualitative and quantitative analysis, have identified five groups of factors that have major impacts on state management in the form of BOT and are ranked according to the degree of gradually reduced impact including:

1. Legal system on State management ( $\beta_1=0.325$ );
2. State management model and management method ( $\beta_2=0.321$ );
3. Human resources involved in PPP projects ( $\beta_3=0.297$ );
4. Financial instruments and management. ( $\beta_4=0.201$ );

### 5. Risk management ( $\beta_5=0.015$ ).

With the results of this study, it is shown that in order to ensure efficiency for the state management of road traffic infrastructure PPP/BOT projects in Vietnam, is necessary to identify to have regulations by the system of legal documents in order to manage and control these five groups of factors in the strictest way. In which, the group of factors of the legal system on State management and State management model and management method in the form of PPP should be carefully considered. Since in recent years, BOT projects implemented in Vietnam have many potential risks in terms of progress, cost, quality, etc., mainly arising from legal system that have not been issued in a timely manner. According to reality, the state management model has not separated the state management role and the business management role in PPP projects, leading to difficulties and confusion during project implementation. In addition, it is necessary to improve the level of expertise and awareness of human resources participating in PPP. Because in many projects, human resources are not qualified enough, causing economic losses to the State budget. Recently some PPP projects must be converted to public investment because they cannot attract investors, typically the East North-South highway project in the 2021-2025 period. This shows that state management needs to improve the investment environment for PPP projects, by building effective financial tools to support investors during project implementation.

The research results have overcome the shortcomings and limitations of previous studies locally and internationally on state management of road traffic infrastructure projects, specifically:

- Analyze and evaluate in detail the shortcomings and limitations in the state management of road transport investment projects in Vietnam, through the practice of a number of BOT projects that have been implemented in the past time.

- Identify and evaluate the level of factors affecting the state management of investment projects of road traffic infrastructure in Vietnam.

- Proposing a state management model to separate the functions of state management and business management.

The study achieved the following results:

- Theoretically: this study complements and continues the background studies in the world and in Vietnam on the principle of ensuring the success of the PPP projects.

- In terms of practice: the study points out the groups of factors that greatly affect the state management of PPP/BOT investment projects, thereby helping project participants (competent state agencies, investors, ...) get a comprehensive perspective through the implementation of BOT projects in Vietnam. Then, they can gradually improve the investment model in the form of PPP in general, form of BOT investment in particular.

## VII. CONCLUSIONS

In Vietnam, the practice of implementing PPP projects shows that this is an ongoing process of both implementation and adjustment. A problem with many variables, many impacts, for which the successful condition requires a high socio-political consensus, to really put public services to serve the interests of the citizens. In economic terms, it must follow the principles of the competitive market and share benefits between the state and project investors/enterprises.

Research results are on scientific and practical basis, providing more feasible and effective tools for the state management of PPP/BOT projects. More specifically, managers/management agencies need to focus on implementing the following contents:

Firstly, perfecting the system of specific sub-law documents for PPP projects. International experience shows that, for successful PPP investment in other countries, in addition to the very stable legal system

promulgated by the Government and the system of sub-law documents issued by the central state management agency, state management in promulgated by localities, it is necessary to ensure the timeliness, consistency, closeness to reality, long-term life of the projects. This guarantees the effective implementation of the management role of the State management in unifying the subjects and properly implementing the set objectives.

Secondly, the role of state management is very important for successful PPP projects. In particular, the factor "State management model and management method" is a crucial factor to ensure effective management of PPP projects. It can be seen that the form of PPP is a special form of investment, so it is very important to build a separate model for PPP, in order to separate the roles of state management and business management. And, at the same time, it can ensure specific responsibilities among departments, sectors and the PPP Board (Figure 2). Thereby, increasing the publicity, transparency and fairness in the PPP investment.

Third, for effective project implementation, the role of human resources participating in PPP is always the core factor. This indicates that, in order to attach the responsibilities of individuals and departments to the process of state management of PPP projects, it is necessary to train people to participate in PPP from both angles: the management team of the State management and business management team of the investors.

Fourth, for effective project management, the financial factor is always carefully considered and evaluated. In particular, for the form of PPP with capital contribution from the State and project investors/enterprises, it is necessary to develop financial instruments and control finance from both the State's and project investors/enterprises' perspectives. In which, the State must develop financial instruments and control the state capital invested in PPP (from the state budget, ODA loans, etc.); project investors/enterprises ensure PPP

investment capital (from equity and bank loans or other mobilized capital).

Fifth, a PPP project with large investment and a long investment period will expose to subjective and objective risks. In order to attract investors, the State must ensure an attractive investment environment on the following principles: adequate legal environment; appropriate incentive mechanism; reasonable risk sharing between the State and investors, etc. on the basis of ensuring a healthy, fair, open, transparent and non-discriminatory competitive environment for all economic sectors.

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# Hi-Tech Automation Technology for Old Age Home

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## ABSTRACT

Smart old age homes are recognized as a suitable medium for an independent and comfortable existence for older and disabled people in the present era. The wireless home automation system used in this research enables fall detection, Bluetooth control switching, location tracking, and health monitoring. The Home appliances like a TV, light, or fan can be remotely controlled using a Bluetooth control switching system. etc. Clinical viewpoints and heavy use of the location tracking and health monitoring system care. To prevent accidental injury and death, a fall detection system has been incorporated. This document will to create a smart senior home, put your attention on integrating automation and health monitoring systems.

Keywords : Arduino , Bluetooth control switching system

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## I. INTRODUCTION

Recent statistics show a rise in the population of senior citizens. Age-related physical weakness makes elderly persons more vulnerable to accidents of various kinds. On the other hand, some persons have physical limitations that prevent them from doing certain motions and tasks. An assisted-living facility might be one of the better options for a lot of senior people. However, the annual cost is very high. Even if the majority of older people want to remain in their homes, it is still necessary to regularly monitor their activities and health in order to offer them prompt assistance. A smart home is a technologically advanced home that allows for increased security, easier communication, and automation of household tasks.

Being able to stay in their homes, where they feel more comfortable, and regularly monitor their health through the applications, smart homes can significantly improve the lives of the elderly. Smart homes can assist caregivers in many ways to enhance the quality of the services they offer because they are designed to cater to the particular needs of the elderly. In residential health and surroundings, smart home systems may typically be built and maintained without any complication. Intelligent monitoring software tracks the use of household electronic appliances, gathers information from various health monitoring sensors, and instantly recognizes activity patterns in a smart home along with a complementing electronic system.

## II. SMART OLD AGE HOME

Modern sensing technology combined with smart houses can provide in-home, self-learning care solutions that can assist ease your mind by continuously monitoring the elderly. A control panel, a collection of distributed sensors and motion detectors to track a person's movements around the house and detect the use of electrical appliances, a collection of Bluetooth-based systems, mobile and web-based apps, and a remote management tool are the typical components of a smart home. The goal of smart home systems is to gather real-time data on monitored people's daily activity levels, medical issue levels, and learn to recognize their unique patterns in the process. Smart home systems warn the manager of the senior living facility and the rest of the management team when those monitored patterns depart from the norm patterns, enabling them to take immediate action.

The majority of smart home features rely on a wireless sensor. In order to measure physiological characteristics, the wireless sensor comprises of numerous distributed sensor nodes placed throughout the surroundings. The wireless sensor network detects daily activities and aging-related lifestyles of senior people living in old age homes as it gathers information about the monitored person's health and activities. Based on the classification model of regular and irregular sensor activity, smart homes enable the prediction of the unexpected behavior of the monitored person using the created activity pattern. Smart house systems based on wireless sensor networks can be easily deployed in already-built homes with little to no alterations or harm.

## III. RELATED WORK

Since most smart home implementations generally make use of a wireless sensor network, researchers focus not only on hardware and software technologies designed to implement smart home functions but also

communication technologies. Considering the recent developments on wireless networking technologies for short-range applications and the communication requirements in the context of the smart home functional areas must be analyzed properly in order to qualify the suitability of candidate wireless standards. Liu in presents the design and implementation of a prototype smart home system based on ZigBee and GSM/GPRS network. The author explains not only the design of the home network but also how the smart home functions are remotely monitored and controlled. Mendes et al. in investigate the suitability of short-range wireless technologies for smart home services. The authors prove that none of the analyzed wireless protocols alone appears to satisfy the communication requirements of smart home functional areas as a whole. However, ZigBee stands out as the best one for smart home network services with low to medium data rates and reliable data communication.

In order to mitigate the impact of wireless interference on smart home networks, eliminate the need for relay nodes and reduce unnecessary energy consumption, Li and Lin in combines the advantages of wireless sensor networks and power line communications. The architecture they proposed employs the power line communication as the network backbone and the wireless sensor network for data sensing and is scalable. Similarly, Ferreira et al. in investigate the use of ultra-wide band receivers for low bit-rate data communication transceivers for smart home applications. On the other hand, Tiwari et al. in propose the use of visible light time division duplex technique for bidirectional data transmission between multiple devices.

Although design and development of smart home systems for the elderly has gathered a lot of interest in both the academia and the industry, most of them focus of sensor technologies and communication requirements. However, the major problem here is



that most of the available sensors are unable to make the distinction in the monitored health and environment. In this respect, Charlon et al. in propose a system to monitor daily activities of the elderly in their living environment. The proposed system includes a set of motion sensors network deployed on different areas and an electronic patch worn by the monitored person to identify him/her and detect falls. The proposed system relies on a novel analysis algorithm to detect abnormal situations and alert the nursing staff in real time.

#### IV. BLOCK DIAGRAM

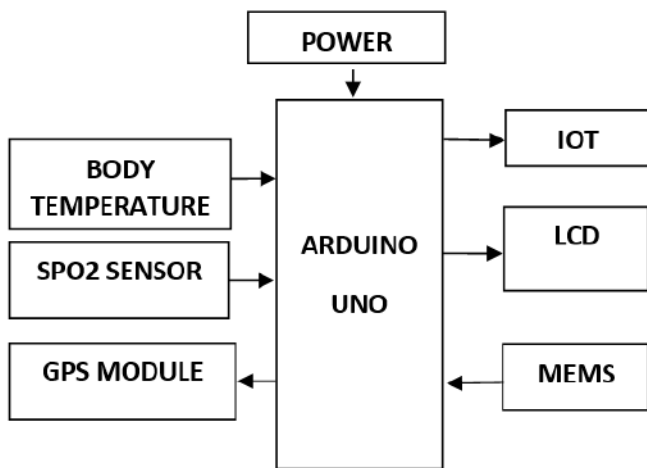


Figure 1 : Block diagram for Health Monitoring system

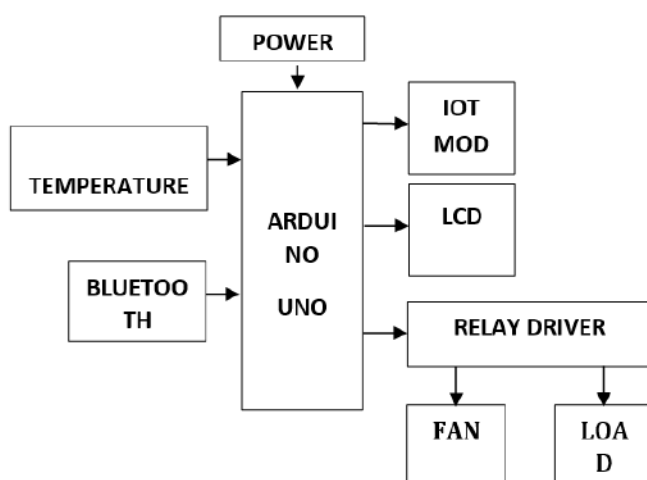


Figure 2 : Block diagram for Appliance Monitoring system

#### PROPOSED SMART OLD AGE HOME APPLICATION

As shown in Figure 1, similar to common smart home systems, a set of sensors and detectors are used to gather data and control health and action. The data gathered by the sensors are sent to the monitoring software running on the Arduino board shown at the center in Figure 1. The values in the gathered data are sent to the system’s users and are compared with the previously set values to decide whether to trigger an alert/alarm or not. A prototype smart home was developed in this study to carry out a set of experiments. Before the installation, the system was designed and tested.

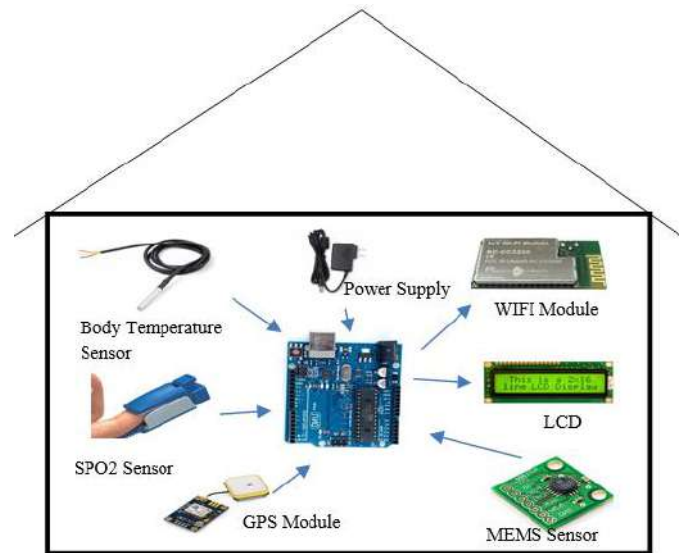


Figure 3: Interface for Health Monitoring system

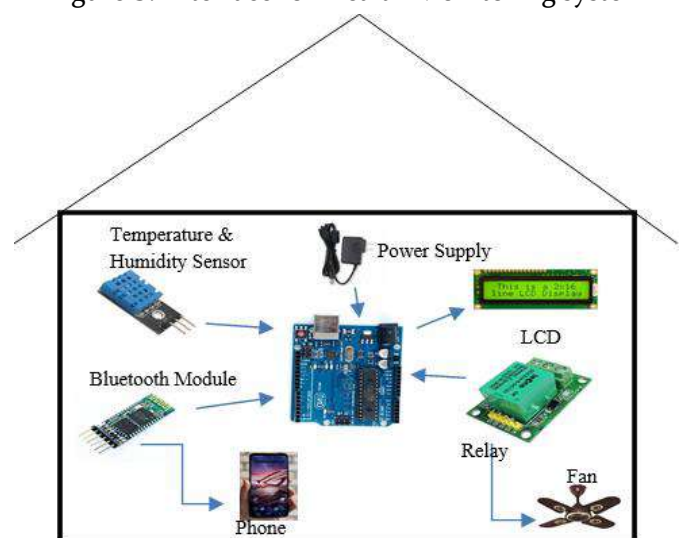


Figure 4: Interface of Appliance Monitoring Unit

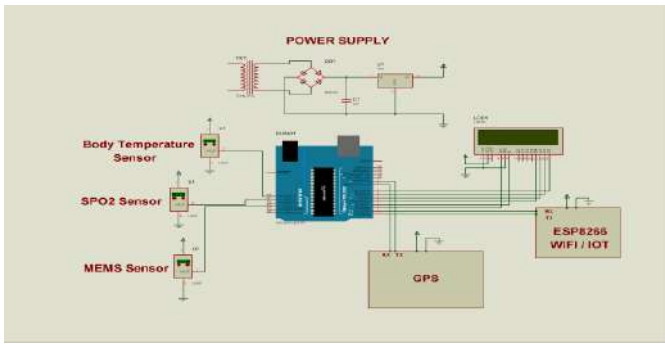


Figure 5 : Software Connections of Health Monitoring System

In prototype when the sensors are connected to elderly, it calculates the sensor levels and send to Arduino uno

board. Then it transfers the data to web-based applications. The monitoring software has a web-based interface and hence is accessible by mobile devices such as smart phones. In the web-based interface, the user is able to manage some specific activities, see triggered alarms/alerts, and read current or logged sensor values. Whenever a user accesses the monitoring software, the user’s identity, login and logout dates and times, and the user’s activities on the monitoring software are recorded. The application presented in this paper is just a simple example of smart home applications and it is still under development.

V. FLOW CHART

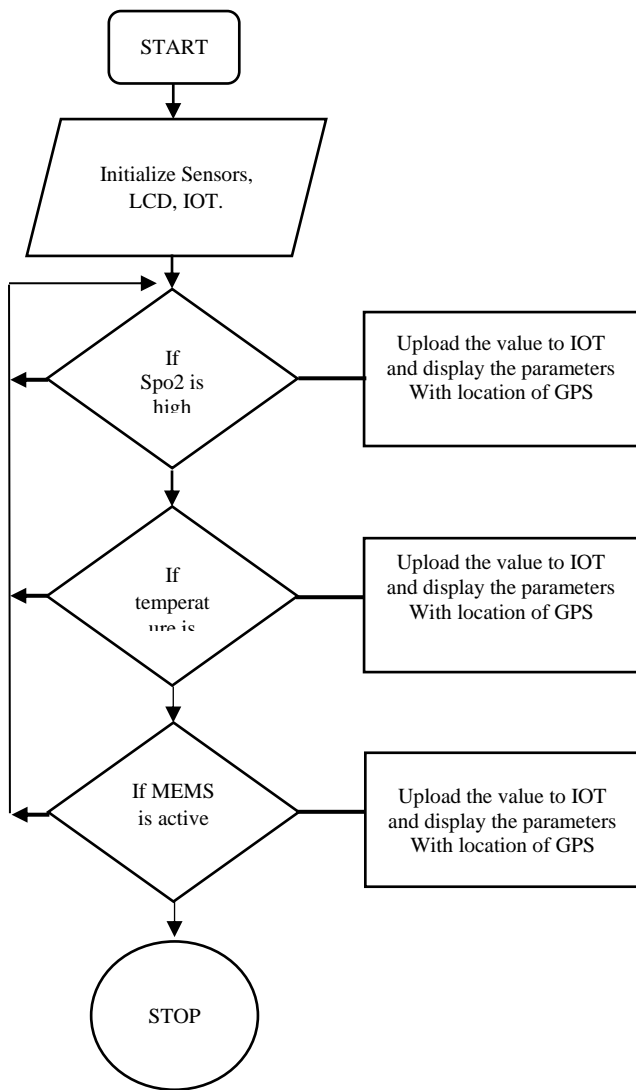


Figure 9 : Flow chart of Health Monitoring System

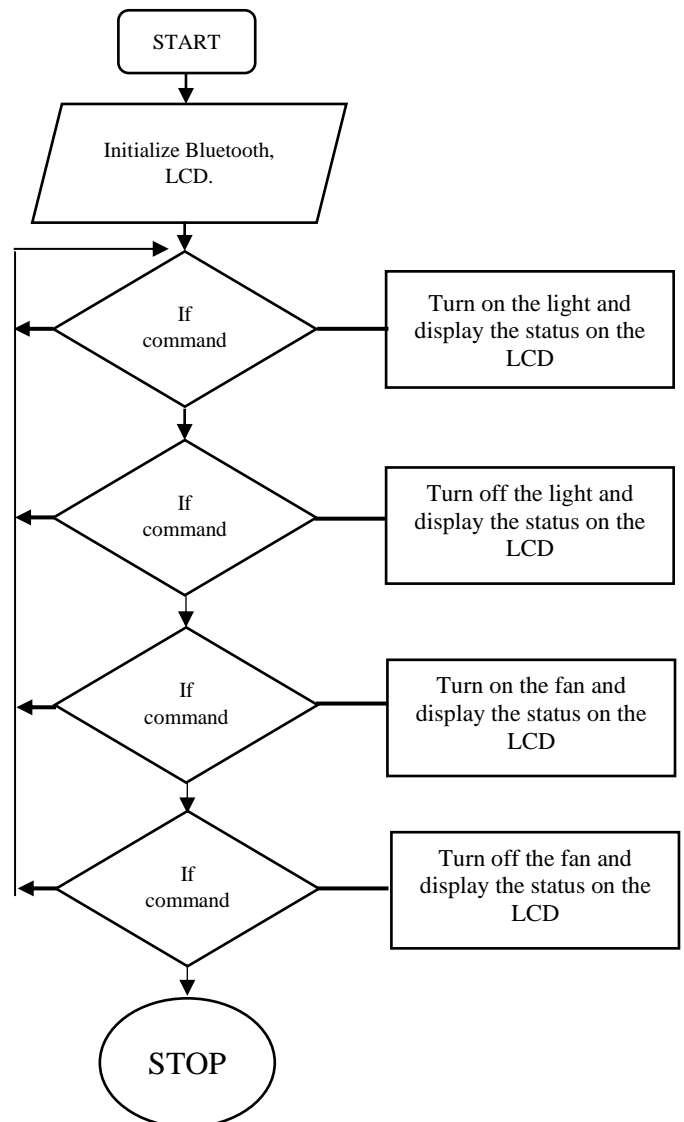


Figure 10 : Flow chart of Appliance unit Monitoring system

## VI. CONCLUSION

The project “DESIGN AND IMPLEMENTATION OF SMART OLD AGE HOME” been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

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# Electrical Safety Related Isolation on Industrial Machines with Multiple Entry Points

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## ABSTRACT

In industrial machine, there is often more than one entry point that might be used during the operation and maintenance functions. Typically, the lockout/tag-out procedures prior to entering the machine have been done using series-connected conventional load-break disconnect switches. Unfortunately, the required verification is problematic for applications requiring only one disconnect switch and is almost impossible when more than one disconnects switch is applied. Industrial equipment design must include safe methods to allow access for either maintenance or operational intervention. Although the overall safety elements of the industrial equipment design efforts are predominately a part of the mechanical machine's design, often, the motive forces that must be considered are directly or indirectly associated with the control of electrical energy. Considerations in selecting safe methods for intervention are those associated with ease of use (human factors) and those associated with equipment reliability. This Project new multiple entry point method is proposed industrial machines for Industrial Electrical Safety System.

**Keywords :** Electrical Safety System, Power System Control

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## I. INTRODUCTION

The "Permit to Work & Safety Tagging System (PTW & STS)" is the process, introduced in NDPL: -a power distribution utility- to put in place standard working practice which will promote a culture of safe working among its personnel while carrying out any work in electrical equipment/system. This in turn will ensure safety of personnel, safety of equipment and safety of society at large. This document defines the process of obtaining a permit to work on a certain electrical

equipment of NDPL and also puts in place the usage of the relevant "Tags" to designate the electrical equipment under maintenance or during any activity that puts off the circuit or abnormal conditions. NDPL system requires 'Power System Control (PSC)', Distribution, Network, Grid Maintenance and Projects personnel to coordinate and to carry out the work on the equipment / system. PTW & STS then becomes a "Safety Contract" between all the personnel and facilitates a safe working environment. The STS is used in conjunction with PTW or otherwise to provide

visible cautions / signage about the area and dangers associated with handling of the electrical equipment / system.

## II. SAFETY FROM THE SYSTEM

The erection of poles in accordance with this Live Working Procedure requires the issue of a detailed work instruction. This instruction shall define the work area by the provision of a detailed map or plan giving pole position and the precise Location of the new pole(s) which is (are) to be erected. The new pole construction type and height shall also be specified. All HV work on sites together with all associated Switching actions shall be carried out in accordance with a detailed Switching schedule. The detailed work instruction shall be issued by the Authorized Person in charge of the work. Throughout the course of the pole erection procedure, the Minimum Safe Working Clearance between any of the lifting equipment and the Live conductors, stipulated below, shall not be infringed

Minimum Safe Working Clearance at Low Voltage:  
1.0m

Minimum Safe Working Clearance at High Voltage:  
3.0

This clearance shall be applied in all directions from the Live conductor – it is NOT a vertical clearance only Throughout the pole erection process, the JCB or Hiab shall be effectively connected to earth via an Approved earth rod connected to the vehicle by an Approved Field Equipment Earth. Prior to the installation of the earth rod, it shall be verified that there are no underground services in the vicinity. The earth rod shall be positioned such that it does not pose a hazard to either the Controlling Craftsman throughout the course of the procedure or to the machine Operator who may require emergency egress from the machine. For HV work, and throughout the duration of the work the Control Person responsible for the circuit being

worked on shall where practicable, ensure that, the circuit protection is set to "one shot to lockout". Where this is not practicable, the Control Person shall be notified. In the event of a Live conductor being brought down into contact with the vehicle carrying out pole erection.

## III. AUTHORIZATION IN NDPL

a) Following are the functional areas in which staff will be identified for authorization to take charge of the equipment's for carrying out the activities of respective functions.

Distribution Network – Operation & Maintenance  
Grid Substation & Transmission Lines – Operation & Maintenance

Projects Testing & Protection and Automation will work under the PTW availed by owner member

b) All 'Section Heads' of the aforesaid functions will identify the members of their group who they deem fit (based upon the work experience / knowledge of the system / level) for working on the electrical equipment of NDPL network pertaining to the purview of their functional area.

A list (herein after known as "Tagging List") based upon the aforesaid exercise will be formed & forwarded to PSC after the due approvals from the functional heads as mentioned below.

## IV. IE RULES: AUTHORIZATION

The statutory document governing the criteria of authorization is "IE Rules 1956". Following are the References to the IE Rules pertaining to authorization

a) IE Rule – 3: Provides the details pertaining to the level of the individual who is to be authorized and the type of installation where he / she is purported to work

b) IE Rule – 36: Provides the details pertaining to the safety procedures and the related authorizations that need to be adopted while carrying out work on "Electric Supply Lines & Apparatus".

## V. SAFETY TAGGING SYSTEM

The safety tagging system is intended to achieve following standards in the working lives of the personnel in NDPL –

- a) Safety of the personnel and the public at large
- b) Safety of equipment & property
- c) Designate the abnormal conditions in the circuit of NDPL network

All circuits, equipment & systems are deemed to be in energized state unless the tags are placed to designate otherwise

## VI. DO NOT OPERATE (DNoP) TAG

1. DNoP tags are associated with the outage of the circuit/equipment for which the PTW is obtained from Power System Control.
2. DNoP will have the same number as the PTW for the circuit/equipment.
3. DNoP has to be filled by the permit holder and to be necessarily placed at all the isolating/grounding points for the circuits/equipment's that are taken out or isolated from the system & are not energized.
4. The Permit Holder to notify the Power System Control about the number of DNoP tags placed on isolating/grounding points for the circuits/equipment's that are taken out or isolated from the system & are not energized.
5. DNoP tags are to be attached to open switches, breakers, isolators, disconnects. Jumpers, taps, GO Switches & other means through which known sources of electric energy may be supplied to the lines & equipment.
6. The DNoP tag acts as a lock. Once the tag is attached to a piece of equipment that equipment cannot be connected to known sources of electric energy, not even for test purposes.
7. Personnel carrying out isolation operations of the particular equipment is responsible for placement & removal of DNoP tags.

The DNoP tags are of specific dimensions & are for the purpose of preventing the personnel from charging the equipment under outage hence have "RED" Colour with the danger mark.

## VII. TESTING STRUCTURES FOR INTEGRITY PRIOR TO UNDERTAKING WORK.

- Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment; and rescue of fall-arrested workers, among others.
- Establishment of criteria for use of 100 percent fall protection (typically when working over 2 meters above the working surface, but sometimes extended to 7 meters, depending on the activity). The fall protection system should be appropriate for the tower structure and necessary movements, including ascent, descent, and moving from point to point.

Open Bus Bar Substations Equipment used to designate a safe work area and access route within a Substation.

a) Safe Working Area: –

Red Cones (up to 7m apart), two orange ropes (10mm) used on each side of the yellow angled cross arm and Green Cones (up to 6m apart), define the safe working area within the roped perimeter. Only Authorized work may be conducted in these areas, with the approval of the safety document holder.

The higher side of the cross arm defines the safe side. Cones should be weighted with loose gravel for stability where appropriate. Access Route to Safe Working Area - Red Cones (up to 10m apart), used to define the access route, only one orange rope (10mm) on the high side of the yellow cross arm. Further procedures/information are contained in the Scottish Power Safety Rule, PSSI 6.

b) Transmission OHL` s: -

Tower Identification is determined by a number plate fitted adjacent to the property plate, which is fitted just

above the anti-climb device. This number provides a unique identification of every transmission tower.

Most towers carry more than one circuit, so each circuit has to be positively identified. Circuit Identification Colour Plates are located on each side of the tower, attached to the climbing leg above the anti-climb device.

Each circuit will be identified by a different Colour. There may be additional Colour plates on the tower at each cross arm.

c) Exclusion, Danger or Hazard Zone: -

Establishing and controlling an exclusion zone around the base of any structure being worked on, will prevent staff or third parties from injury due to falling objects, this is also considered demarcation. The demarcated area shall be physically controlled (minimum of continuous rope, chain or tape).

### VIII. WORK ISOLATED ORIGINS OF THE "SAFETY-DISCONNECT-SYSTEM" DEVICE CONCEPT

The unseen failure to open the power circuit can happen with either conventional mechanical load-break disconnect switches or when power contactors are used. One example with a disconnect switch occurs when the connection between the control handle and the actual movement of the power contacts fail. A normal manual load-break disconnect switch ordinarily has some form of spring assistance, which is essential for the load make and break operating mechanism to accomplish the needed arc extinguishing and to avoid the possibility of "teasing" the contacts. The requisite mechanical snap action is a factor in limiting the mechanical life of the device. Undetected failures to open the power circuit have been experienced in these types of switches, despite the operating handle's requirement typically found in standards: "When the handle on a heavy-duty switch is moved to its full off position, it shall be capable of positively operating the contacts to their off position without requiring spring assistance".

National Fire Protection Association (NFPA) 79 and IEC 60204-1 allow the use of a contactor to remove motive power for limited operator intervention; some methods also included the use of local indicators for verification. This limited acceptance indicated that the basics are present for a safe design using a contactor as a component of a device or unit.

### IX. SAFETY-DISCONNECT-SYSTEM CONCEPT EVOLUTION

Initial and subsequently later proposed disconnect-device or unit-design concepts were submitted to the Process Safety and Risk Management group at the Battelle Memorial Institute of Columbus, Ohio, to do an independent study of the risk seen by the operator. Battelle concluded that "the proposed (new) concepts were found to present the lowest risk to the operator". The Battelle studies were initially done in 1994 and later updated in 2001. The study results showed that the concept was directionally correct. The following items were submitted to the Office of Safety Compliance Assistance of the U.S. Department of Labor— Occupational Safety and Health Administration (OSHA), requesting a letter of interpretation/variance

- The initial safety-disconnect-system device concept description.
- The "results of the Battelle study" (1994).
- A "risk assessment of typical design requirements which were based upon the device concept;" other documents outlining the existing comprehensive Industrial Hygiene and Safety program in which the safety-disconnect-system device would be deployed. The resulting OSHA Interpretation letter agreed with the proposal and outlined the basic features of the safety disconnect-system device concept.

1) The system measures and ensures no (electrical) motive force to the drive system. Comment: Additional devices that incorporate the same concept to control



other motive forces on the machine such as pneumatic and hydraulic are being and have been developed.

2) The system provides fail-safe verification, i.e., defaults to the safe position. Comment: The devices being developed today use several mechanisms to make the fail-safe verification possible, either by prohibiting the machine from having motive force available or by preventing access to the hazardous portions of the machine.

3) Verification is provided by a system, which checks the position of the contactor and actively confirms zero energy state to the drives before the verification light comes on. Comment: This would also include checking the change of state of other related components, whether a contactor or some other component is used to achieve the zero-energy state.

4) When an individual initiates the lockout sequence by opening the system switch and placing a lock on it, then the verification light will come on, if the machine is at a zero-energy state (electrical motive energy).

Comment: From a generic point of view, the requirement is as follows:

The individual initiates the request to enter the machine, gets from the device a positive indication that the motive force has been safely controlled or removed, and

## X. "SIE" DEVICE

The concept has been translated into design requirements which have resulted in several device designs. Many of the present executions of the concept are devices, which among their components include one or more power contactors. The contactor is only a component of the device or unit, NOT the complete System Isolation Equipment (SIE) device or unit. In order to correct this misinterpretation, several names have been tried for the devices)

- Safety Lockout System.
- Grounding Isolation System.
- SIE

The following general descriptions pointing toward the device concept have been published in application standards:

1) redundantly monitored remotely operated contactor isolating system that incorporates control lockout provisions and is listed for disconnection purposes.

2) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1 as well as a utilization category defined in the product standard as appropriate for on-load switching of motors or other inductive loads.

The term SIE is defined in the 2005 and 2008 editions of the National Electrical Code (NEC). 430.2 Definitions: SIE. A redundantly monitored remotely operated contactor-isolating system,

packaged to provide the disconnection/isolation function, capable of verifiable operation from multiple remote locations by means of lockout switches, and each having the capability of being padlocked in the OFF (open) position. The SIE is recognized as a disconnect means in the 2005 and 2008 editions of the NEC. 430.109(A): (7) SIE. A SIE shall be listed for disconnection purposes. SIE shall be installed on the load side of the over current protection and its disconnecting means. The disconnecting means shall be one of the types permitted by 430.109 (A) (1) through (A) (3). Comment 1: "SIE shall be installed on the load side of the overcurrent protection and its disconnecting means." See Figs. 1–3. Comment 2: The other 430.109 (A) types:

- motor circuit switch.
- molded case circuit breaker; and
- molded case switch.

A third-party listing standard of the SIE [Underwriters Laboratories Inc. (UL) 6420 draft] is in its final stages of development; it describes the performance requirements and the test methods to proof those requirements for the disconnecting devices that are intended to meet the device concepts described in this project.

## XI. CONCLUSION

The control circuit components are selected to meet established construction and performance requirements. The proposed UL listing standard includes details of such requirements and methods for them to be evaluated. The severest hazard being mitigated by the SIE for connected equipment circuits is electrocution; thus, the overall design requirements of the SIE device would be for it to achieve the required behavior of safety-related parts to category 4. In order for the internal circuits and components of the SIE device to achieve the safety performance of category 4, they have to be designed so that the following are achieved.

- 1) A single fault in any of the safety-related parts does not lead to a loss of the safety function.
- 2) The single fault is detected at or before the next demand upon the safety functions, such as immediately, at switch on, or at the end of a machine operating cycle. If this detection is not possible, then an accumulation of faults shall not lead to a loss of the safety function.
- 3) If the detection of certain faults is not possible, for reasons of technology or circuit engineering, then the occurrence of further faults shall be assumed. In this situation, the accumulation of faults shall not lead to the loss of the safety function. The present designs for the SIE involve circuits and equipment that can be evaluated in a deterministic fashion, and thus, the use of safety performance categories is the present practice. If future systems develop beyond the usefulness of deterministic evaluation, then probabilistic methods would be required.

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# An Outline of Wearable Gadgets

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## ABSTRACT

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It is envisaged that technology must be made good use in order to make life convenient and comfortable in this 21 st century; more convenient when the gadgets are handy. One of the things is the wearable gadgets to take care of the emergency needs and health care. This article tried revamp the current developments.

**Keywords :** Wearable Gadget, Sensors

## INTRODUCTION

A wearable device is a hot topic of these days, as announced by \$5,000 "Make it Wearable" challenge recently issued by Intel. This is challenge which is driving both designers and manufacturers in order to conceive, redesign, construct wearable applications which will shift from personal computing into new innovative on the development of the wearables.. Wearables have been a part of our life and an important digital transformation since many years . In 1980s, when the first digital hearing aids were first released, we could not imagine that today we find many benefits from them.

More generally the wearables may be helmets, lenses , rings , belts , shoes, shirts, gloves and some electronics gadgets etc used for convenience. Wearable technologies, wearables, smart-wears, tech togs, street-wear tech, skin electronics or fashion electronics are smart electronic devices (with micro-controllers) that are worn close to and on the surface of the skin, where they detect, analyze, and transmit

information concerning body signals related to vital signs, ambient data, that allow immediate biofeedback to the wearer. There are many exciting new wearable electronic devices on the market that measure blood pressure, offer sleep tracking, and let you control your phone and apps without actually using your phone. Till this day, the most useful options are watches, but rings, clothing, and especially head-mounted options make good showings. The most common current types of wearable technologies being Smart watches, Smart rings, Smart clothing, Advanced medical tech., Head-mounted displays (HMDs, Smart jewelry, Body-mounted sensors. , Fitness trackers, Smart clothing, ., Augmented reality (AR) headsets, VR headsets, AI hearing aids.

Some simple design considerations which must be kept in mind, when making a new development. In reality they are all part of the whole and must be considered in a totality. They are 1.) Understanding User Needs 2.) Choosing the Best Sensor Location, 3.) Considering the

type of Function, 4.) Displaying Data, 5.) Connectivity, 6.) Translating Data Into Action

The components components of wearables are

**1. Control** - Wearable-specific microcontrollers are small, so as to be comfortable and discrete. On the other hand, the distinctive shapes and colors can function as a decorative element. Several of the boards available are hand-washable (minus the power source). Read the documentation carefully.

**2. Input/Output** -

In place of pins, these boards have metal eyelets which you can loop conductive thread through to sew soft circuit connections. Some boards also have snaps — or eyelets large enough to solder on snaps — for easy removal.

**3. Conductive Textiles** A material containing metals, such as silver or stainless steel, through which an electrical current can flow is said to be conductive. Wearable systems can make use of these materials in a variety of ways, such as: Thread for making circuits, Fabric for capacitive touch sensors, Hook-and-loop for switches.

**4. Sensors** - Sensors gather information about the environment, the user, or both. Examples of the former include light, temperature, motion (ACC), and location (GPS). Examples of the latter include heart rate (ECG), brain waves (EEG), and muscle tension (EMG). A few wearable microcontrollers have basic sensors onboard. Other manufacturers offer a range of external sensor modules that connect to the main board.

**5. Power** - When scoping out a wearable design one of the first things to consider is the power requirement. Boards with an integrated holder for a lithium coin battery are nice for low-power projects that need to be self-contained. However boards with a standard JST connector (with or without a circuit to charge LiPo batteries) are more versatile.

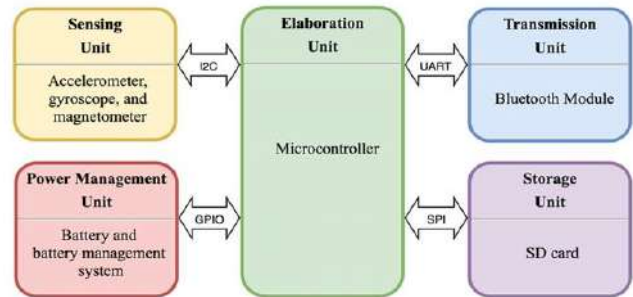
**6. Actuators** - One generic way to describe a wearable system is: In response to X, where X is the input from a sensor, Y happens. Actuators such as LEDs, buzzers or speakers, and servomotors are what make things happen.

**7. Networking** - To communicate with smart devices, the internet, or other wearable systems, you need wireless

connectivity. In addition to wi-fi and Bluetooth, wearable-friendly options include:

## THE HISTORY OF WEARABLE TECHNOLOGY

The origins of wearable technology goes back to 13th century when eyeglasses were first invented. In the 15th century, timepieces were created -- some of which were small enough to be worn -- but it was not until the 1960s



Block diagram of a wearable device,

1) that modern wearable technology came into existence. Further in 1961, Edward Thorp and Claude Shannon created wearable technology in the form of a tiny four-button computer that could fit into a shoe or be strapped around the user's waist helped. In 1970s Wearable tech gained popularity.. The first calculator wristwatch was released in 1975 by Pulsar and quickly became a fashion statement. In 1980s Sony released the Walkman and it became the most popular wearable music device throughout the 80s. The healthcare industry was also transformed with the release of the first digital hearing aids in 1987. In 1990s Steve Mann, a Canadian researcher, invented the wearable wireless webcam in 1994. The bulkiness facilitated the use of future IoT technologies. In 2000s, this saw an explosion in wearable technology with the introduction of Bluetooth headsets, Fitbits and the Nike plus iPod Sport Kit. 2010s is a period which was the tipping point for wearable technology. Google Glass entered the scene in 2013, while the Apple Watch debuted in 2015, followed by The Oculus Rift Headset in 2016. 2020s is the gaming industry, continues to add newer AR and VR headsets, while

clothing designers are rapidly bringing smart clothing to the mainstream.

## 2) THE FUTURE OF WEARABLE TECHNOLOGY:

Wearable technology is becoming increasingly popular and is all set to revolutionize the future. It may be noted that fitness trackers, smart devices, intelligent clothing and VR and AR headsets have gained widespread approval but, they are only a small part of the problem

The biggest challenge for the wearable industry is to get a sustainable customer engagement. Many wearable electronics are short lived because of its short term customer engagement. Bad quality, pain to sync with smartphones, poor battery life, uncomfortable and awful design, UX problems, are some of the functional reasons which put the user off the device. Wearable devices which are very strong functionally and physically and they failed to create any meaningful impact on the users due to their lives, habits or behaviors.

Some futuristic products and concepts are Apple **Glasses**. Initial reports from Bloomberg and The Information suggest that these AR smart glasses are designed to transfer information from a user's phone to their face. These glasses will be able to synchronize with a wearer's iPhone to display texts, emails, games and other item.. These Apple Glasses could be released by 2023.

**Energy harvesting** is being researched and could prolong battery life by converting body heat, movement or solar energy into power. Piezoelectricity is one example of energy harvesting, where piezoelectric ceramic is used to convert the body vibrations into energy. But one drawback of using wearable technology is that it must be taken off for regular charging.

**Smart contact lenses** - Nothing short of a sci-fi movie, smart contact lenses that can deliver real-time

information to the human eye will be available to consumers soon. Tech giants, including Google, Mojo Vision, Samsung and Sony, are working on developing these soft electronic smart contact lenses that can sync up with smartphones and other devices to provide real-time, hands-free information along with vision correction.

**AI for the human brain** - Facebook is developing a brain-computer interface that could enable people to type Facebook status updates by using their minds instead of typing. Elon Musk's company Neuralink is supposed to be working on an interface that could help people who suffer from traumatic brain injuries.

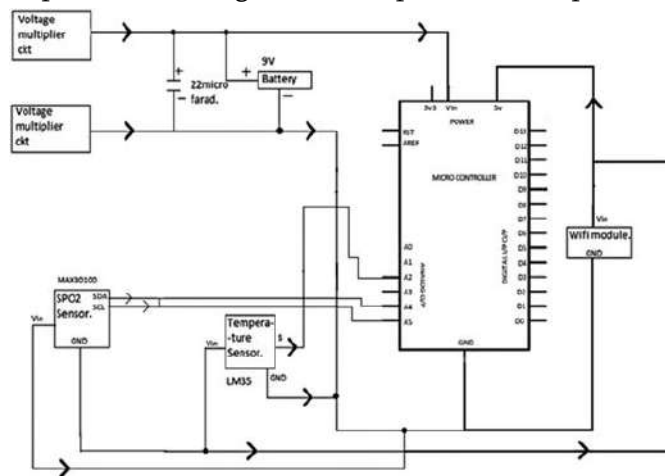
## FACTORS THAT AFFECT THE SUCCESS OF A WEARABLE:

The various factors that affect the success of a wearable related to hardware design are 1.

**Low power design** - Low power consumption is critical to wearable designs and the device last longer before each charging cycle. Low power consumption is important to wearable designs and many developers are shifting to low power consumption design that is helpful to make the device long-lasting before each charging cycle. 2. **Connectivity protocols** is very important when it comes to wearable devices. One of the commonly accepted and used connectivity protocols is Bluetooth 4.2. 3. An excellent alternative when you have to transfer small quantities of data or only transfer across operational leadership particularly in 2.4GHz range. Due to low energy consumption, it allows a broader range, as it does not require more 3V battery to work. Low power consumption provides a reduction in the measurement of the battery, as well as the size and weight of the product. This in aid also decreases the cost. **Battery**. Various components in a wearable device like microcontrollers and sensors among others. This means that these components require power to perform their tasks wearable devices need to be small in size and they are also portable. Also maintaining the compressed nature of the design

factor, one of the batteries' prototypes for wearables is lithium-polymer. They are flexible and are available in several sizes and are also be customized. 4. **Human factors engineering** is one which influences hardware design of a wearable device. Human factors can include any hazard caused by faults in the device, effect of any kind of radiation emitted by the device, any harm caused to human body, and usability. Usability tests with users can be conducted in between iterations in

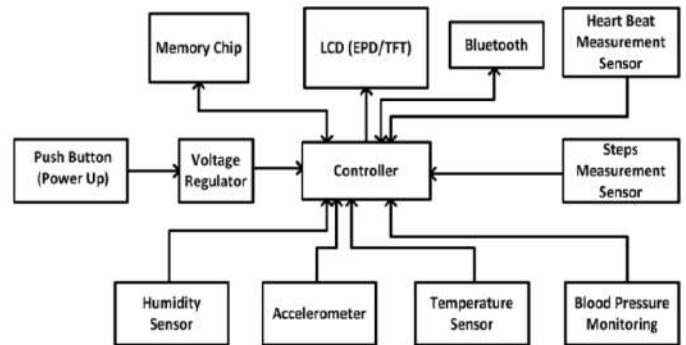
order to capture their feedback or interactions and implement changes to improve the product.



Circuit diagram and connections for the device

In fact one of the main factors that affect the achievement of a wearable product is Embedded Hardware Design. Power concerns were paramount, because without power to bring them to life, electronics are just dead metal. Wearables are electronic technology or devices incorporated into items that can be comfortably worn on a body. These wearable devices are used for tracking information on real time basis. They have **motion sensors** which take the snapshot of your day to day activity, and sync them with mobile devices or laptop computers. After the invention of smartphones, wearable electronics are the next big innovation in the world of technology.

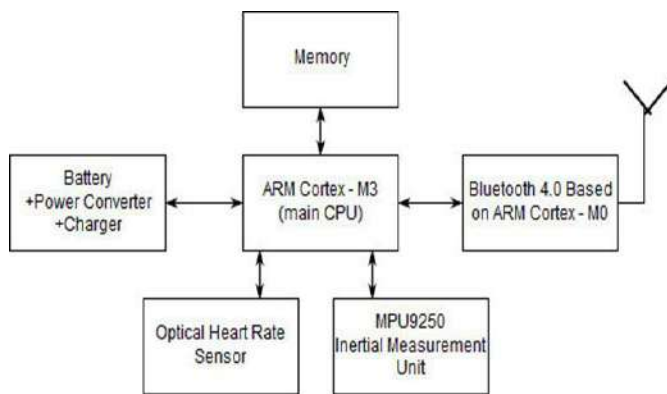
Wearable technology and wearable devices were used in the **field of military technology since a long time**. Further these devices were an integral part of the medical and healthcare sector in the military forces. 'Wearable Motherboards' or 'Smart Shirts' are also used to monitor the health of the patients.



Designing wearable that sense, think and communicate

**AI IN WEARABLE DEVICES:** The complex and massive data requires stronger data processing technologies. Making wearable technology intelligent, so that the value the users get at the back of every interaction should be high. This preparation has been given the name of Wearable AI. As you can infer, the sector is what has emerged out of the incorporation of Artificial Intelligence and Wearable tech in the world. Wearable devices are used for augmented, virtual, and mixed reality, artificial intelligence, and pattern recognition. These technologies commonly contain microprocessors and sensors. Additionally, these devices are usually capable of recording data and exchanging them to others over wireless connections. Various AI techniques such as supervised, unsupervised, semi-supervised and reinforcement learning (RL) have been in use to carry out various tasks. The AI based smart watches that are available in today's market have the best performance, design with several functionalities. AI enables these smart watches to track and keep a record of personalized preferences and activities. It helps in maintaining our health and with daily fitness goals.

**IOT IN WEARABLE DEVICES:** The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and have the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A complete IoT system integrates four distinct components: sensors/devices, connectivity, data processing, and a user interface.



Wearable sensor block diagram

Firstly, sensors or devices collect data from their environment. This could be as simple as a temperature reading or as complex as a full video feed. The sensors and devices can be connected to the cloud through a variety of methods like cellular, satellite, Wi Fi, Bluetooth, low-power wide-area networks (LPWAN), or connecting directly to the internet.. Once the data gets into the cloud, software performs a kind of processing on it.

A user might have an interface that allows them to proactively check in on the system. For example, a user might want to check the video feeds in their house via a phone app or a web browser.. Depending on the IoT application, the user may also be able to perform an action and affect the system. For example, the user might remotely adjust the temperature in the cold storage via an app on their phone.

Sometimes some actions are performed automatically rather than waiting for you to adjust the temperature, the system could do it automatically via predefined rules. And rather than just call you to alert you of an intruder, the IoT system could also automatically notify relevant authorities.

#### HOW AN I.O.T. SYSTEM IS USED IN THE DESIGN OF WEARABLES

-- An IoT system consists of sensors/ or devices which “talk” to the cloud through some connectivity. Once the data gets in to the cloud, software processes it and then decides to perform an action, like sending an alert or automatically adjusting the sensors and devices without the need for the user.

If the user wants to check in on the system, a user interface allows them to do so. Any actions that the user makes are sent in the opposite direction through the system, from the user interface, to the cloud, and back to the sensors to make the necessary changes.

User **interface, convenience, and privacy** concerns prevent people from using their wearables as part of the "internet of things" (IoT).. Wearables are the most visible consumer internet of things ( IoT ) technology. IoT refers to electronic devices that can be connected through internet networks. Wearables connect people to the “internet of things” through direct contact with your body – on a wrist with smart-watches or fitness trackers or on a face with smart glasses or necklaces, and virtual reality (VR) headsets. IoT-enabled medical wearable devices provide individuals the information needed to achieve better health outcomes. Health care wearables improve visibility into relevant aspects of an individual's health status. Benefits include - Real-time health monitoring. Wearable IoT devices are a key part to remote patient monitoring. Doctors can easily and reliably track health vitals, physical activity, and other vital aspects that lead to adjustments to treatment plans or interventions.

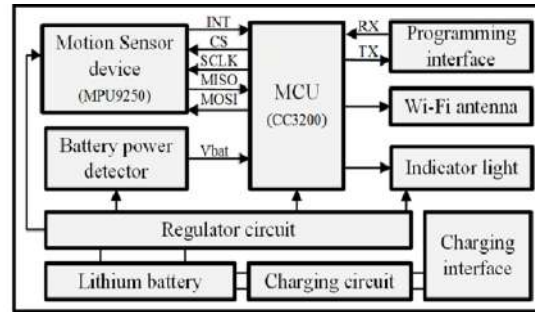
**WEARABLE ASSISTIVE ROBOTICS:** Wearable assistive robotics is an emerging technology with the potential to assist humans with sensorimotor impairments to perform daily activities. This assistance enables individuals to be physically and socially active and perform activities independently aiming at quality of life. These benefits to society have motivated the study of several robotic approaches. Developing systems ranging from rigid to soft robots with single and multimodal sensing, heuristics and machine learning methods with autonomous control are also some of the investigations being carried out. The current challenges and trends for the design and deployment of wearable assistive robotics include clinical and user needs, material and sensing technology, machine learning methods for god perception and control, adaptability and acceptability, datasets and standards, and translation from lab to the real world.

**HARDWARE ASPECTS OF WEARABLE DEVICES:** Here we are interested in as to how data is processed in wearable devices through sensors. The 6 Key Challenges of Wearable Product Development are

- 1) Battery Life - Battery life is one of the biggest challenges in wearable tech today. Wearable
- 2) Ergonomics - Ergonomics and comfort are of prime importance, when devices are to be worn for a long time
- 3) Differentiating and Providing Value - people buy a story to which they can relate to and express themselves about the product which appeals at an emotional level, aesthetically pleasing and marketable.
- 4) Sealing - Waterproofing is another challenging area for wearables.
- 5) Miniaturization and Integration - Effective integration of multiple antennae with reasonable signal strength at small size is difficult.
- 6) Safety, Security and Privacy - Lithium batteries can be dangerous if mishandled and are of substandard

quality, Wearable devices containing these batteries being so close to the body all the time, there is a potential safety risk.

**NEW ALGORITHMS FOR WD s:** Several years ago, wearables were still a relatively unknown device category, but today you'd be hard pressed to find a tech company that isn't involved in the wearables market.



Hardware diagram of the wearable device

Wearable players find ways to differentiate their software experience — because a wearable without good software is just jewelry worn for the sake of fashion.

Algorithms must ensure that the data should be accurate and has a wide array of movements and users. It isn't just having algorithms go beyond steps to track a more diverse range of body actions – it's also demonstrating that the way actions are measured is accurate.

As consumers become more wearable savvy, accuracy will become an even greater priority. This will be particularly true for amateur and professional athletes, where training accuracy can directly influence their ability to achieve goals. Users are hungry for data that captures all of their daily active moments accurately. More research is on the way to improve algorithms that consistently understand specific user activity across a variety of body types.

Most of the algorithms should be based on the technology and specific application areas, like medical and specific healthcare applications,. Some of them are



open source algorithms, machine learning algorithms , cryptographic applications, smart wearables, anxiety detection etc.

## CONCLUSION

Five critical factors which must be taken into account for designing practical wearables for industrial applications:

- 1) Ergonomic product design: a. The wearables must be lightweight. b. The parts which keep contact with human skin must be made of comfortable materials. c. Occupying the user's hands or restricting the movements of wearables due to wired connections is not an option.
- 2) Data interaction on device: a. The wearables should provide essential information concisely. Fully detailed information on the wearable screen may also be disturbing. b. Limiting feeding of too much typing of data on keyboard may make the process complicated, rather voice interaction is most convenient.
- 3) Operational stability: a. The batteries used must last more than eight hours, without charging. b. The stability of network connections such as Wifi, Bluetooth, etc. is critical and should be easily deployable and they should be easy-to-use. c. The industrial wearables must stay operational under the conditions of high temperature, humidity, and shock.
- 4) External software integration: a. they cannot work independently as they are required to be integrated into the enterprise systems seamlessly. b. The industrial wearables must have the ability to process data in real-time and make- decentralized decisions. c. The wearables must be designed in such a way that human experience must be involved whenever needed.
- 5) External hardware integration: a. The wearables must be able to collect data from machines or robots of the manufacturing site. b. The wearables must be able to control external equipment so that the user can control the equipment and intervene with the operation process if necessary. c. The wearables must

support human-machine cooperation ( should be able to control by a series of gestures and signs ) which improves the flexibility , accuracy of the machines to improve efficiency.

Continuous improvements in design, function, and variety of available wearable devices, innovations is introduced by wearable app Development Company. Emergence of edge computing on powerful processors of the Qualcomm, Snapdragon Wear 3100 Platform with enhanced AI algorithms and advancements in wireless connectivity such as 5G, are increasing the functionality for providing a seamless user experience. Smart wearable device market will be able to sustain a double-digit growth, with 780 Million units poised to sell between 2018-2022. In future, it will be useful to also investigate the application of wearables in other domains. The role of AI methods in development of wearable devices is a very fruitful area for future research.

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# Assessing the management of road traffic infrastructure in form of BOT in Tien Giang province from the perspective of traffic safety and investment efficiency

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## ABSTRACT

Road traffic infrastructure management and exploitation is a material production industry with both service and technical attributes, directly related to human life, means of transport and other assets. Traffic safety criteria are expressed through the ability to smooth traffic and the safety when traveling. To meet the above requirements, the road traffic infrastructure system must ensure quality in all aspects such as: design - construction - operation management. The Trung Luong - My Thuan expressway through Tien Giang province, invested in BOT form, phase 1, does not meet traffic safety criteria. The route does not have an emergency stop lane for rescue activities in the event of an accident. This is due to the issues in investment project planning, surveying and designing. For that reason, the article evaluates the management and operation of roads invested in the form of public-private partnership (BOT) in Tien Giang province from the perspective of traffic safety and investment efficiency. The, the article points out the gaps of state management in the field of road exploitation, as a basis for proposing solutions to improve the efficiency of BOT road traffic operation in Tien Giang province, Vietnam.

**Keywords:** Public Private Partnership (PPP); Safety in exploitation; Exploitation management; Traffic safety; Build Operate Transfer (BOT)

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## I. INTRODUCTION

The planned economy as well as the "stagnation, avoidance of responsibility" attitude is present in many manufacturing industries of Vietnam, especially the

public investment. The traffic construction industry is also affected by this thought.

The transition to an internationally integrated market economy, inheriting as well as accessing scientific and technological advances has promoted and raised the

awareness of Vietnam's manufacturing industries. Because of the above-mentioned macro reasons, the exploitation of road traffic infrastructure in Vietnam has been taken into consideration in the past two decades and identified as an important production sector related to the development of road traffic infrastructure and human life in particular, to the development of the whole economy in general.

The road traffic exploitation activities in recent years has been increasingly complicated by the constant increase in vehicle density and loading capacity, in order to meet the mandatory requirements of economic development. The construction, renovation and upgrading of the road traffic system is an increasingly urgent requirement. The phrase "Management and exploitation of road traffic infrastructure" was created in order to meet the requirements of transportation activities.

The theoretical basis of the field of road traffic construction has been shown through the textbook "Economics - Management of the exploitation of bridges and roads" by Professor, Doctor of Science Nghiem Van Dinh and group of authors [3].

Diving into the specialized field with the textbook "Construction Management and Exploitation" by author Le Manh Tuong [10].

Textbook "Management and exploitation of traffic tunnels" by the group of authors Le Manh Tuong, Nguyen Anh Tuan [11].

Such textbooks have supplemented in a specific and detailed manners to serve the teaching of undergraduate and graduate students of Vietnam's universities specializing in construction engineering.

The exploitation management of road traffic infrastructure includes the following contents:

- + Manage project technical documents (survey, design, construction, acceptance, completion and records of repairs, renovations and upgrades).
- + Protection, maintenance and repair of works (regular, periodical, special)...
- + Manage costs (management costs, technical costs) and toll collection (if any) in the form of PPP

investment and other business activities permitted by law.

All of these activities are for the purpose of maintaining the operational function of the roads, meeting the conditions for optimal transportation activities on the basis of ensuring traffic safety at the highest level.

The current problem of the whole country in general and Tien Giang province in particular is the lack of transport infrastructure, in the context of limited public investment capital. It is necessary to mobilize and attract investment capital from other sources [8]. According to the experience of developed countries in the world such as the United Kingdom, the United States, the Republic of Korea, the Philippines, etc. the type of investment in the form of PPP (Public Private Partnership) has been successful and effective for the economy development [6], [7].

In the past 20 years, Vietnam has applied the PPP form with a certain amount of success [5], [9]. In addition, there are still some shortcomings, many inadequacies are reflected in exploitation activities such as: design quality, construction quality, road surface quality, traffic speed, ability to ensure traffic safety, etc ... that have not yet satisfied the requirements for use. It is necessary to make timely adjustments to ensure the project's objectives in terms of work performance, traffic speed, and safety in exploitation. Currently, many investment projects under the mode of public-private partnership (BOT) highways are still ambiguous between the two concepts of expressways and "tolled" roads. They are expressed right from the design stage, the section of the route, the speed of the vehicle, the ability to rescue, the connection work, the time and the toll level, etc. Such issues created many inadequacies, from the use of the road, the fares, traffic safety, etc., causing bad public opinion about transparency in PPP investment [12].

Thus, the control responsibility of the state management needs to be reconsidered since there are many negative public opinions of the community during the exploitation process. To identify the above

inadequacies, we can evaluate through a number of projects in Tien Giang province and neighboring provinces to serve as a basis for identifying shortcomings in order to take remedial measures and make lessons for the whole country.

## II. INVESTMENT PROJECTS UNDER BOT FORM IN TIEN GIANG PROVINCE

### A. Trung Luong - My Thuan expressway

Trung Luong - My Thuan expressway project (phase 1) with the route length of 51.5 km. The starting point is at Than Cuu Nghia intersection (Saigon - Trung Luong), the ending point intersects with National Highway 30 at An Thai Trung intersection. The whole route has a width of road surface including hard medians and guardrails of 17m with four lanes (4x3.5); there is no emergency stop lane, the maximum design speed is 80 km/h. However, there are many sections where the speed limit is 60km/h. Regarding the plain condition of this area, such speed is not suitable, reducing the efficiency of exploitation [13].

With a roadbed design of 17m wide, including 4 lanes, each lane is 3.5m wide and a median strip with guardrails, no emergency lanes, in case the vehicle has a problem or traffic accident, there will be no ground to serve the repair and rescue, leading to traffic congestion and unsafety.

\* This project had a number of shortcomings and limitations, including the following points [8]:

- Traffic safety

Report of the Department of Transport of Tien Giang: in 10 days (from January 28, 2022 to February 6, 2022 during the test of the route) 4 traffic accidents occurred with 1 person killed, 10 cars damaged. From April 30, 2022 to June 9, 2022, through the test of toll collection, there were 225 breakdowns of vehicles and traffic accidents, causing traffic jams for many hours; rescue work was also slow, due to lack of connection points for rescue vehicles to enter.

At the intersection of Trung Luong - My Thuan expressway and National highway 30, there was a serious traffic accident at 3:30 pm on August 12, 2022, a 7-seat car with plate No. 51H5-54689 crashed into the median, severely damaged, some people on the vehicle were slightly injured. While dealing with the accident, the 62A-07689 vehicle running in the same direction also crashed into the median right next to the accident. The driver died, many people were injured. The issue of safety needs to be carefully studied at this intersection.

- There is no emergency lane, causing unsafety and traffic jams

With a roadbed design of 17 m wide, including 4 lanes of 3.5 m wide and a median strip with guardrails, there is no emergency lane. So in case the vehicle encounters a traffic accident, when there is no emergency stop lane to serve the repair, rescue works, leading to traffic congestion and great economic losses.

- Fee collection

From August 9, 2022, the project was officially put into toll collection, but according to the report of the BOT route management unit, the number of vehicles participating in traffic was the half of the trial period. Moreover, the number of vehicles traveling through the route gradually decreased, equivalent to only 1/3 of the trial toll collection day. So the efficiency of the operation decreased gradually. Business vehicles did not accept the above price and switched to National Highway 1. It is necessary to determine the reason for such decrease, the toll price or the danger due to traffic insecurity.

- Speed

The maximum allowable operating speed is 80 km/h, which is not suitable for highways in the plain areas.

This shows that the investment appraisal of the State management is not effective, because the maximum allowed speed of the highways in the delta in Vietnam is usually from 100 to 120 km/h. Therefore, calling this project "highway" is not appropriate in practice, this case can only be called "toll road". This shows that the design and appraisal agencies have not complied with

the mandatory standards on highway design. These agencies also lacked of practicality as well as traffic safety knowledge. The design agency could not evaluate the economy growth, leading to increased density and vehicle load. The process of exploiting the route has revealed errors, especially the inefficient appraisal work of the State management.

- Investor capacity is not guaranteed

This is reflected in the fact that the project has changed investors twice. The first time (in 2015) - the investor was a consortium of investors Tuan Loc. The second time (in 2019) – the investor was Deo Ca Group. This proves that the project preparation, bid evaluation, investor selection of the State management do not meet the requirements of the project. This is entirely the responsibility of the State Administration in selecting investors. On the other hand, if the investor's professional capacity is qualified, then, why they did not propose to the State management about traffic safety and traffic speed right from the construction preparation stage. This is due to the lack of professionalism of the investor.

### **B. Cai Lay Bypass Project**

The BOT project of Cai Lay bypass is part of the investment project to build the National Highway 1 bypass and strengthen the National Highway 1 road surface of the section passing Cai Lay town. The route length is 38 km, in which the length of the National Highway 1 bypass section passing Cai Lay town is more than 12 km and the length of the old National Highway 1 route is 26 km. The project collected the toll fee from August 1, 2018.

\* This project had some shortcomings and limitations in the exploitation process, including the following points [7], [8]:

- Unreasonable station location

During the toll collection process, many vehicle owners refused to pay the toll, causing trouble, congestion at the station for a long time. This affected security and social order, forcing the BOT project to temporarily stop toll collection. The main reason is

that the toll station is placed improperly and must be adjusted (Cai Lay toll station is located on National Highway 1 to collect tolls for all vehicles traveling on National Highway 1 route and bypass). This is not reasonable because vehicles that do not take the bypass still have to pay the toll. Thus, the appraisal of station location is not good, lacking of transparency. This also confused public investment with investment under BOT mode, proving that the controlling role of state management is inadequate during the preparation and implementation process. Currently, the state management of the project has not really paid attention to the social environment, affecting the investment environment for the PPP form. In terms of traffic safety, the purpose of the bypass is to reduce the density of vehicles passing through Cai Lay town. However, there is no sign prohibiting trucks and containers, especially during rush hour, to go by bypass while vehicles still circulate normally on National Highway 1 through Cai Lay town. Therefore, the traffic safety goal is not achieved. On the other hand, National Highway 1 must be a public investment, but the appraisal is still for investment under the BOT method, to collect tolls, which has created public unrest in the community about the lack of transparency in investment.

- The toll policy has many shortcomings

Cai Lay BOT station collects fees from VND35,000 to VND180,000/turn for cars of all kinds, not considering exemption or reduction for citizens living near the station, citizens not travelling the entire route. After that, it must be adjusted to exempt 100% of the fee for the above-mentioned people [16]. The state management has not fully anticipated the social impact; State management in some areas also has different ways of understanding, affecting the investment environment under the PPP method.

### **C. My Thuan - Can Tho highway project**

My Thuan - Can Tho highway project with route length of 23 km. The starting point is at Km107+363.08, located in Tan Hoa Ward, Vinh Long City, Vinh Long,

the ending point is at Cha Va intersection (with National Highway 1, coinciding with the beginning point of Can Tho bridge project), in Thuan An commune, Binh Minh Town, Vinh Long. The project is constructed with 6 lanes, the width of the roadbed is 32.25m, the design speed is 100km/h. Phase 1 with 4 lanes, roadbed width of 17m, bridge width of 17.5m and the design speed is 80km/h.

\* This project had some limitations, including the following points [7], [8]:

The total project investment in the PPP form is VND 5,408 billion (approved by the Ministry of Transport in 2017). However, in April 2020, the project was adjusted to the form of public investment. At this time, the total investment decreased to VND 4,758 billion (a decrease of VND 650 billion) [16]. It proves that the control of the BOT project preparation stage has been abandoned and the appraisal is not good. On the other hand, from the perspective of traffic safety, similar to Trung Luong - My Thuan expressway project, the road surface is 17m with 4 lanes, it is inevitable that traffic jams will occur, especially at the connection points to National Highway 1 and Trung Luong Expressway - My Thuan, Cao Lanh - An Huu Expressway, from An Huu to Can Tho bridge when connecting to My Thuan - Can Tho Expressway.

#### **D. Cao Lanh - An Huu expressway project**

An Huu - Cao Lanh expressway project - phase 1 has been approved by the Prime Minister by Decision No. 769/QĐ-TTg, the project has a route length of 27.43 km. The first point intersects with My An - Cao Lanh expressway (Dong Thap province) and the ending point intersects with Trung Luong - My Thuan expressway in Cai Be district, Tien Giang province. Scale of 4 lanes, road bed width of 17m including hard medians and guardrails, operating speed of 80 km/h. Currently, the newly approved project has not been implemented, so it is not possible to evaluate other factors. As for the traffic safety factor, with 2 one-way lanes, 3.75m each, there is no emergency stop lane, while the traffic density on the route is very large,

certainly not ensuring traffic safety, In case of traffic jams due to accidents, due to breakdowns, when they occur, there will be no emergency stop lanes to serve the rescue and rescue work and ensure traffic flow, which requires timely adjustment [8].

#### **E. Ho Chi Minh City - Trung Luong expressway project**

Ho Chi Minh City - Trung Luong expressway project with route length of 61.9 km. The starting point of the route is at the intersection of Cho Dem - Binh Chanh - Ho Chi Minh City, the ending point is the intersection of Than Cuu Nghia - Chau Thanh district - Tien Giang province.

The route is invested to build standard expressways of grade A, grade 120 corresponding to 120Km/h. Phase 1 is built with 4 lanes and 2 emergency stop lanes (4 x 3.75m + 2 x 3.0m) excluding hard medians and guardrails with the width of the roadbed from 25.0 m to 26.0 m.

\* This project had a number of shortcomings and limitations, including the following points [7]:

- The regional linkage has not been promoted, reducing the efficiency of exploitation.

The connection from the expressway to Ben Luc and Thu Thua districts is not available. When the project is put into operation, it must be supplemented. Currently, such construction has not been completed stopped because technical contractor violated the law and was prosecuted. This proves that the project appraisal is not good. There are shortcomings when not considering the connection effect, reducing the efficiency of the route's exploitation.

- Insufficient business management process - inadequate (O&M) form

This leads to a loss of state budget (VND 725 billion of tax and incorrect determination of vehicle traffic due to the lack of automatic ETC toll collection). This proves that the state management has not done well in the project transfer contract and control the toll collection activities. On the other hand, from the perspective of exploitation, issues in toll collection as

mentioned above have resulted in a loss of government revenue of thousands of billion VND. Moreover, from the perspective of traffic safety, the state has now determined that the density of vehicles is too large, which does not guarantee the speed of traffic, due to the small cross-sectional area. It must be upgraded, and an additional lane must be added in each direction. So each direction of traffic will be 3 lanes for traffic and 1 emergency lane. In this case, the route with the minimum width of the roadbed excluding medians, guardrails, railings, etc. will be  $(6 \times 3.5 + 3 \times 2 = 27\text{m})$  and the connector segments will increase to over 40m. Thus, the route will ensure safe traffic for a long time without congestion. Overall, when connecting Ho Chi Minh city - Trung Luong expressway to Trung Luong - My Thuan route, it will cause a big traffic jam at Than Cuu Nghia intersection because there are only 2 lanes on the way to Trung Luong - My Thuan expressway, causing traffic unsafety and when merging 2 expressways.

In general, this will be a gap in the planning and investment of the State management, which has created serious local inefficiencies. When investing in expressways, the PPP Department of the Ministry of Transport has not fulfilled its responsibility in investment proposal and control when connecting expressways. This will be the first cause of traffic unsafety in management and operation of the expressway system, as commented by author Le Manh Tuong (Doctoral thesis "Planning affects the quality of construction works")

### III. EVALUATION OF ROAD TRAFFIC PROJECTS IN MEKONG DELTA REGION

#### A. Results

Reviewing objectively at the macro level, the transport system, including public and PPP investment, has partly changed the Mekong Delta. It is the foundation for other industries, especially rice processing and export, seafood processing, fruit and vegetable trade to

all regions of the country and overseas. Particularly for rice production, due to the development of transportation to remote areas, it has lowered the rice cost in Ho Chi Minh city, the Southeast region and the central highland provinces, etc. The transportation system has changed the countryside, reducing the urban-rural gap in many aspects.

Thus, in general, thanks to the transportation infrastructure, the Southwest localities in general and the whole country in particular have made significant economic development, serving as a driving force and a basis for the development of Vietnam economy.

#### B. Drawbacks of the projects

In-depth assessment of the highway system in the South region, there still have been shortcomings in terms of planning, quality, etc., causing many inadequacies for the above-mentioned exploitation process. In addition to reducing the efficiency of operation, there are potential risks of traffic unsafety due to the following reasons:

- The planning of road traffic infrastructure is not synchronized. It is clearly shown through the Ho Chi Minh City - Trung Luong expressway; Trung Luong - My Thuan; My Thuan - Can Tho; An Huu - Cao Lanh, etc., because the expressway system is becoming increasingly narrow in terms of road cross-section, number of lanes in each direction, rescue points, etc. State management and investors use the phrase "Investment phase 1" to defend themselves when calculating the toll price. Thus, when connecting routes together, it is easy to form bottlenecks, which are potential causes of congestion, traffic accidents, reducing the efficiency of route operation, causing damage to the economy.
- Design work is complied with old standards, lacking practical usage. Up to the present time, the expressways in the delta are still designed with 2 lanes, no emergency lane with a maximum speed of 80km/h. Meanwhile, the national road system also allows



driving speed of 80km/h. Thus, the design perspective of the consultanting agencies is that the vehicles never break down, never lose their brakes or blow a tire, etc., which are true "ideal" assumptions. Meanwhile, the design appraisal needs feedback to re-evaluate and control the design contractor to find the most effective and safest solution. But the appraisal agency still approved the design. They do not evaluate the the safety of human life and property of society.

**- Roles and Responsibilities of the State Management**

The roles and responsibilities of state management are currently confusing. The state management cares much about the capital in the context of limited public investment. As for investment in the form of PPP, the safety and profit for investors are the highest priorities. So, the state management does not consider social benefits of the projects.

To summarize, state business management are two confusing concepts, which are the causes for low investment and road exploitation efficiency. State management needs adjustments to improve their roles and responsibilities.

**IV. RECOMMENDATIONS FOR SOLUTIONS**

**A. Foundations**

- Law on investment under the mode of public-private partnership No. 64/2020/QH14 dated June 18, 2020 [4].
- Decree No. 35/2021/ND-CP dated March 29, 2021 of the Government detailing and guiding the implementation of the Law on Investment under the mode of public-private partnership [2];
- Circular No. 09/2021/TT-BKHDT dated November 16, 2021 of the Ministry of Planning and Investment guiding in detail the selection of investors to implement PPP projects [1].

**B. Solutions**

1) Completing the master plan

Expressway projects connected to the national road system in the Mekong Delta (Southwest) generated

many shortcomings, specifically through the connection between routes that are not synchronized on the basis of transparency, ensuring the right of criticism of economic sectors, beneficiaries, and service-using communities. The two phrases "Investment phase 1" and "Investment phase 2" are unconvincing reasons for such issues.

**\* Proposed solutions**

Transparency in the overall planning scheme of the Transport sector, including highway projects in any form (Public investment, PPP, etc...). Currently, regarding investment and planning of the road transport system, the link between industries (river & sea ports, electricity, construction industry, seafood processing industry, etc.) and economic regions on the basis of contributions, criticisms, ministries, sectors and localities, has not been thoroughly studied, including investment scale, schedule, etc., Such research should be publicized and transparent with a protective legal corridor, within a certain time limit as proposed by the Ministry of Transport.

- The adjustment of the planning should be based on the principles for economic development, the benefit of the people not for the investors. This is the only way to regain the trust of the people, which has been lost for a long time.

- Traffic planning must be determined as the orientation and basis for other material production industries to have investment and production development plans.

- Sectoral planning also needs to be submitted to the National Assembly for criticism, because this is the agency closest to citizens and delegates in general, and local delegates in particular.

2) Promulgating mandatory standards for design works

From capital perspective, to eliminate group benefits, there should be regulations on classification of Level 1 expressway and Level 2 expressway, etc.

- Level 1 expressway: In each direction, there must be at least 4 lanes (3 lanes for driving; 1 lane for emergency stop) with a dark cross-section (3x3.5+3) so

the cross-section has a minimum size of 13.5m excluding hard medians, guardrails, slope of about 3m.

- Level 2 expressway: In each direction, there must be at least 3 lanes (2 lanes for driving; 1 lane for emergency stop) with a minimum cross-section (2x3.5+3) so the cross-section must have the minimum size. > 10m excluding hard medians, guardrails, about 3m.

This is the authors' proposal from the perspective of traffic safety, project effectiveness, minimizing accidents and traffic jams.

3) Strengthen the roles and responsibilities during design appraisal

- In the transition period, the design appraisal, especially small projects, is sometimes just a procedure. But currently, especially PPP projects, (BOT projects or a combination of BOT and BT), there is a pressing public opinion about the transparency of projects in terms of cost and quality. In which, the quality of design work is being criticized by public opinion in terms of safety, trafficability, and efficiency. Therefore, Decree No. 35/ND-CP dated March 29, 2021 stipulates the legality of project appraisal for investment projects in the form of PPP, which is the responsibility of the Ministry of Planning and Investment. But for specialized projects that specialize in technical aspects and safe operation during exploitation, specialized ministries or independent specialized agencies should be assigned to be responsible for the appraisal of technical aspects and safety. It is important for investment projects to be transparent. This will be an issue that can create "group interests".

4) Defining the roles and responsibilities of state management

Currently, in Vietnam, projects invested in public-private partnership form have low investment attraction. So, what is the cause? What is the responsibility of the state management? According to the research of group of authors, state management has not fulfilled its responsibilities on the following issues:

- The legal framework is not compatible with actual circumstances, not suitable for PPP investment method.

- The system of Decrees and Circulars is not detailed, easily causing misunderstanding or leading to delays and increasing costs. Such issues expose many potential risks for the state and investors.

- There are not regulations defining responsibilities and resolutions for minimum standards on design, construction, exploitation, etc....

- Transparency regulations have not been developed in all aspects, especially public's opinions in order to increase the control level of the community.

- State management is still dominant (abuse of power) in the field of business management, which has created an inequity between investors and state management. They must be two equal subjects in the contract to perform the bidding package. The feedbacks between the competent state agency and the investor/project enterprise can not be properly conducted which inevitably leads to a decrease in the effectiveness of the bidding package (traffic safety, effectiveness, etc.)

## V. CONCLUSIONS

The PPP investment method has been successfully applied in many countries, reducing the pressure on the shortage of public investment capital. Meanwhile, in Vietnam, this form has not been a huge success, especially the investment in expressways.

From the perspective of project exploitation and efficiency, there have been many issues and concerns such as: the project efficiency is not high, the traffic clearance and traffic safety are low, the rescue work is still forgotten. Therefore, in phase 1 of investments, how to deal with the target of recovering capital of investors. What are the measures to ensure traffic safety; minimize vehicle speed; limit vehicles with large loads; oversized, overloaded vehicles, etc.? Finally, the efficiency of the project is low. This question should be left to the Ministry of Transport to answer and provide appropriate solutions.

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# An Efficient Routing Scheme for Manet Using 3des Approach in CNN Technique

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## ABSTRACT

A Mobile ad-hoc network (MANET) is an instance of intelligent transportation system. It provides Mobile-to-Mobile communication with the assistance of road side infrastructure for the purposes of in-mobile entertainment and safer road environment. MANET is characterized by highly mobile, predetermined topology and the requirement of reliable time bound message delivery over error prone shared wireless medium. The security solutions are constrained by these characteristics. By generating a secret group key that can be used to encrypt or authenticate the members of MANET. To address this need, a new secure 3DES algorithm and Convolutional Neural Network are proposed, which prevents several attacks. The enforceability and the privacy of the proposed scheme are demonstrated to study the secure-efficiency. The performance analysis of this technique is implemented in NS2 Software.

Keywords : Electrical Safety System, Power System Control

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## I. INTRODUCTION

A Mobile ad hoc network is an autonomous collection of nodes do not rely on any pre-established infrastructure that forms dynamic communicative network. Nodes in these network make use of mobility and wireless communication to maintain connectivity. However, the limited propagation range of these wireless environment make a challenging issue to establish the routes. Subsequently, MANETS are multi-hop infrastructures less network that establishes the routes themselves "on the fly". These networks are suitable for applications like battlefield, emergency search, rescue operations, vehicular ad-hoc

communications and mining operations etc. In such applications, communication and collaboration of nodes among the group is necessary. Therefore, multicast communication is very much intended to the group communication which saves network resources and bandwidth. Moreover, Multicasting is a service for disseminating information to a group of hosts that sends the data from a source to multiple destinations in the network.

The unique properties of multicast communication is first, the node can join anytime and can leave anytime from multicast group dynamically. Second, the nodes have no constraints on the group regarding its location

and members in the group. Third, a node may be a member of several groups. However, the nodes have send the packets to the members in the group, even it is not a member of a group. Over the last decade, researchers proposed several multicast routing protocols for MANETs for effective multimedia communication. More importantly these routing protocols can be categorized into tree based and mesh-based routing protocols. However, other multicast routing protocols are also available, which is out of scope of this paper.

First, the tree based multicast routing protocols maintains a single path and establishes a shared multicast routing tree to transmits the packets from source to receivers in a multicast group. The main idea behind these protocols is to maintain memory for their children instead of all the nodes. Additionally, these protocols do not provide sufficient robustness due to the limited bandwidth efficiency. One of the tree based multicast routing protocol is MAODV. While, Mesh based multicast routing protocols establishes a mesh network and maintains multiple paths between sources to receivers. Due to the multiple paths, mesh based multicasting is more suitable for frequently changing topological environments and provide more robustness. PUMA and ODMRP are the routing protocols that falls under mesh based routing protocols. Moreover, in spite of the routing issue many mobile adhoc network applications requires various multicast routing protocols that need to operate correctly even in hostile environment. Because the MANETS are more vulnerable to different routing attacks wormhole, black hole, rushing attack, man in the middle attack, etc., due to its inherited characteristics of MANETs.

Networks are a group of system networks linking together. There are two main classifications, Peer to Peer and Client/Server. Networks can be characterized by their size and purpose. The size of the network is

explained by geographical area that they occupy and the number of links that are part of the network. Some networks based on size are; LAN (Local Area Network), WAN (Wide Area Network), MAN (Metropolitan Area Network), PAN (Personal Area Network). Some Networks based on their purpose are; SAN (Storage Area Network), VPN (Virtual Private Network), MANET (Mobile Ad-Hoc Network). In this paper we discussed about the intrusion detection systems on MANETS. Mobile Ad-Hoc Network or MANET is an infrastructure-less IP based on network of mobile and wireless machine nodes. It is a type of ad-hoc network that can change locations and configure itself while moving.

In MANET each node act as a “router” to transmit the traffic to other specific node in the network. MANETs is very successive, attractive, and pervasive technology in wireless network. To maintain the mobility is an important task done by MANETs. MANETS is much more easier to be affected by different types of attack because it provides distributed architecture, volatile network topology, limited bandwidth of single hop and multi hope. In single hope, the entire node is in the defined coverage area, if there is intermediate node used for communication between two nodes is been called multi hop network. In MANETs there are two types of attack possible one is active attack and the other is Passive attack. MANETs is used in emergency requirements because it allows easy deployment, minimal configuration, and low cost. However, it has restricted the battery power and resources. The aim of networking is to facilitate the exchange of data such as audio, text or video between various points across the world. For the delivery of data, various types of switching techniques are used in networking. The various types of switching techniques are packet switching, message switching and circuit switching. In this paper, we are dealt with packet switching.

## II. LITERATURE REVIEW

A collection of tiny power, multifunctional and communications nodes with observation and recording situations at distinct places, afterwards, convert this data to signals that can be processed, Such nodes are randomly implemented on a large or small scale, this becomes a significant field for study because these networks are used today in numerous consumer and industrial applications, for instance in healthcare, the industry, the transport system, government security and military systems, the environment and agriculture and underwater sensor systems. If the amount of sensors is big, this enables for greater monitoring with greater accuracy, but it can be very costly or even impossible to charge or replace batteries because of the challenging environment.

Active research work for MANETs is carrying on mainly in the fields of Medium Access Control (MAC), routing, resource management, power control, and security. Because of the importance of routing protocols in dynamic multi-hop networks, a lot of MANET routing protocols have been proposed in the last few years. Considering the special properties of MANET, when thinking about any routing protocol, generally the following properties are expected, though all of these might not be possible to incorporate in a single solution. A routing protocol for MANET should be distributed in manner in order to increase its reliability. A routing protocol must be designed considering unidirectional links because wireless medium may cause a wireless link to be opened in unidirectional only due to physical factors. The routing protocol should be power-efficient. The routing protocol should consider its security. A hybrid routing protocol should be much more reactive than proactive to avoid overhead. A routing protocol should be aware of Quality of Service (QoS). On the basis of the above

requirements, several existing studies are carried out as follows.

Lei Deng et al [2021] proliferation of real-time applications over wireless communications, it becomes more and more important to support delay-constrained traffic in MANETs. In such applications, each packet has a given hard deadline: if it is not delivered before its deadline, its validity will expire and it will be removed from the system. This feature is fundamentally different from the traditional delay-unconstrained one. We for the first time investigate distributed scheduling schemes for a topology-transparent MANET to support delay-constrained traffic.

Carlo Kleber da Silva Rodrigues et al [2019] proposes a novel BitTorrent-like algorithm for video-on-demand streaming over mobile ad hoc networks: the BT-MANET algorithm. Its conceptual innovations mainly lie on (i) a flexible data-transmission scheme between direct neighbors and on (ii) a sliding window to prioritize data request, settling a compromise between data diversity and playing continuity. Through a number of simulations and assessing four different competitive metrics, we are able to validate our proposal and confirm its attractive performance for on-demand streaming.

Taj Rahman et al [2020] have extensively studied clustering schemes and divided the schemes into multiple types based on the Cluster Head (CH) selection criteria, which provides a good understanding of how each type of clustering algorithm differs from each other. The authors analyzed the performance of existing schemes based on the quality of service (QoS) metrics. Based on findings, the authors clarified some important tradeoffs between QoS metrics and also established some important factors influencing the efficiency of clustering schemes.

Ruo Jun Cai et al [2019] propose an evolutionary self-cooperative trust (ESCT) scheme that imitates human cognitive process and relies on trust-level information to prevent various routing disruption attacks. In this scheme, mobile nodes will exchange trust information and analyze received trust information based on their own cognitive judgment. Eventually, each node dynamically evolves its cognition to exclude malicious entities. The most attractive feature of ESCT is that they cannot compromise the system even if the internal attackers know how the security mechanism works.

Masood Ahmad et al [2019] Mobile ad hoc networks (MANETs) are self-organized networks without any fixed infrastructure. The topology changes are very frequent in MANETs due to nodes' mobility. The topology maintenance creates an extra overhead, as the mobility information of a single node is shared with all nodes in the network. To address the topology maintenance overhead problem in MANETs, the researchers proposed different cluster-based algorithms to reduce the size of a routing table. The clusters are formed to locally adjust the topology changes within the cluster. If a node wants to communicate with a node outside the cluster, it only communicates with its cluster head (CH). The CH communicates with other CHs to transmit data toward the destination. To efficiently utilize the clustering mechanism in MANETs, stable and balanced clusters are required. To form good quality and optimized clusters, some metrics, such as relative mobility (node speed and direction), node degree, residual energy, communication workload, and neighbor's behavior, are required.

Taoufik Yeferny et al [2019] considering the great success of mobile devices in recent years, P2P applications have also been deployed over mobile networks such as mobile ad-hoc networks (MANETs).

However, the mismatch between the P2P overlay and the MANET underlay topologies makes the resources lookup mechanism in mobile P2P applications very difficult. Therefore, this downside is the main hindrance to the deployment of such applications over MANETs. To overcome the mismatch issue, we propose in this paper RLSM-P2P a cross-layer resource lookup scheme for Mobile P2P applications. The main thrust of RLSM-P2P consists of building an efficient unstructured P2P overlay that closely matches the underlay physical network and swiftly adapts to its volatility and dynamicity by considering different MANET constraints.

BurhanUl Islam Khan et al [2021] examines a pragmatic scenario as a test case wherein the mobile nodes must exchange multimedia signals for supporting real-time streaming applications. There exist two essential security requirements viz. i) securing the data packet and ii) understanding the unpredictable behavior of the attacker. The current study considers sophistication on the part of attacker nodes. They are aware of each other's identity and thereby collude to conduct lethal attacks, which is rarely reflected in existing security modeling statistics. This research harnesses the potential modeling aspect of game theory to model the multiple-collusion attacker scenario. It contributes towards i) modeling strategies of regular/malicious nodes and ii) applying optimization principle using novel auxiliary information to formulate the optimal strategies.

Nousheen Akhtar et al [2019] present a bandwidth aware routing scheme (BARS) that can avoid congestion by monitoring residual bandwidth capacity in network paths and available space in queues to cache the information. The amount of available and consumed bandwidth along with residual cache must be worked out before transmitting messages. The BARS utilizes the feedback mechanism to intimate the

traffic source for adjusting the data rate according to the availability of bandwidth and queue in the routing path. We have performed extensive simulations using NS 2.35 on Ubuntu where TCL is used for node configuration, deployment, mobility and message initiation, and C language is used for modifying the functionality of AODV.

Osamah Ibrahim Khalaf et al [2020] Security and correspondence happening between network central points will be an instance for principal issues in Mobile Ad-hoc Networks (MANETs). Due to some ideas created by the organization leading to avoid attacks but may end

in failure due to inappropriate way and thus attacks need recognized and cleared. The Dual- Cooperative Bait Detection Scheme (D-CBDS) is one of the ways that is in the stake for the discovery of MANET-dark/dim opening assailants. The current CBDS calculation consolidates the intensity of proactive and responsive security advancements to characterize lure mode assailants as proactive and receptive engineering. In CBDS, an adjacent source node is randomly selected as a bait target for searching. By reverse tracking as a reactive method, the attackers are identified. However, in some time, the chosen bait destination node may be an intruder that is not handled in the current CBDS approach.

Jae Seang Lee et al [2019] mobile ad-hoc network (MANET), unmanned vehicles are deployed for surveillance and reconnaissance. They send multimedia data to a center node in real time. In this letter, we propose a centralized TDMA slot and power scheduling schemes which maximize energy efficiency (EE) considering Quality-of-Service (QoS) for the tactical MANET. We formulate this problem as a non-concave ratio optimization, and propose the optimal slot allocation and power control algorithms based on

the Dinkelbach method and the concave-convex procedure.

BabatundeOjetunde et al [2019] introduce a new mobile payment system utilizing infrastructureless mobile Adhoc networks to enable transactions that permit users to shop in disaster areas. Specifically, we introduce an endorsement-based mechanism to provide payment guarantees for a customer-to-merchant transaction and a multilevel endorsement (MLE) mechanism with a lightweight scheme based on Bloom filter and Merkle tree to reduce communication overheads. Our mobile payment system achieves secure transaction by adopting various schemes such as location-based mutual monitoring scheme and blind signature, while our newly introduced event chain mechanism prevents double spending attacks.

Fifi Farouk et al [2020] a Vehicular Ad-hoc Network (VANET) is a type of Mobile Ad-hoc Network (MANET) that is used to provide communications between nearby vehicles, and between vehicles and fixed infrastructure on the roadside. VANET is not only used for road safety and driving comfort but also for infotainment. Communication messages in VANET can be used to locate and track vehicles. Tracking can be beneficial for vehicle navigation using Location Based Services (LBS). However, it can lead to threats on location privacy of vehicle users; since it can profile them and track their physical location. Therefore, to successfully deploy LBS, user's privacy is one of major challenges that must be addressed. In this paper, we propose Privacy-Preserving Fully Homomorphic Encryption over Advanced Encryption Standard

(P 2 FHE-AES) scheme for LBS query.

Jae Seang Lee et al [2020] on a future tactical-battle field network, combat radio nodes will be deployed for various operations, forming a mobile ad-hoc network (MANET). However, because of the nodes' mobility, a



single group might be divided into several small groups with fewer nodes. Conversely, several small groups might be merged into one group. In such an environment, an unmanned aerial vehicle (UAV) will provide an effective way to improve network coverage and connectivity among the small groups. However, some issues should be considered for the optimal deployment of the UAV. One issue is to find the proper position of the UAV, which enhances the connectivity among the groups, because a tactical network places a high priority on network survivability rather than throughput maximization. We also need to exploit real topographic information to obtain more accurate connectivity information among nodes. Second, an efficient resource allocation scheme for reliable communications through the UAV should be taken into account. Since most of the links between the UAV and the ground nodes are line-of-sight (LoS), due to the good quality of these links, the traffic via the UAV will be heavy in spite of the limited data slot resources.

M. Sivaram et al [2019] the quality of service (QoS) is improved by enhancing the capability of the DBTMA for better network service in the MANETs. The proposed method uses an improved DBTMA called Retransmission Dual Busy Tone Multiple Access (RDBTMA) protocol. This is based on two elements namely: busy tones and Ready to Send/Clear to Send (RTS/CTS) dialogues. In addition to this fast retransmission, a strategy is used further to improve its effectiveness. The retransmission strategy is adopted using negative acknowledgment after the collision occurred by the hidden nodes. A hidden node, where the collision occurs at access point, listens to the NACK signal and uses the signal to determine the requirement fast retransmission scheme. The proposed method is simulated and compared against existing methods in terms of various network parameters.

Bin Yang et al [2019] investigates the non-asymptotic capacity in MANETs under a general packet routing scheme with multicast traffic, where each source has multiple destinations. Under the routing scheme, when the destinations move into the communication range of their source, a packet at source will be directly sent to destinations; otherwise, it can be replicated to multiple different relays, which help to forward it to destinations. To study the non-asymptotic capacity in the MANETs, we first develop the two Markov chain theoretical frameworks to characterize the fastest packet propagation process at source and the fastest packet reception process at destinations under the routing scheme. Based on these two theoretical frameworks, we then derive an analytical expression for the capacity.

### III. RELATED WORK

A plethora of research works have been performed to address high security and low-latency solutions for resource constrained WSNs. In this context, some of the existing IPS based authentication procedures have been developed using classical key management authentication mechanisms. For example, an IPS combining Internet Protocol (IP) trace-back with an enhanced adaptive acknowledgment (EAACK). Moreover, Location-Based Keys (LBKs), binding private keys of individual nodes to both their identifications and geographic locations. These approaches improved the security at the cost of increasing the latency of the network. To address the challenges associated with the low-latency requirements, some works used physical

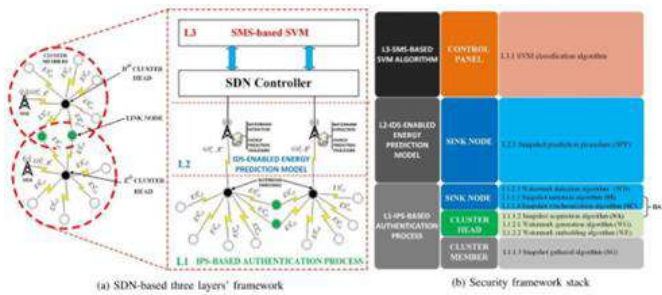


Figure 3.1 A collaborative security framework for SDWSNs

Layer features. For instance, a two-factor user authentication mechanism was recommended, where the authors devised an authentication mechanism comprising of registration and authentication phases. Furthermore, the authors in, explored a biometric-based continuous authentication technique, without the the need for an authentication server. These approaches reduced the latency but at the cost of increasing the complexity of the authentication procedures.

Furthermore, some works also exploited physical layer features in IDS to achieve low- latency in WSNs. In this context, a novel intrusion detection scheme based on energy prediction for cluster-based WSNs was introduced in, wherein the authors used the energy states of wireless sensor nodes to predict malicious behaviors at a given time. Excessive false alarms are a common artifact of these approaches.

Consequently, machine learning procedures have been widely used to develop IDS-based solutions. For instance, the use of neural networks and watermarking techniques was suggested in. A SVM methodology was proposed in, while a hybrid machine learning approach for network anomaly detection was put forward in. A hybrid anomaly based IDS was recommended which employed SVM and multi-layer perceptron (MLP) to identify anomalies in the network. Further, the authors in presented an intrusion detection engine based on neural networks combined

with a protection method-based on a watermarking technique. While these algorithms improve the accuracy of network anomaly detection models, they also introduce high computational cost which is inadequate for WSNs. Even though relevant works have been proposed in the literature to target security issues in SDWSNs, challenges such as high security, excessive false alarms, low-latency, and high computational cost still remain unaddressed.

#### IV. CONTRIBUTIONS

To address these imperative challenges, in this paper, a bottom-up security framework is designed. The novelty of the proposed work lies in devising and evaluating a collaborative framework which amalgamates a recurrent lightweight authentication method in conjunction with intrusion detection and a real-time smart monitoring system; achieving lightweight authentication and enhanced anomaly detection mechanisms in SDWSNs.

Since a single-gateway (cluster head) architecture is not scalable and might cause an incremental overhead in large scale WSNs, the proposed work uses a cluster-based SDWSN architecture that provides a hierarchical organization to a flat sensor network topology, considerably reduces the latency of the network. This architecture consists of four kinds of dynamic nodes, namely, cluster members, cluster heads, link nodes, and sink nodes. Further, in this framework, a Distributed Snapshot Algorithm (DSA) is executed to capture network snapshots periodically so as to obtain the global energy state of the WSN; wherein the global energy state corresponds to a map of the energy state for each node at a given moment. Moreover, the DSA is also used to dynamically adapt the network topology within the cluster to reduce the energy consumed for communication; thus, extending the lifetime of the network while achieving an acceptable performance for data transmission.

The proposed framework hierarchically combines three security layers. At the bottom of this approach (Layer L1), an IPS-based authentication process is designed to provide a lightweight security scheme in the data plane. In the middle of the framework (Layer L2), an IDS-enabled energy prediction model within the edge is designed with the aim of supplying a cost-effective intrusion detection solution near the data plane. Finally, at the top of this framework (Layer L3), in the control plane, a SMS-based SVM algorithm is introduced to achieve isolation, high performance, enhanced anomaly detection, and efficient mitigation by segregating malicious nodes over the SDWSNs. Since the SMS-based SVM algorithm has global visibility of the sensor network, it can see the correlations between true positives, which lets it filter out the False positives. Thus, the main contributions of this work are summarized as follows:

- 1) A novel security scheme based on network snapshot readings, providing continuous authentication in large scale SDWSNs, is proposed.
- 2) A watermarking technique is exploited to guarantee the accuracy of concurrent authentications while performing data integrity checks for the entire SDWSN.
- 3) The authentication method is improved by introducing a link node, which creates a connection between all the cluster of sensors.
- 4) An edge computing empowered IDS is leveraged to efficiently handle the limited resources in SDWSNs.
- 5) A two label dataset is generated in the edge, with the aim to train an SVM classification algorithm that is subsequently used by the SMS; wherein the latter is deployed at the control plane and is designed to correlate the alerts from the low-delay IDSs distributed across the edge network.

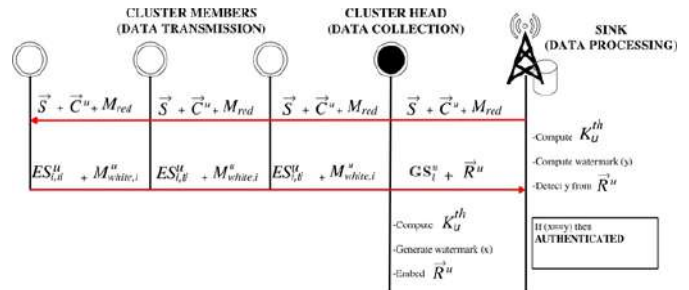


Figure 3.2 DSA-based authentication and a watermarking technique

Moreover, analysis of the computational complexity is provided and simulations showing the effectiveness of the proposed framework are executed by leveraging the AVISPA tool and MATLAB. The results demonstrate an accuracy of 84.75%. The remainder of this paper is organized as follows: Section II and Section III introduce the different layers of the proposed framework. In Section IV, security analysis and performance evaluation are conducted. Finally, the paper is concluded in Section V, where some future endeavors are also put forward.

## V. SYSTEM MODEL

Aiming to achieve high-security, address the limited resources constraints and take advantage of SDN architectures, our work proposes a collaborative security framework design, as depicted in Fig.3.1a. To summarize, the proposed security framework possesses a hierarchical structure and comprises of three layers. At the bottom of the framework stack, in the data plane, in L1, an IPS-based authentication process is performed. At the middle, at the edge, in L2, an IDS-enabled energy prediction model is executed, and finally, in the control plane, in L3, the SMS-based SVM algorithm is designed. In this context, in L1, a cluster-based WSN is created and DSA is employed, where the sink nodes initiate the snapshot acquisition process by sending a marker message to their cluster heads in order to form a global energy state of the network. Afterwards, the marker message is propagated to the

cluster members. Each member sends its energy state back to its cluster head post receiving the message. Once the cluster head collects the global energy state from its cluster members, it protects the data using a watermarking embedded method with the aid of a generated public key and other security parameters to ensure that the derived data will not be altered on the fly by possible malicious attackers. Consequently, the network snapshot and the watermarked data is forwarded to the sink node. Likewise, the sink sends a copy of the energy map to the control plane, which is located in the cloud. Moreover, in the edge, the sink node periodically receives the snapshot readings aiming to detect the embedded watermark for the sake of continuous authentication and for the subsequent energy consumption prediction procedure. Furthermore, the appropriate watermarked data is considered reliable, while the data without a correct watermark is marked as unreliable. Subsequently, in L2, an IDS-enabled energy prediction model is executed, where a Markov chain prediction procedure is used to detect nodes' misbehavior. Conclusively, to amalgamate this framework, in the control plane, in L3, an SMS-based SVM algorithm is designed where the dataset resulting from L2 is processed by employing a SVM classification algorithm. A summary of the security framework stack is presented in Fig.3.1b.

## VI. PROPOSED SCHEME

In the following subsections, the proposed L1, L2, and L3 layers along with their corresponding stack of algorithms are elaborated.

### L1:IPS-BASED AUTHENTICATION PROCESS

In SDWSN applications, the reliability and the integrity features of the cluster nodes should not be compromised. However, if the data transmission is not reliable, the integrity of the whole network is affected. To handle this security challenge, this work considers deploying an IPS-based authentication mechanism which is an amalgamation of the DSA and

watermarking techniques. The designed mechanism aims to provide a two-way authentication handover between the cluster node, the cluster head, and the sink node.

In the following subsections, the sublayers, the DSA-based authentication procedure, and the watermarking-based authentication technique are detailed.

1) L1.1:DSA-Based Authentication Procedure: As illustrated in Fig. 3.2, this procedure starts when the sink node initiates snapshot acquisition by sending the first message to its cluster head; from there, the request message is propagated to every cluster member. After receiving this message, every cluster member sends its energy state back to its cluster head which is then used to generate the key fingerprint with other security parameters. It is worth mentioning that a link node could receive multiple request messages from multiple clusters' heads. Thus, each link node must send a reply back to all of them, in order to provide scalability for large-scale WSN and maximize the efficiency of the authentication procedure. Before data transmission, the energy state of the cluster heads is embedded into the global energy state gathered by them. The concurrent snapshot readings gathered in a given time by the uth cluster head are represented as follows.

$$GSu_l = [E_{Su_{1,t1}}, E_{Su_{2,t2}} \dots, E_{Su_{i,t_i}}], \quad (3.1)$$

where  $GSu_l$  represents the snapshot readings collected in  $l$  cycles at  $t_i$  time of arrival from the  $i$ th cluster member  $E_{Su_{i,t_i}}$  to the  $u$ th cluster head. This time of arrival significantly reduces the possibility of impersonation of the  $GSu_l$  vector by an intruder. This is due to the random behavior of wireless communications which makes the time of arrival unforeseeable. The cluster head then averages the  $GSu_l$  vector to generate the  $k$ th  $u$  fingerprint using the following equation.

$$kth_u = E[GSu_l], \quad (3.2)$$

where  $E[.]$  is the mean operator. Afterwards, the  $k$ th  $u$  fingerprint is encrypted with the advanced encryption standard (AES) algorithm with a key length of 128 bits [28]. The generated  $k$ th  $u$  fingerprint contributes to making the public key unpredictable. Further, the aim of the DSA is to obtain a distributed network global state by recording the consistent energy state at a specific time [29]. In this sense, as shown in Fig. 1b, the DSA is divided in four algorithms hierarchically distributed as follows:

- The Snapshot-Initiation (SI) algorithm (L1.1.1), launched by the sink node;
- The Snapshot-Acquisition (SA) algorithm (L1.1.2), exploited by the cluster head;
- The Snapshot-Gathering (SG) algorithm (L1.1.3), executed by the cluster members;

TABLE 3.1 ALGORITHMS' NOTATIONS

Notation	Description
$\vec{S}$	Represents the vector of cluster heads' identification
$\vec{C}^u$	Represents the vector of cluster members' identification
$\vec{Z}^u$	Is the vector of cluster members' identification whose snapshot is not collected by the sink at timeout
$\vec{R}^u$	Is the watermarked data
$M_{red}$	Is a request message from the sink node to the $i^{th}$ cluster members
$M_{white,i}^u$	Is a response message from the $i^{th}$ cluster members to the sink
$A_c = (TP + TN)/(TP + TN + FP + FN)$	Accuracy at the sink node
$W^u$	Is a random position used to select the most significant bits (MSB) at the $u^{th}$ cluster head
$D_r = TP/(TP + FP)$	Proportion of the marked data at the $u^{th}$ cluster head
$\alpha^u$	Is a value used to calculate the embedded location of the head
$F_a = FP/(FP + TN)$	False alarm rate

The Snapshot-Synchronization (SC) algorithm (L1.1.4), exploited by the sink and the cluster head nodes.

Next, we detail the four algorithms which use the notations presented in Table 3.1.

a) L1.1.1: Snapshot-initiation algorithm: Since DSA collects snapshots through messages, it is important to ensure message delivery. Thus, in order to solve this problem, we implement a two-way handshake between the cluster node and the sink node. Here, the authentication procedure relies on the SI algorithm, which assumes that the number of sensor nodes and

their first snapshot is known by the sink in a setup stage. The sink ensures reliable  $E_{Su,i}$  delivery by keeping a table indexed with nodes' identification. In this context, the sink node sends an initial  $M_{red}$  message to its cluster head. The SI algorithm execution ends only when the sink node acquires the network snapshot from all functioning nodes. In this manner, the sink node waits until timeout  $t_w$  expires.

The evaluation of L3's classifier accuracy uses L2's output as ground truth, where trusted and malicious nodes are represented by a non-linear classification model. The obtained results demonstrate that there are 61 False Alarms (FA) as shown in Table V, where TP is the true positive (a malicious node detected as a malicious node), TN is the true negative (a trusted node identified as a trusted node), FP represents a false positive (a trusted node detected as a malicious node), and FN is a false negative (a malicious node recognized as a trusted node). The performance evaluation of the experiment is carried out by evaluating the accuracy Ac of the framework, the detection rate Dr, and the false alarm Fa rate by using the following equations.

$$(3.3)$$

$$(3.4)$$

$$(3.5)$$

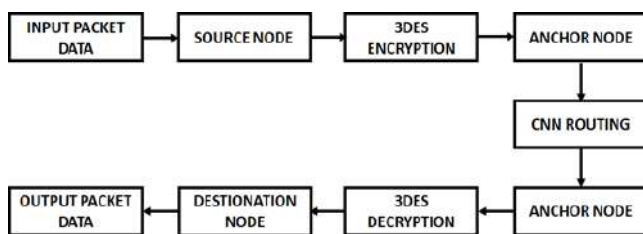
From the experimental results and the performance evaluation, Ac is found to be 84.75%, Dr is equal to 87.55%, which was increased in comparison with the second layer, whereas the false alarm rate is equivalent to 14.36%. To the best of our knowledge, the concept of a unified SDN-based security framework stack, integrating IPS, and a hierarchical collaborative anomaly detection system has never been attempted in any previous research works.

## VII. PROPOSED SYSTEM

### INTRODUCTION

In the recent years, one could assist to a spectacular growth in the use of wireless equipments. The number of mobile devices such as PDAs, mobile phones laptops, is also tremendously increasing. To ensure the connectivity between all these devices, ad hoc networks appear to be a promising solution. An ad hoc network is a collection of wireless mobile nodes, which communicate together without the assistance of any fixed nor central infrastructure. MANET an autonomous collection of mobile nodes forming a dynamic wireless network. The administration of such a network is decentralized, i.e. each node acts both as host and router and forwards packets for nodes that are not within transmission range of each other. A MANET provides a practical way to rapidly build a decentralized communication network in areas.

### PROPOSED SYSTEM



3DES algorithm is introduced to achieve isolation, high performance and enhanced anomaly detection. To apply 3DES, the considered optimization problem is first converted to the problem of finding the best parameter vector which minimizes an objective function. In this proposed method optimization technique is used. A novel fitness function has been designed for the 3DES algorithm based on which the nodes are segregated. Based on the segregated node list, the CNN structure is trained, which helps to deliver data with a small delay. The list of affected nodes and the normal node is created by a 3DES

algorithm based on which accurate route is selected by the CNN algorithm. This process helps to enhance the speed and hence reduce the delay. In MANETs, location information is important for the generation of shared keys and is highly applicable. Thus, DES based key management is a core part of the research into MANET key management. This key management system is used to improve the stability and security of the transmission.

### DES ((DATA ENCRYPTION STANDARD) ALGORITHM

DES algorithm was born in the mid-1970s. It is a block cipher algorithm, which is grouped in 64-bit data encryption and decryption. And the data encryption and decryption algorithm are using the same structure, in which only the use of keys are in different order. The length of keys is 56-bit (the keys are usually expressed as 64-bit, but each eighth bit is used as parity check bit and can be ignored). And very little keys are considered as the weak keys, but they can be easily avoided.

DES is a symmetric-key algorithm based on a Feistel network. As a symmetric key cipher, it uses the same key for both the encryption and decryption processes. The Feistel network makes both of these processes almost exactly the same, which results in an algorithm which is more efficient to implement.

DES has both a 64-bit block and key size, but in practice, the key only grants 56-bits of security. 3DES was developed as a more secure alternative because of DES's small key length. In 3DES, the DES algorithm is run through three times with three keys, however it is only considered secure if three separate keys are used.

3DES runs the DES algorithm three times, with three 56-bit keys:

- Key one is used to encrypt the plaintext.
- Key two is used to decrypt the text that had been encrypted by key one.
- Key three is used to encrypt the text that was

- **decrypted by key two. 3DES keying options:**

Technically, 3DES can be implemented with three different key configurations. Despite this, the second and third option are insecure and should never be implemented.

Keying option one – This option uses three independent keys and is the most secure. Keying option two – In this configuration, the first and third keys are the same.

Keying option three – This uses three identical keys. When identical keys are used, the decryption process in the second stage cancels out the first encryption, leaving only the final encryption to alter the data. This makes the result the same as ordinary DES.

### DES ALGORITHM - ENCRYPTION PROCESS

DES algorithm encryption process can be divided into 5 steps to operate:

- 64-bit key produces 16 sub-keys through a Sub-key algorithm which are  $K_1, K_2 \dots K_{16}$  used respectively for the first, second...sixteenth iterative encryption.
- 64-bit plaintext was rearranged after the IP(Initial Permutation) and divided into left side  $L_0$  which is the left 32 bits and right side  $R_0$  constituted by the right 32bits.
- $R_0$  is encrypted by the sub-key  $K_1$  through the encryption function. The result is a 32-bit data set  $f(R_0, K_1)$ , the diagram shown in Figure 4.3 A 32-bit data set  $L_0 \oplus f(R_0, K_1)$  is gotten after  $f(R_0, K_1)$  combines with  $L_0$  using mode 2. Then this set is used as the  $R_1$  in the second iteration and  $R_0$  is used as the  $L_1$  of the second iteration. Thus the first iteration encryption is completed.
- The second iteration encryption to the sixteenth iteration encryption keys were used to sub-keys  $K_2 \dots K_{16}$ , and their processes are same to the encryption in the first iteration.
- At the end of the sixteenth iteration encryption it creates a 64-bit data set. Its left 32-bit is considered as  $R_{16}$  and the right 32-bit is  $L_{16}$ . After the two sides merged, 64-bit encrypted messages will be got by the data rearranged through inverse initial permutation  $IP^{-1}$ . By now all the encryption process is over.
- DES encryption process mathematical formula described as follows:
$$L_i = R_{i-1}$$
- $$R_i = L_{i-1} \oplus f(R_{i-1}, K_i) \quad i = 1, 2, 3, \dots, 16$$

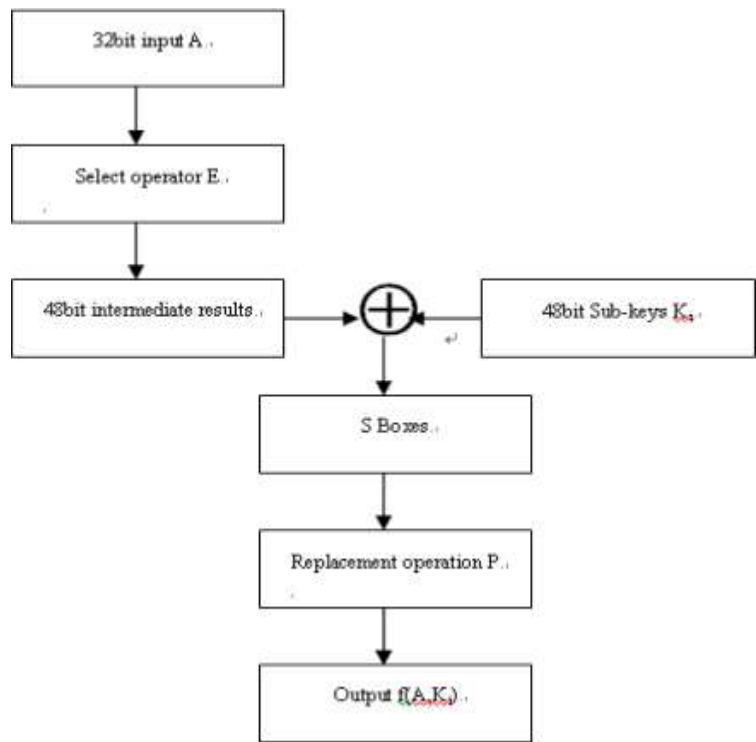


Figure. 4.2 Encryption Function f

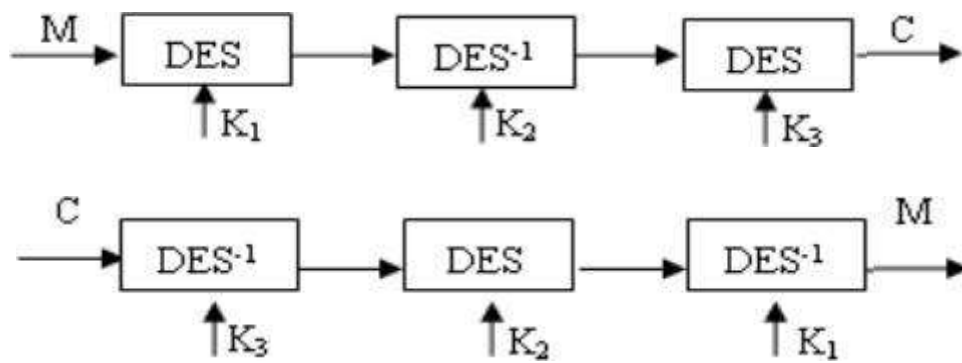


Figure 4.3 3DES Encryption/Decryption Process

Inversed DES encryption process and using the decryption sub-key  $K_i$ , the encrypted messages can be decrypted. 3DES is a more secure DES morphing. 3DES algorithm is the cumulative computing of the three times DES algorithm that is the process of Encryption - Decryption - re-encryption. In order to obtain higher security, three keys should be separate. In essence, this is equivalent to use a length of 168-bit keys for encryption. The structure of 3DES algorithm is shown in Figure 4.3.

### 4.3.2 S-BOX DESIGN

S-box is a critical step in DES algorithm which is a complex nonlinear function and all other operations are linear. Through the non-linear transform of S-box, plaintext has been able to express well as the confusion to have strong security. It is a certain difficult to realize the S-box whose realization is the main factor of impacting the speed of overall encryption and decryption. Therefore, this work aims the original algorithm for improving S-box, uses a single S-box to replace the original eight, and the expanded 48-bit data is divided into eight blocks. These data is passing S-box through a MUX and then the generated results are composed into a 32-bit data which input

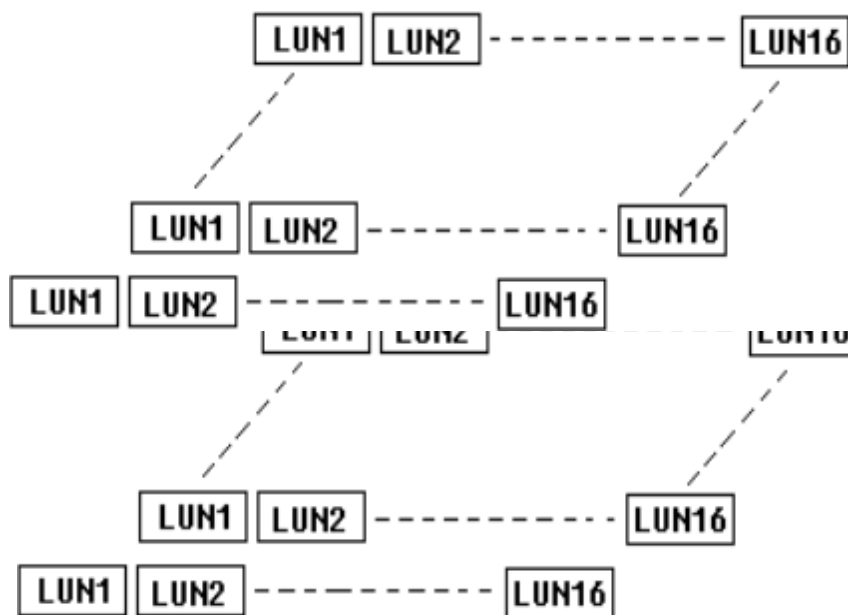


permutation matrix P. This will significantly reduce the size of the circuit, at the same time as a result of the reduced size of the entire circuit power consumption will reduce circuit will reduce so as to enhance the overall performance of the system.

### 4.3.3 LUN FUNCTION

A logical unit number (LUN) is a unique identifier for designating an individual or collection of physical or virtual storage devices that execute input/output (I/O) commands with a host computer, as defined by the Small System Computer Interface (SCSI) standard.

Each packet of the DES algorithm requires sixteen LUN operations. If using sequence circuit structure, one encrypted packet can be only generated after sixteen LUN operations. This method significantly reduces the efficiency of the encryption. Therefore, high-speed DES algorithm uses pipeline structure, as shown in figure 4.4



sixteen iterative design sixteen computing modules, respectively, called as LUN1, LUN2... LUN16. Data is computed pipeline operation in each module. When the first i input data is computed the first j operation, the first i+1 input data is computed the first j-1 operation and the first i+2 input data is computed the first j-2 operation...in order to improve the computing efficiency of the system. 3DES algorithm is based on DES algorithm, so completing a 3DES encryption /decryption algorithm needs forty- eight LUN operations.

Figure 4.4 The Pipeline Structure of DES

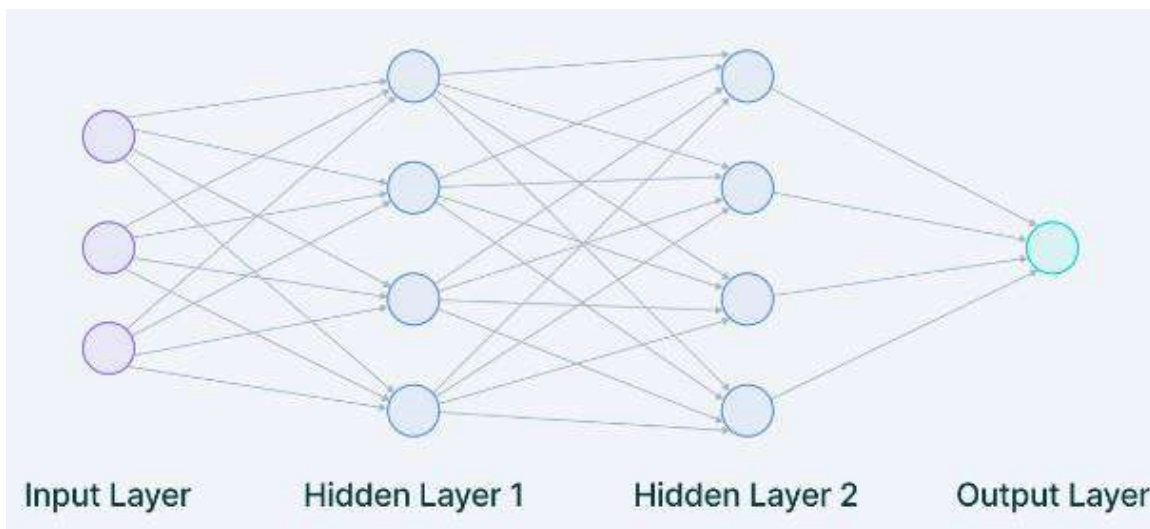
Therefore, the encryption efficiency will be even lower if not using pipeline structure. Considering the efficiency, 3DES also uses pipeline structure in this article. The pipeline structure of 3DES is based on which in DES. In the DES algorithm, two signals flag and ready are set, which respectively represents the end and the beginning of the sixteenth operation. When the sixteenth operation begins in the first DES, the data is beginning to load in the second DES. When the sixteenth operation ends, the second DES begins operating. When the sixteenth operation ends in the second DES, the third DES begins operating. In this way, supposing completing a LUN operation needs

n clocks, sixteen LUN operations need  $n+15$  clocks(completing a DES), so completing a 3DES needs  $3(n+15)-2$  clocks.

The peripheral circuit to achieve 3DES algorithm includes four selectors, a key-module and a control-module. The four selectors choose the correct data path between the internal and external in DES algorithm (DES composes the convergence of 3DES) driven by the control- module. The key-module driven by the control-module selects one output among the 48 sub-keys produced from the three keys K1, K2, K3 to participate in iterative calculations. The control- module needs produce the right signal for driving the input clock, key and encryption/decryption operators, to control the entire system work correctly.

### CONVOLUTIONAL NEURAL NETWORK (CNN)

Convolution neural network (also known as Convolution Neural Network or CNN) is a type of feed-forward neural network used in tasks like image analysis, natural language processing, and other complex image classification problems. It is unique in that it can pick out and detect patterns from images and text and make sense of them. Before diving deeper into this topic, let's take a step back and understand the origin of the Convolutional Neural Network (CNN).



**Figure 4.5** convolutional neural networks look at one patch of an image

#### ALGORITHM FOR CNN CLASSIFIER

1. 2-D convolutional layer with 96 filters of [11 11] size where stride is 4.
2. ReLU layer
3. MaxPooling layer
4. 2-D convolutional layer with 10 filters of [5 5]
5. ReLU Layer
6. MaxPooling layer
7. Fully connected layer with output size of 512
8. ReLU Layer
9. Dropout layer with dropout probability 0.1
10. Fully connected layer with output size of 2 to classify stroke as hemorrhagic or ischemic

11. Apply softmax layer
12. Classify image dataset using classification layer

## DES DECRYPTION

In DES, the decryption process is incredibly straightforward. The algorithm's Feistel structure allows it to easily be reversed. The process is run almost exactly the same to decrypt information. The only difference is that the subkeys are applied in reverse. This is an efficient setup, because it means that the same software and hardware can be used in both the encryption and decryption processes.

To decrypt the data, it first goes through an initial permutation, then the block is split and the right half goes through the F function. The difference is that in the first round of decryption, the 16th subkey is applied. Everything else proceeds as normal. Once the F function is complete, it is XORed with the left side of the block. The blocks are switched over and the result goes through the same process for the second round, with the only exception that the 15th subkey is applied. This process continues up until the 16th round, when the 1st subkey is used. Just like in the encryption process, the blocks aren't swapped in the final stage, and then the data undergoes a final permutation. This finishes the decryption process, resulting in the original plaintext of the message.

Take the text that has been encrypted with key one, then send it through the "decryption" process with key two:

1. Key schedule – the 16 sub keys are derived from key three
2. Initial permutation
3. The block is split into left and right halves
4. The right half is sent through the F function
  - Expansion permutation
  - XOR with the sub key for the round
  - Substitution
  - Permutation
5. XOR the result of the F function with the left side
6. Make the old right side the new left side, and the result the new right side
7. Repeat the above steps 14 times
8. The right half is sent through the F function
  - Expansion permutation
  - XOR with the sub key for the 16th round
  - Substitution
  - Permutation
9. XOR the result of the F function with the left side
10. Combine the left and right sides of the block together
11. Final permutation

The result is the 3DES decrypted form data.

## SYSTEM TESTING

It is a critical software quality assurance method. It ensure that the designed system network work properly based on the requirement of the user.

### 5.1 TESTING TYPES:

The testing process is classified into four types. They are

- System Testing
- Unit Testing
- Integration Testing
- Functional Testing

#### 5.1.1 SYSTEM TESTING:

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

#### 5.1.2 UNIT TESTING:

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit test ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

#### INTEGRATION TESTING:

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

#### 5.1.4 FUNCTION TESTING:

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

ValidInput : identified classes of valid input must be accepted. InvalidInput : identified classes of invalid input must be rejected. Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised. Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

## VIII. RESULTS AND DISCUSSION

### MODULE IMPLEMENTATION

VMware Workstation Pro is a hosted hypervisor that runs on x64 versions of Windows and Linux operating system. It enables users to set up virtual machines (VMs) on a single physical machine and use them simultaneously along with the host machine. Each virtual machine can execute its own operating system, including versions of Microsoft Windows, Linux, BSD, and MS-DOS. VMware Workstation is developed and sold by VMware, a division of Dell Technologies. There is a free-of-charge version, VMware Workstation Player, for non-commercial use. An operating systems license is needed to use proprietary ones such as Windows. Ready-made Linux VMs set up for different purposes are available from several sources.

VMware Workstation supports bridging existing host network adapters and sharing physical disk drives and USB devices with a virtual machine. It can simulate disk drives; an ISO image file can be mounted as a virtual optical disc drive, and virtual hard disk drives are implemented as .vmdk files.

VMware Workstation Pro can save the state of a virtual machine (a "snapshot") at any instant. These snapshots can later be restored, effectively returning the virtual machine to the saved state, as it was and free from any post-snapshot damage to the VM.

VMware Workstation includes the ability to group multiple virtual machines in an inventory folder. The machines in such a folder can then be powered on and powered off as a single object, useful for testing complex client-server environments.

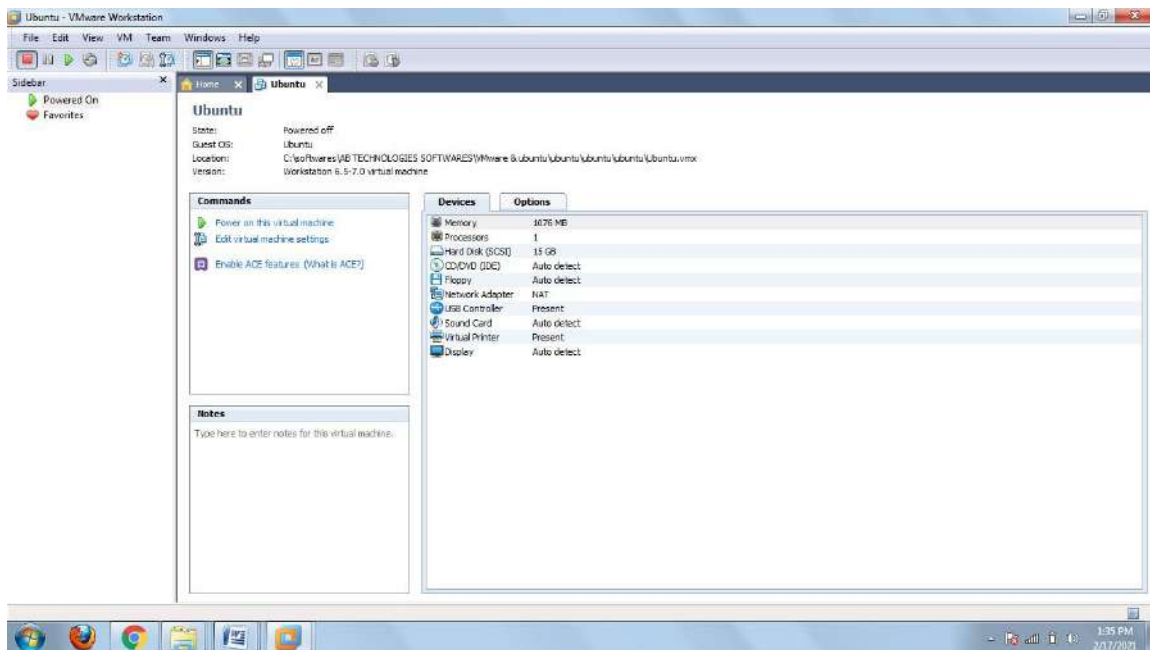
#### *VMware Home Screen:*



Figure 6.1 VMware Home Screen

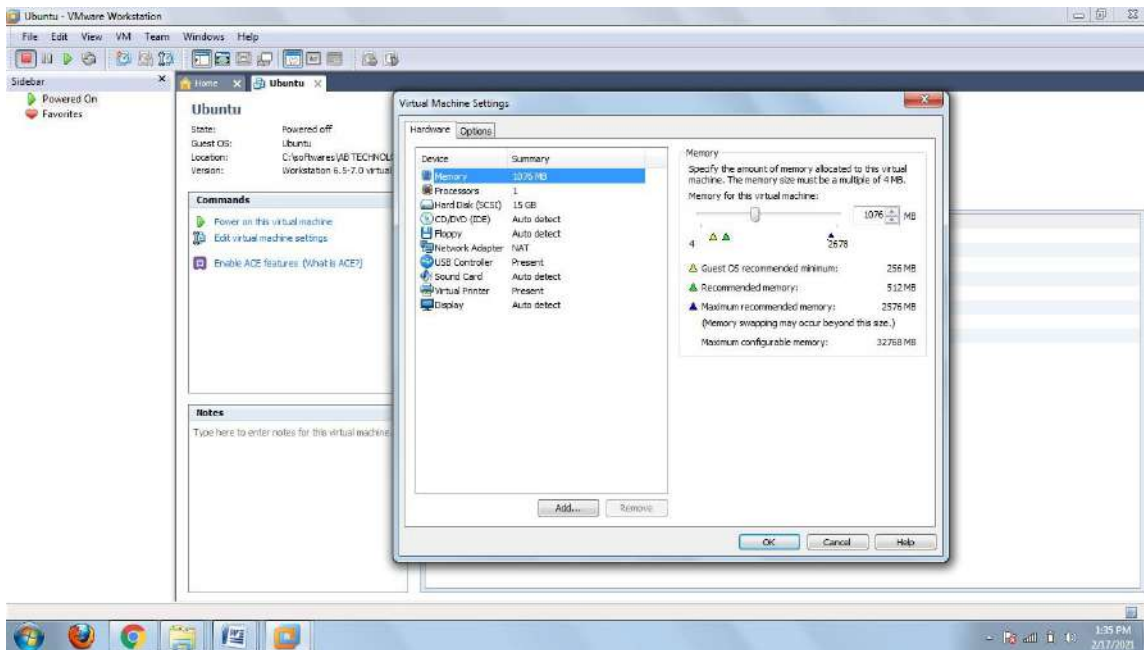
Ubuntu is built on Debian's architecture and infrastructure, and comprises Linux server, desktop and discontinued phone and tablet operating system versions. Ubuntu releases updated versions predictably every six months, and each release receives free support for nine months with security fixes, high-impact bug fixes and conservative, substantially beneficial low-risk bug fixes. The first release was in October 2004.

Current long-term support (LTS) releases are supported for five years, and are released every two years. Since the release of Ubuntu 6.06, every fourth release receives long-term support (LTS). Long-term support includes updates for new hardware, security patches and updates to the 'Ubuntu stack' (cloud computing infrastructure). The first LTS releases were supported for three years on the desktop and five years on the server; since Ubuntu 12.04 LTS, desktop support for LTS releases was increased to five years as well. LTS releases get regular point releases with support for new hardware and integration of all the updates published in that series to date.



**Figure 6.1(a) VMware Home Screen**

Ubuntu packages are based on packages from Debian's unstable branch, which are synchronised every six months. Both distributions use Debian's deb package format and package management tools (e.g. APT and Ubuntu Software). Debian and Ubuntu packages are not necessarily binary compatible with each other, however, so packages may need to be rebuilt from source to be used in Ubuntu. Many Ubuntu developers are also maintainers of key packages within Debian. Ubuntu cooperates with Debian by pushing changes back to Debian, although there has been criticism that this does not happen often enough. Ian Murdock, the founder of Debian, had expressed concern about Ubuntu packages potentially diverging too far from Debian to remain compatible. Before release, packages are imported from Debian unstable continuously and merged with Ubuntu-specific modifications. One month before release, imports are frozen, and packagers then work to ensure that the frozen features interoperate well together.



## LOGIN PAGE:

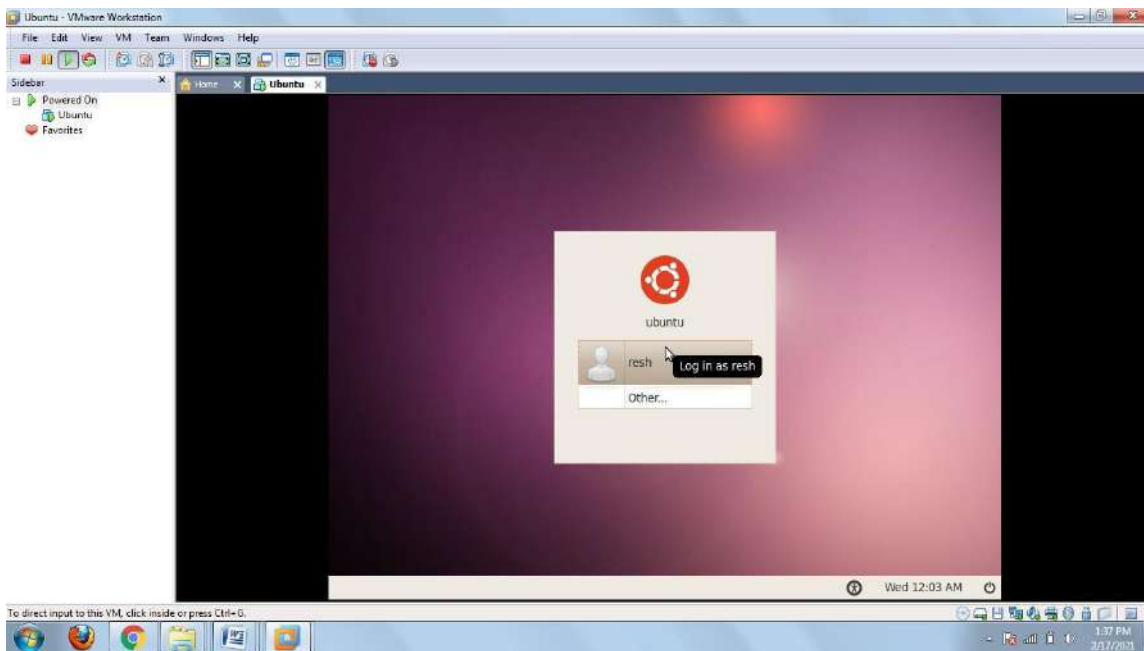
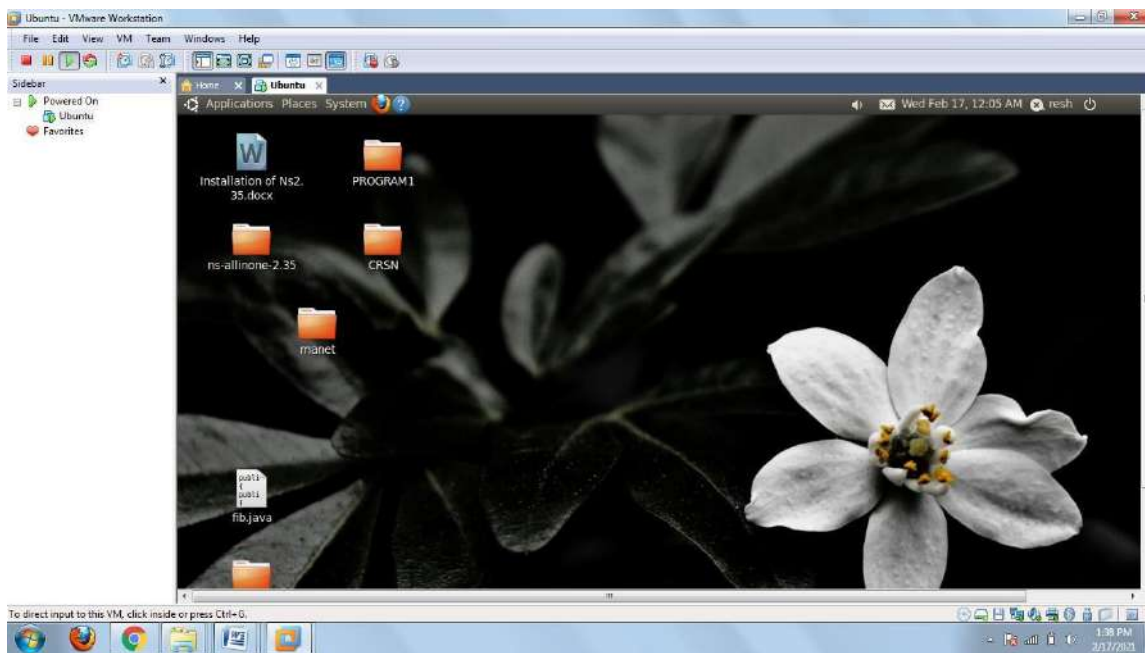


Figure 6.2 Login Page

## UBUNTU HOME SCREEN:

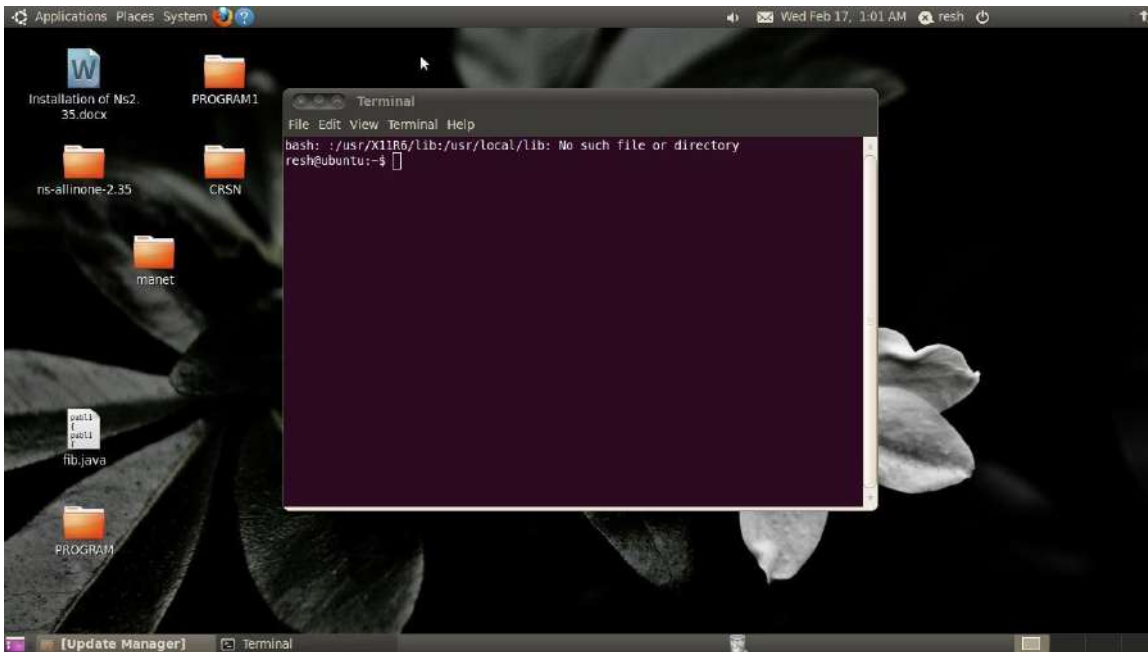


*Figure 6.3 Ubuntu Home Screen*

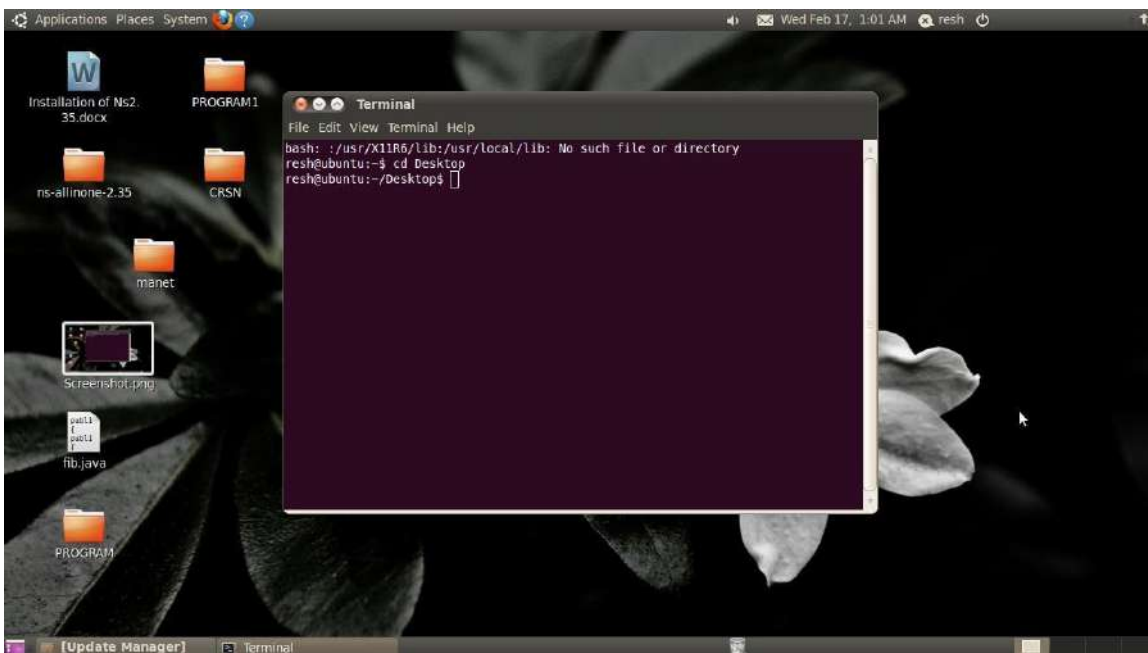
To access the pop-up menu, click on application → terminal. A command window will

open.

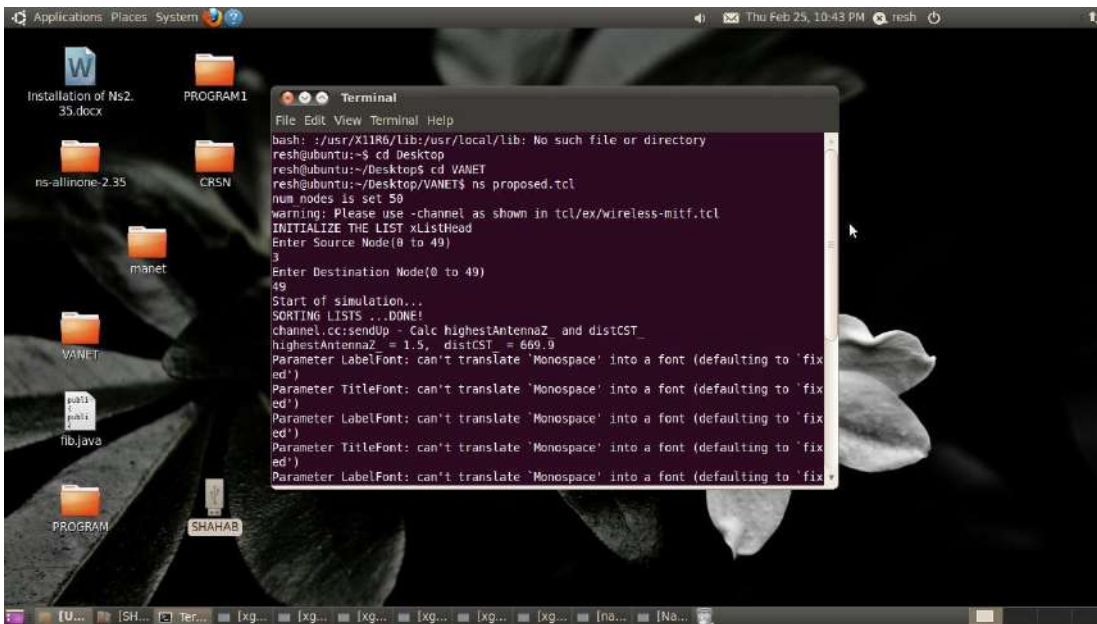




Type cd Desktop to direct the command window to desktop.

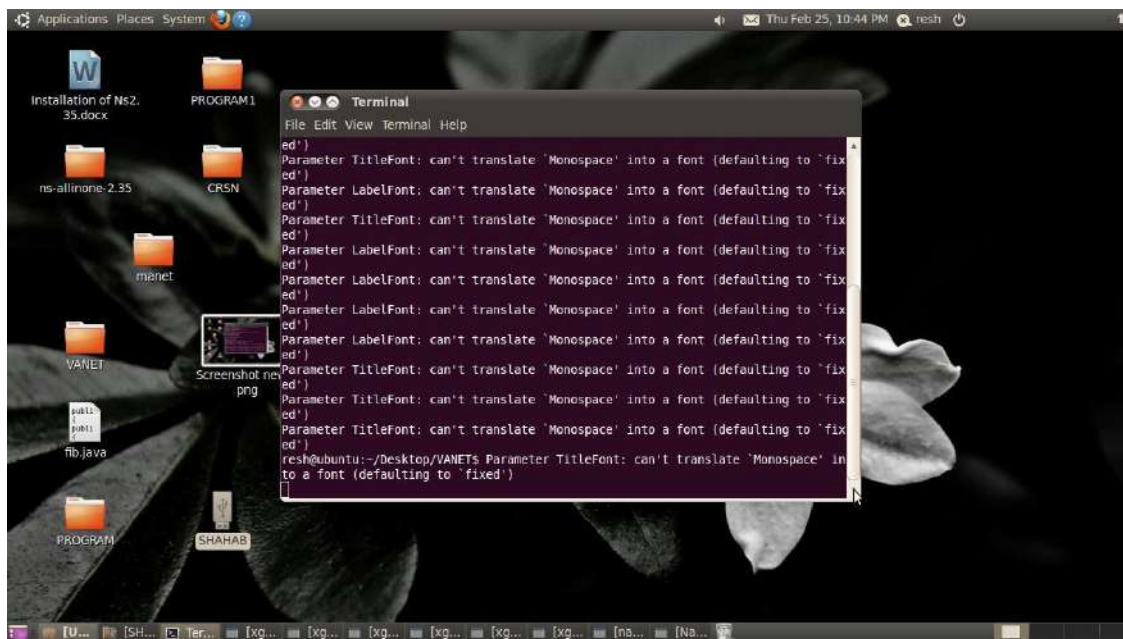


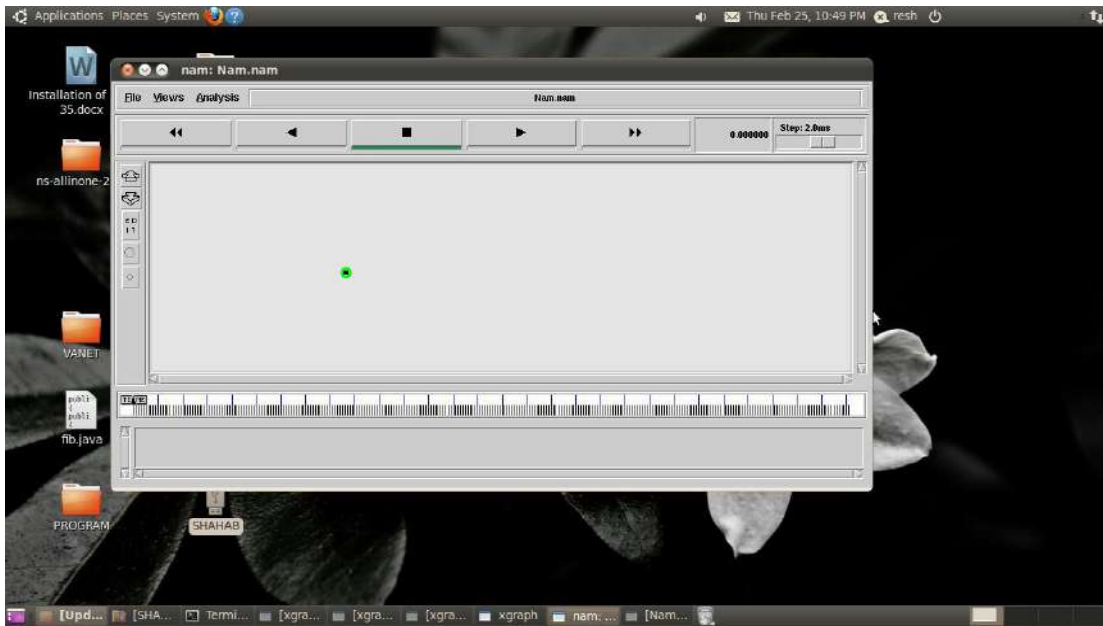
Type cd folder name where the program file is stored.



Type `ns proposed.tcl` and press enter. A command window as shown in above figure will appear. Initially the network assigns a total of 50 nodes.

The source node and destination node has to be decided by the user. The network selects number of antennas for data transmission between source node and destination node.





## NODE CREATION

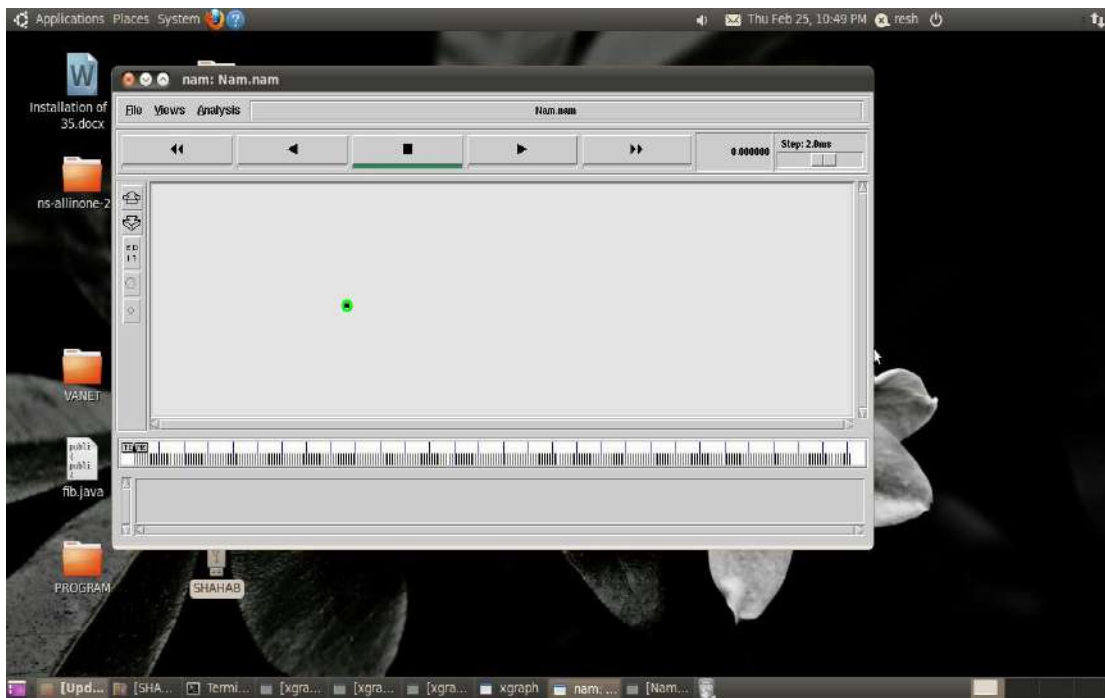


Figure 6.4 NODE Creation

## NEIGHBOUR NODE DISCOVERY

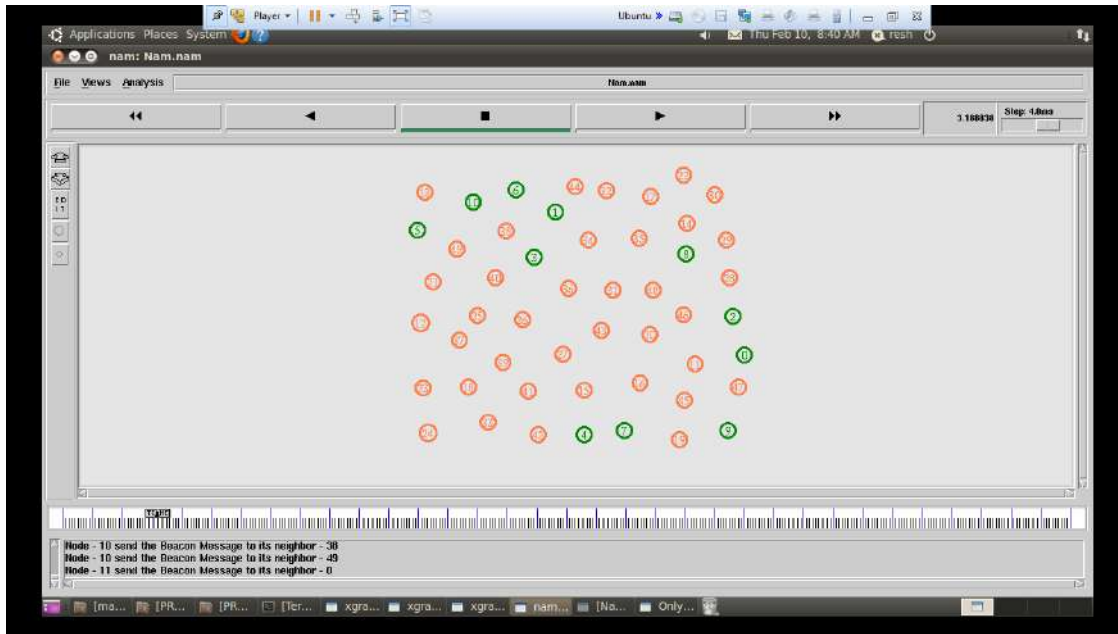


Figure 6.4 (a) Neighbor Node Discovery

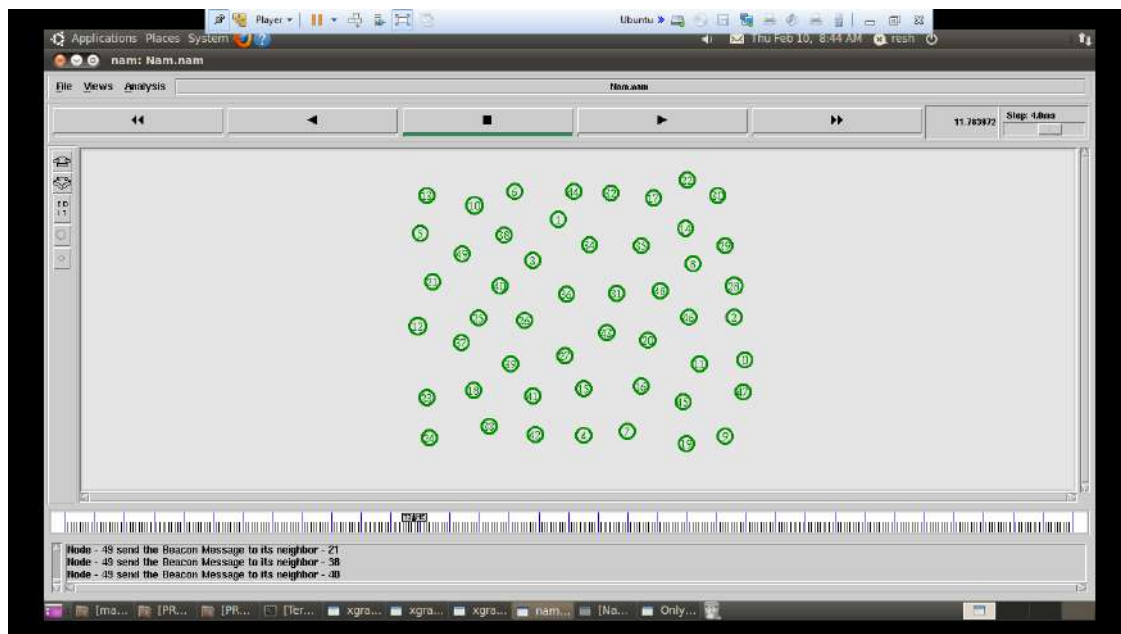


Figure 6.4 (b) Neighbor Node Discovery

## ROUTING PATH CREATION

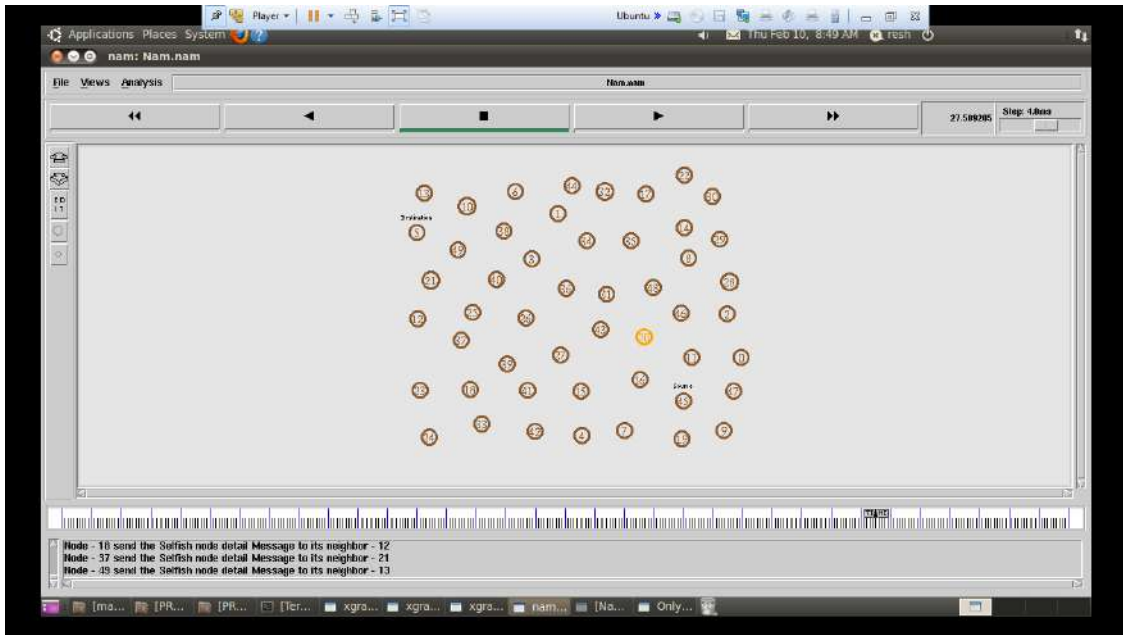


Figure 6.5 Routing Path Creation

#### FINAL ROUTING PATH FOR THE DATA TRANSMISSION

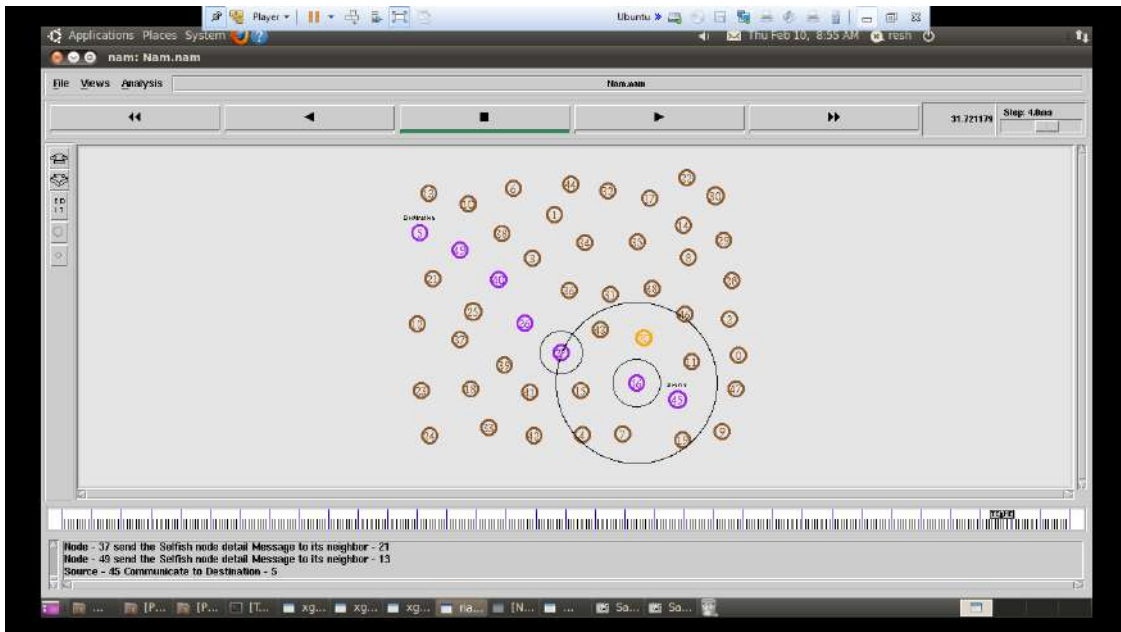


Figure 6.6 Final Routing Path For The Data Transmission

The anchor node formation between source node and anchor node. In this project main objective is to minimize the energy consumption.

## THROUGHPUT

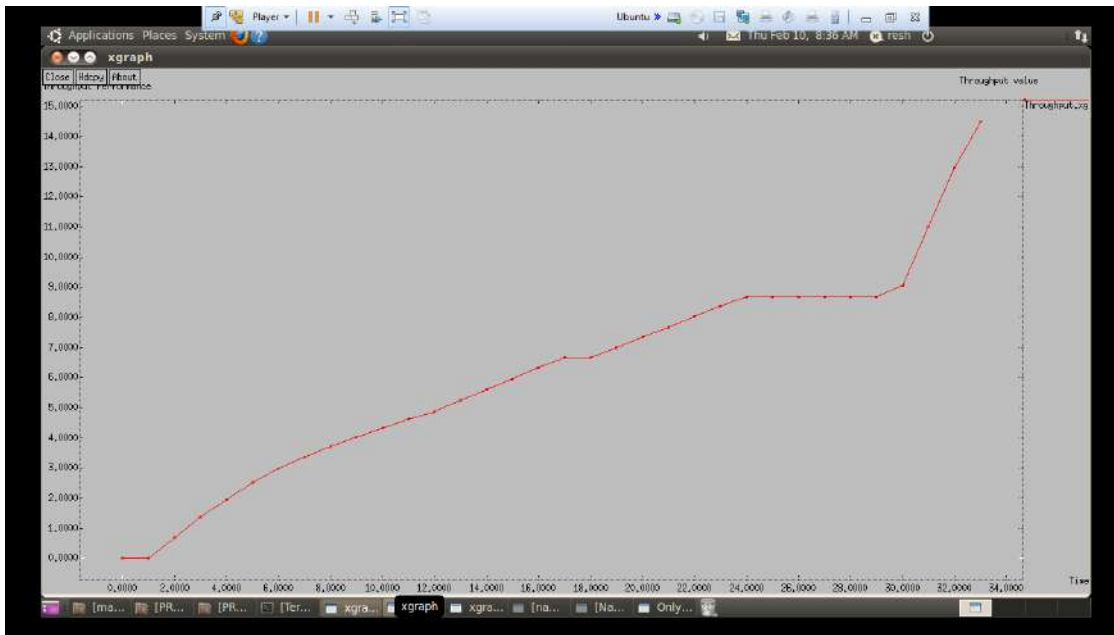


Figure 6.7 Throughput

In data transmission, network throughput is the amount of data moved successfully on communication channel, the data that these messages contain may be delivered over physical or logical data.

## PACKET DELIVERY RATIO

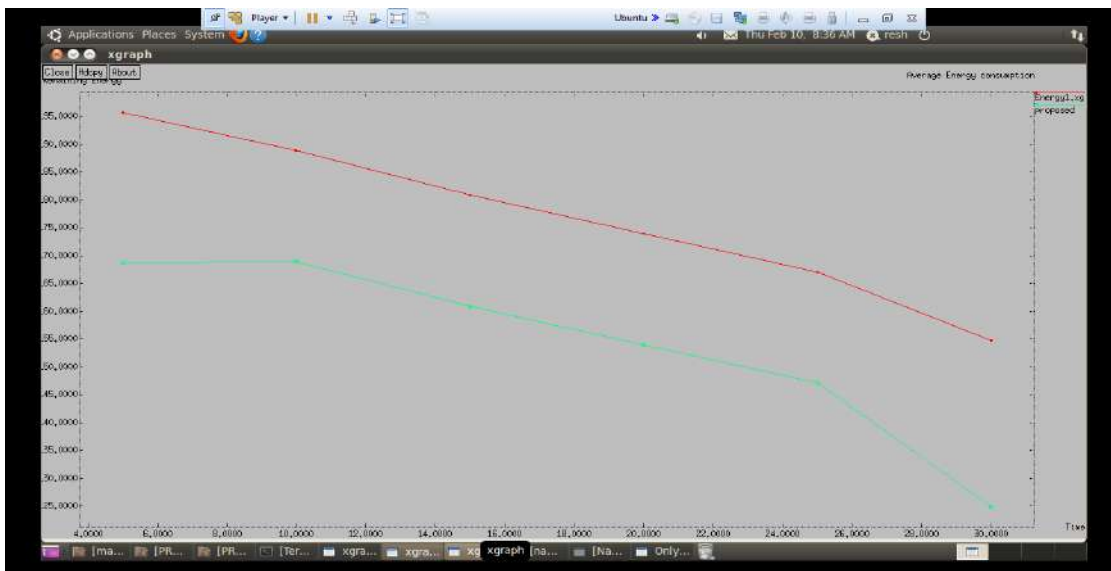


Figure 6.8 Packet Delivery Ratio

The packet delivery ratio can be obtained from the total number of data packets arrived at destinations divided by the total data packets sent from sources. In other words Packet delivery ratio is the ratio of number of packets received at the destination to the number of packets sent from the source.

## IX. CONCLUSION

In this project an improved MANET routing authentication technique. To accomplish isolation, high performance, and improved anomaly detection, a 3DES technique is presented. The techniques for encryption and decryption are more effective. Three keys have been created in this system, resulting in three alternative key configurations for the 3DES implementation. The CNN (Convolutional Neural Network) technique is used to implement the routing mechanism. The MANET operation is successfully realised by this CNN algorithm. The primary benefit of adopting CNN is speed. The time it takes for CNN to make a decision is constant. The findings demonstrate that the CNN is capable of accelerating packet delivery with an average rise in networks with some malicious nodes. It simultaneously boosts the network's connection rate in the face of several attacks. PDR, throughput, and latency have been used as the metrics for performance analysis.

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# Multiclass Brain Tumor Detection and Classification Using Deep Learning Techniques

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## ABSTRACT

Brain tumor is a severe cancer and a life-threatening disease. Thus, early detection is crucial in the process of treatment. Recent progress in the field of deep learning has contributed enormously to the health industry medical diagnosis. Convolutional neural networks (CNNs) have been intensively used as a deep learning approach to detect brain tumors using CT brain images. Due to the limited dataset, deep learning algorithms and CNNs should be improved to be more efficient. Thus, one of the most known techniques used to improve model performance is Data Augmentation. CNN classifier used to compare the trained and test data, from this we can get the classified result for tumor. The experimental results of proposed technique have been evaluated and validated for classification performance on magnetic resonance brain images, based on accuracy, sensitivity, and specificity. Detection, extraction and classification of tumor from CT brain images of the brain is done by using Python.

**Keywords :** Convolutional Neural Networks, CT Brain, Brain Tumor

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## I. INTRODUCTION

The Medical image processing can be defined as picturing of body parts, tissues or organs for clinical analysis and treatment. It is one of the technique used to create an images of the human body. Imaging techniques are in the fields of radiology, nuclear medicine and optical imaging. The medical image processing consist of display of an image, enhancement, and analysis that captures an image through instruments like MRI (Magnetic Resonance Imaging), X-ray, Nuclear medicine, Ultrasound, optical imaging, and Computed Tomography (CT) scanners respectively.

The medical imaging systems are used to analyses the human body in both macro and micro level such as organ level and cellular correspondingly. Medical image processing is a highly challenging research area. The internal parts of the human body are diagnosed through medical imaging technique. Medical imaging have high importance because of correct diagnosis and treatment of diseases in health care system. The image of internal body parts where produced by the equipment's like CT scanner, MRI. These images are assigned with composed pixel of discrete brightness and colour values.

## II. PROBLEM STATEMENT

- Limited number of training samples are available and accuracy of classification is not high.
- The technique's performance on the boundaries between different regions is relatively poor.
- The algorithm complexity of training and testing on the datasets is high.

### OBJECTIVES

- To perform pre-processing by using median filter for the removal of noise and enhancing the quality of input image.
- To perform efficient data augmentation by altering the existing data to create more data for the model training process.
- To perform efficient classification of brain tumour detection with the help of CNN for the generation of accurate and improved outputs.

### LITERATURE REVIEW

Jiangjun Peng et al [2020] propose an enhanced 3DTV (E-3DTV) regularization term beyond the conventional. Instead of imposing sparsity on gradient maps themselves, the new term calculates sparsity on the subspace bases on gradient maps along all bands of an HSI, which naturally encodes the correlation and difference among all these bands, and thus more faithfully reflects the insightful configurations of an HSI. The E-3DTV term can easily replace the conventional 3DTV term and be embedded into an HSI processing model to ameliorate its performance.

Yunping Mu et al [2019] Speckle noise removal problem has been researched under the framework of regularization-based approaches. The regularizer is normally defined as total variation (TV) that induces staircase effect. Although higher-order regularizer can conquer the staircase effect to some extent, it often leads to blurred. Considering the upper questions, The combination of first and second-order regularizer will be an effective and prior method to tackle speckle noise removal. So a variational model with hybrid TV and higher-order total curvature (TC) term is proposed in this paper, the data fidelity term is derived based on G 0 distribution. In order to preserve the edge detail

better, the boundary detection function is combined with the regularizer. Furthermore, the Mellin transform is used to estimate the parameters of the model. To address the speckle noise removal optimization problem, alternating direction method of multipliers (ADMM) framework is employed to design a convex numerical method for the proposed model. The numerical method can be used to update the variables flexibly as required by the hybrid regularizer.

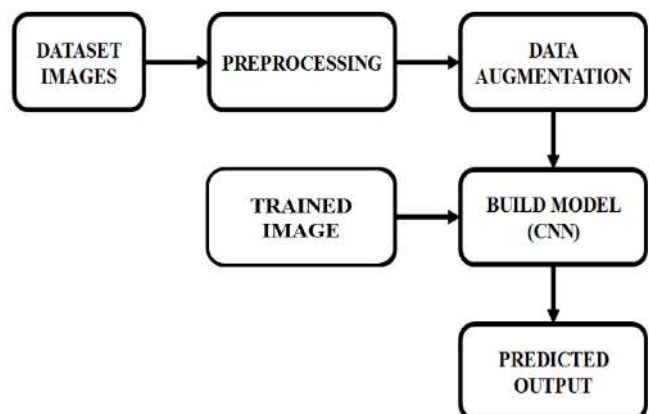
### EXISTING SYSTEM

- In this system, we proposed a novel deep learning denoising framework aiming to enhance the quantitative accuracy of dynamic PET images.
- This is done via introduction of deep image prior (DIP) combined with Regularization by Denoising (RED), as such the method is labeled as Deep RED denoising.
- The network structure is based on encoder-decoder architecture and uses skip connections to combine hierarchical features to generate the estimated image.
- Based on simulated data and real patient data, the quantitative performance of the proposed method was compared with state-of-the-art methods. The comparison study proves that several limitation are existed.

### DRAWBACKS

- Accuracy of the results are very low.
- The time taken for training and testing data are more.
- The computational complexity of data is too high.

### PROPOSED SYSTEM BLOCK DIAGRAM



DATASET

```
826 glioma_tumor_images
822 meningioma_tumor_images
395 no_tumor_images
827 pituitary_tumor_images
```

CNN CLASSIFICATION

• CLASSIFICATIONS: Convolutional Neural Networks (CNN) are deep learning algorithms that are very powerful for the analysis of images.

• There are three types of layers in Convolutional Neural Networks:

1. Convolutional Layer
2. Pooling Layer
3. Fully-Connected layer

CNN ALGORITHM

• Classification of Brain Stroke using Convolution Neural Network

- Input: Load all CT images *I* from the dataset
- Output: Classified brain stroke images (CI) into hemorrhagic and ischemic
- Step 1: Function CI=Classify (I)
- Step 2: Apply contrast stretching
- Step 3: Perform image filtering using average filter with image sharpening procedure
- Step 4: Use quad tree based image fusing technique by fusing contrast and filtered image
- Step 5: Partition the fused image dataset into training and testing set
- Step 6: Feed the training dataset of  $512 \times 512 \times 1$  into P\_CNN network

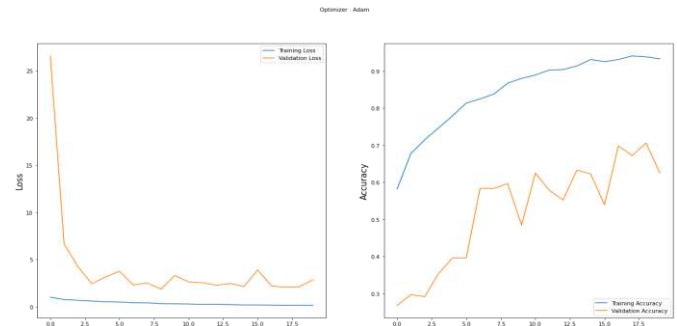
1. ReLU layer
2. MaxPooling layer
3. 2-D convolutional layer with 10 filters of [5 5]
4. 2-D convolutional layer with 96 filters of [11 11] size where stride is 4.
5. ReLU Layer
6. MaxPooling layer
7. Fully connected layer with output size of 512
8. ReLU Layer
9. Dropout layer with dropout probability 0.1

10. Fully connected layer with output size of 2 to classify stroke as hemorrhagic or ischemic

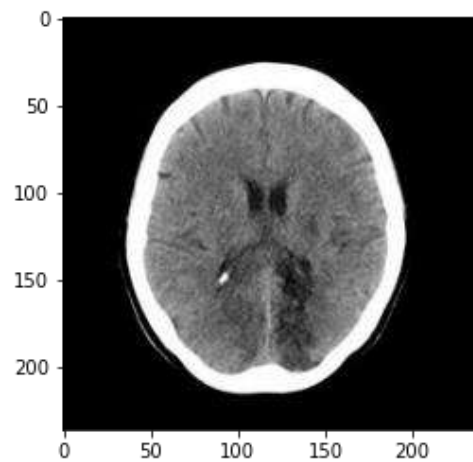
11. Apply softmax layer

Classify image dataset using classification layer

ACCURACY AND LOSS

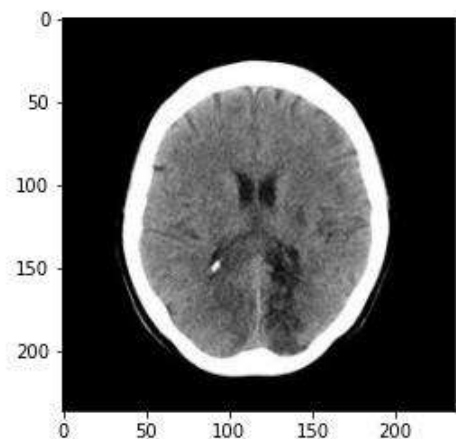


TESTIMAGE

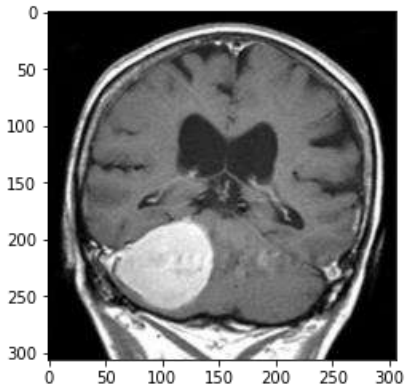


PREDICTED OUTPUT

Out[19]: 'no\_tumor'

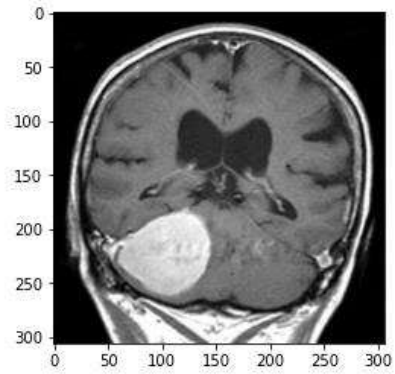


TEST IMAGE



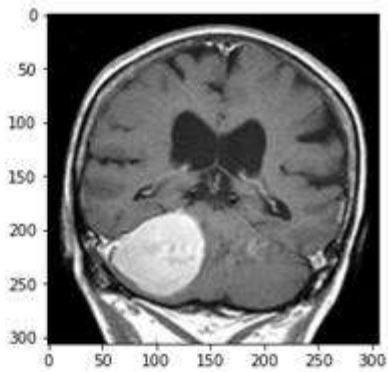
PREDICTED OUTPUT

Out[20]: 'meningioma\_tumor'

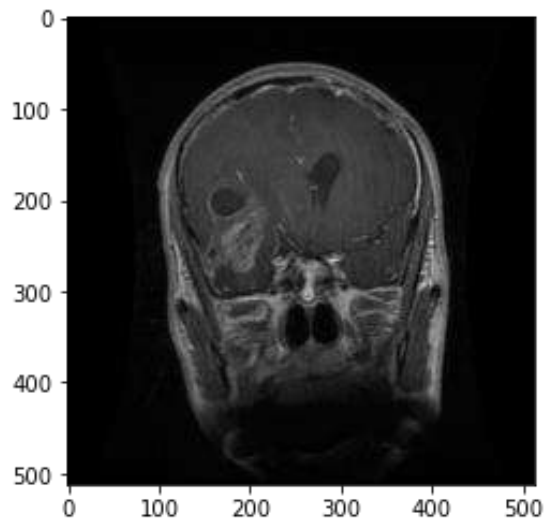


PREDICTED OUTPUT

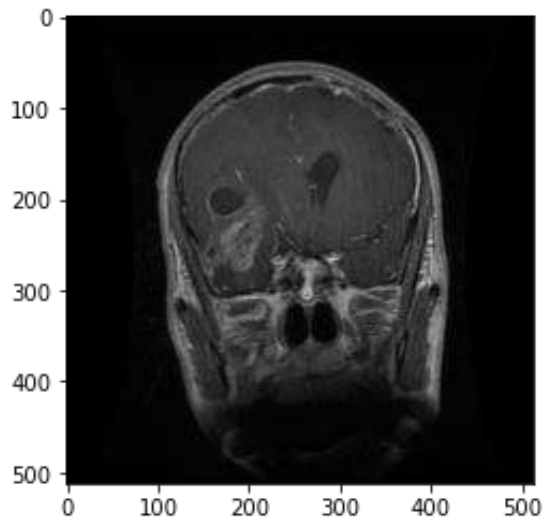
Out[20]: 'meningioma\_tumor'



TESTIMAGE

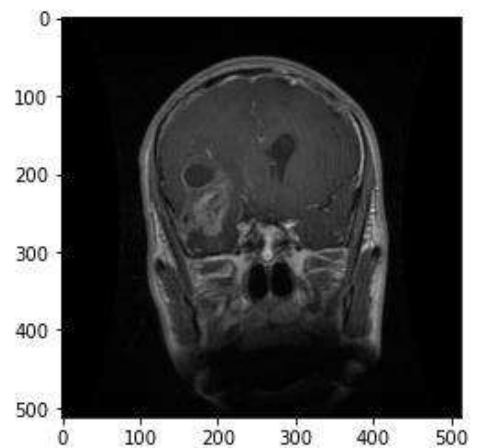


TESTIMAGE

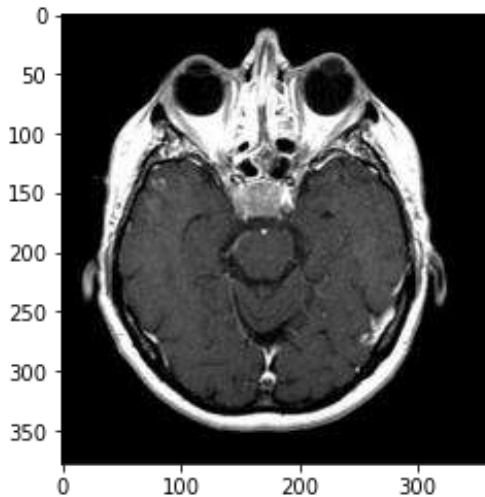


PREDICTED OUTPUT

Out[29]: 'glioma\_tumor'

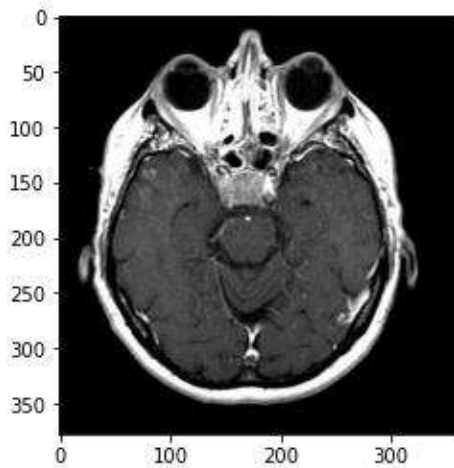


## TESTIMAGE



## PREDICTED OUTPUT

```
Out[23]: 'pituitary_tumor'
```



## ADVANTAGES

Time consumption is low.

Accuracy of the results is high.

Computational complexity of the algorithm is low.

## APPLICATIONS

Image Polishing and restoration.

Small Lesion Detection

Image Segmentation

## CONCLUSION

In this Project, we proposed a deep learning convolutional neural networks framework to get exact haemorrhage segmentation in CT brain images.

Initially, for the input of the network, data symmetry, and data augmentation are considered in the proposed model to abstract the structural symmetry of the brain image and prepare enough training data. Second, median filter is used to segment the interest area from the background. Comparing the experiments based on CT brain images demonstrated that the proposed CNN based model shows great advantages compared with human experts on haemorrhage lesion diagnosis.

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# Content Based Medical Image Retrieval Using Clustering Technique

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## ABSTRACT

Tumors of the brain are life-threatening and life-defying diseases for humans. For the radiologist, finding a suitable MRI brain tumour picture might be a difficult challenge. Text-based techniques are still the most common method used by most search engines to retrieve pictures. The major issue in MRI image analysis is that the MRI machine captures low-level visual information and the assessor identifies high-level data. To bridge this conceptual chasm, researchers in this study devised a brand-new feature extraction method. CBMIR (Content-Based Medical Image Retrieval) is a new approach to finding pictures of brain tumours in vast databases. MRI pictures are first cleaned up by using a variety of filtering procedures. This is followed by the construction of an algorithm for extracting representative features from MRI images using the Gabor filtering approach and the Walsh-Hadamard transform (WHT) technique, both of which concentrate on a certain frequency content at a specific area of the picture. Using Fuzzy C-Means clustering Minkowski distance metrics, we can then get the most accurate and dependable picture by comparing our query image to a database of photos. Brain tumour MRI images were used to evaluate the suggested technique design. Experiments on brain tumour detection using our suggested method show that it outperforms most of the current methods including Gabor, wavelet, and Hough transform. For radiologists and technicians, the suggested technique will help to construct an automated decision support system that will deliver repeatable and objective outcomes with high accuracy.

Keywords: CBMIR (Content-Based Medical Image Retrieval), Walsh-Hadamard transform (WHT), Magnetic resonance imaging(MRI)

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## I. INTRODUCTION

Among children and individuals under 40, brain tumours are the leading cause of death. When a mass of abnormal cells begins to proliferate and spread throughout the brain, it is considered a tumour. Headaches, visual issues, seizures, memory loss, changes in personality, trouble in concentration, loss of coordination and changes in speech, loss of balance, and mood swings are just some of the physical symptoms that people with a brain tumour suffer. Cancerous (malignant) and noncancerous brain tumours are both forms (benign). Cancerous brain tumours develop more rapidly and infiltrate surrounding tissue than benign ones. When tumours develop, the pressure within the skull might rise. This is true for both benign and malignant tumours. Brain injury, which is life-threatening, may result from this. A patient's quality of life is significantly impacted by brain tumours, and their loved ones must adjust to this new normal. According to the American Cancer Society, the number of Americans who will succumb to malignancies of the brain and spinal cord in 2021 will be about 18,600 [1].

The most common method of identifying a brain tumour is via the use of MRI. MRI provides a wealth of information on the structure of the brain, spinal cord, and arteries. The axial, sagittal, and coronal orientations of these three images will be shown. It is common to use T1- and T2-weighted MRI sequences, as well as Flair (Fluid Attenuated Inversion Recovery). Three-dimensional (3-D) visualisation of anatomical structure is possible using T1 weighted brain images in all three planes: axial, coronal, and sagittal. From the neck to the head, the axial orientation of the MRI head picture is examined. Starting at the point of the nose, the coronal orientation extends back behind the head. From ear to ear, the sagittal alignment is in place. Medical imaging technologies such as CT, MRI, ultrasound, and positron emission tomography (PET) are non-destructive in their approach. As a result, they aid in the acquisition of pictures of organ interiors.

Research on brain image retrieval using Content-Based Image Retrieval (CBIR) has focused on two basic ideas. One kind of technology focuses on automatically extracting pictures from PACS-like databases, which search images of the same imaging modality, body orientation and body area. Another kind of technique focuses on obtaining photos of comparable diseases that are easy to compare for diagnostic purposes. Radiologists face a tough and time-consuming process when attempting to retrieve MRI images from a large collection of similar-structured images. For this method to work, the radiologists must have access to and be able to comprehend MR pictures and be able to retrieve relevant images from the stored data. For a large amount of stored material, this human retrieval method is inefficient, nonreproducible, and time-consuming.

CBIR is a possible approach for indexing historical pictures without the need for radiologists' participation. The retrieval of pictures of brain tumours is the subject of this study, which utilises CBIR. When a radiologist submits a query picture, the CBIR system searches the database for images of the same pathological kind of brain tumour. The radiologist then picks the most closely connected photos that are relevant to the present case's diagnosis and treatment. Over 120 different types of brain tumours have been identified by the WHO, including astrocytoma, gliomas, meningioma, medullo blastoma, and many more. Tumors are divided into three types depending on three factors: their location, grade, and the kind of cells that make up the tumour. Glioma is a specialty in the medical field since it is a common malignancy among adults. When it comes to the treatment of glioma, it depends on its form, location, and size.

A content-based method for obtaining MR images of Glioma brain tumours was developed in this study. Based on the information in the images, the system develops visual characteristics that reflect the content of the picture. To reduce noise, we use many filtering approaches, including Mean Filter, Median Filter,

Conservative Filter, and Crimmins Speckle Removal, and then use the Gabor Walsh-Hadamard Transform strategy to extract features. Last but not least, we use Fuzzy C means with Minkowski to calculate similarity distances between the collected characteristics and an accurately identified brain tumour. Data from a publicly accessible CE-MRI dataset, the entire brain atlas, and other services like IBSR are used to test the method's effectiveness. On the same dataset, we tested robustness, assessed the suggested method's performance, and compared our findings to those of other researchers working on glioma brain tumour picture retrieval.

### 1.1. Need for Brain Portion Extraction

The extraction of the brain component from MR Head scans is a crucial step in numerous image processing and analysis fields, such as image registration, image segmentation and image compression (Atkins and Mackiewich, 1998). In future phases of the tool, the processing time is greatly reduced since the brain's surrounding areas may be disregarded. An important topic of research in medical diagnostics and prognosis is the removal of non-brain areas such as the scalp (bone), skull (fat), eyes, and neck from MR head images (Atkins and Mackiewich, 1998). Skull-Stripping / Brain Extraction is a common term for this technique.

### 1.2. Image Segmentation

Tissue classification is another name for image segmentation, which is the process of identifying distinct kinds of tissue in an MRI scan. Grey matter (GM), white matter (WM), and cerebral spinal fluid (CSF) are the three major brain tissues that are segmented by the brain extraction technique used (CSF). Some of these tissues, such as skin, bone, muscle, fat, and dura, have signal intensities that overlap with those of various other tissues in the brain. This causes an artefact in the strength of the overlap and makes it difficult to accurately identify tissue sections and features. A segmentation or a classification or a clustering algorithm's speed may be correlated to the

number of tissue types or areas it segments. Because of this, it is necessary to first separate the brain in MR images before conducting the brain tissue segmentation technique. GM, WM, and CSF segmentation of head scans is beneficial for a variety of applications, including the identification of cancers, lesions, and multiple sclerosis (MS) (Atkins and Mackiewich, 1998; Clark et al., 1998; Fennema-Notestine et al., 2006; Hartley et al., 2006; Khotanlou, 2009; Smith, 2002).

## II. MRI Principles

Nuclear magnetic resonance is the underlying basis of MRI (NMR). Raymond Damadian and Paul Lauterbur were the first to show the use of NMR for medical imaging in 1971 and 1973, respectively. In NMR, magnetic systems have both a magnetic moment and an angular moment. There are atoms in everything. The nuclei of atoms are made up of protons, neutrons, or a mixture of both. A nuclear spin and a magnetic moment may be found in nuclei with odd numbers of protons, neutrons, or both. The nuclei of most materials, such as  $^1\text{H}$ ,  $^2\text{H}$ ,  $^{13}\text{C}$ ,  $^{31}\text{Na}$ , and  $^{31}\text{P}$ , have magnetic moments (Dhawan, 2003).

The nucleus is formed by the union of protons and neutrons with spins that are in opposition to one another. Since there are equal numbers of protons and neutrons in nuclei with an even number of protons and neutrons, there is no net spin. Because hydrogen has just one proton in its nucleus and hence has a net spin, its nucleus has an NMR signal. Fat and water, both of which have a high concentration of hydrogen atoms, make up the bulk of the human body. The hydrogen nuclei in the bodily tissues are the primary source of the NMR signal for medical MRI.

As the nucleus rotates around its axis, an angular moment is created. Due to its positive charge, the proton creates an axis-defying current loop. A magnetic field is created as a result of the current flowing through it. The magnetic dipole moment of

the proton is formed by the combination of the angular momentum and the self-generated magnetic field. In normal circumstances, there will be no net magnetic field generated by the volume, since the magnetic dipole moments are orientated at random in the material.

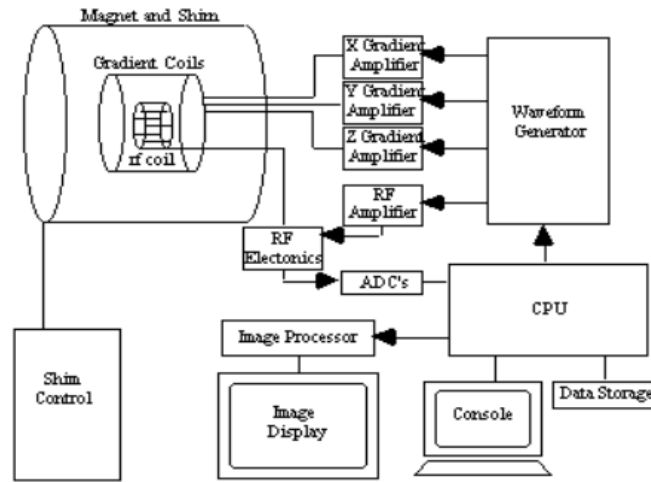


Figure 1.1: A schematic representation of MRI system (Clare, 2006)

Fig.1.1 depicts the key components of a magnetic resonance imaging system. The  $B_0$  imaging field is generated by the magnet. The gradient coils for creating a gradient in  $B_0$  in the X, Y, and Z axes are located inside the magnet. The RF coil is housed inside the gradient coils. In order to rotate the spins through  $90^\circ$ ,  $180^\circ$ , or any other number determined by the pulse sequence the RF coil creates the  $B_{rf}$  magnetic field required. The RF coil also picks up signals from the body's internal spinning. A computerised patient table guides the patient within the magnet's confines. An accuracy of one millimetre may be achieved with this table. A radio frequency (RF) barrier surrounds the scan chamber. Radiation from high-power RF pulses is prevented by the shield. It also shields the 24 imager from the numerous RF frequencies broadcast by television and radio stations. A magnetic shield surrounds certain scan rooms to prevent the magnetic field from leaking out into the rest of the facility. As technology has progressed, the magnet shield has become a fully integrated component of the magnet. At its core, an imager is a computerised device. All of the imager's components are under its command. It is the computer that directs the radio frequency source and pulse programmer, both of which are electronic devices. The source generates a sine wave with the required frequency output. In order to create apodized sine waves, the pulse programmer is used. From milliwatts to kilowatts, the pulse power is increased by the RF amplifier. An additional computer-controlled device is used to adjust the form and amplitude for each gradient pulse. The gradient amplifier boosts the gradient pulses' power so that they can drive the gradient coils' current. A two-dimensional Fourier transform may be performed in a fraction of a second by the image processor on certain imagers.

A pulse sequence is a series of RF pulses used to generate a certain kind of NMR signal (Hornak, 2008). There are a variety of imaging pulse sequences to choose from. SE, inversion recovery (IR), and gradient recalled echo are some of the most often used MRI sequences (GRE). Most people utilise the SE sequence for their pulses since it is the most prevalent. Slice-selective  $90^\circ$ -degree pulses, followed by one or more  $180^\circ$ -degree refocusing pulses, are part of every SE sequence (Ballinger, 2009). In SE sequence, the TR and TE are the two most important variables to consider. When TR and TE are chosen, it has an impact on the overall picture contrast. The addition of T2 dependency to the signal is a benefit of this approach. A T2 dependent imaging sequence is beneficial since

various tissues and diseases have comparable T1 values but vary in their T2 values (Hornak, 2008). With IR pulse sequences, the T1-weighting may be made more pronounced. A 180-degree RF pulse inverts the magnetization, followed by a 90-degree RF pulse that moves the remaining longitudinal magnetism into the transverse plane, where an RF coil can detect it. This is the fundamental portion of an inversion recovery sequence. In imaging, a 180-degree pulse is used to refocus the signal, similar to the SE sequence. The interval between the first 180-degree pulse and the second 90-degree pulse is known as the inversion period (TI). A benefit of this sequence is that its T1 permits the signal from one component to be nulled. This sequence may be used. Fat suppression may be achieved using the STIR (short TI inversion recovery) sequence, which utilises a short TI to eliminate the fat signal while still preserving water and soft tissue signals. The loss of proton signal during the TI period is one of the drawbacks of this sequence. For longitudinal magnetization to be recovered, the TR duration must be longer than the SE time.

### III. Proposed Work

It is the goal of this project to detect brain tumours using a content-based picture retrieval system. In this proposed work, we provide a novel framework for extracting texture features by combining Gabor Walsh-Hadamard Transforms (GWHT). The distance metric measure is utilised for matching in order to get comparable database pictures of brain tumours to the input query image. Fuzzy Clustering using Minkowski distance is a novel distance metric we propose in this work to measure the distance for the similarity between query and database pictures. The optimization of the prediction system is broken down into three stages, as follows.

Using Mean, Median, Conservative, and Scimmins Speckle Removal, we eliminate noise from the raw MRI dataset in Phase 1 (Pre-processing).

Feature Extraction (Phase 2): Using a variety of feature extraction approaches, including the Gabor Transform, Wavelet Transform, Hough Transform, and a hybrid of the Gabor and WalshHadamard Transform, we attempt to extract important properties of the brain tumour.

Phase 3 (Retrieval of Brain Glioma Tumor Image): Using Fuzzy Clustering with Minkowski Distance, we extract brain tumour pictures from an MRI database. The suggested system's design.

#### An MRI Image Pre-Processing

The goal of pre-processing is to enhance the MRI brain pictures' clarity and quality so that they may be used in future analysis. In this study, we used image denoising to remove the noise from the brain picture, allowing us to go back to the original image. Mean filter, Median filter, Conservative Filter, and Crimmins Speckle Removal were some of the tools we used to achieve this end. Using a single filter to preprocess brain tumour photos is very difficult. In the current study solution, a single filter output has more error characteristics, which results in an incorrect prediction. Multiple preprocessing steps provide reliable noise filtering for increased efficacy. The following subsections go into great depth about each filter.

#### Filtering by Means

An image's noise may be reduced using the mean filter. Mean pixel values are calculated using a  $M \times N$  kernel, which is the sum of the individual pixel values. In order to minimise pixel-to-pixel fluctuation, the mean filter is used. This filter replaces each pixel's value with the average of the values in the neighbourhood where it is located. It is possible for a mean filter to remove unrepresentative pixel values from the surrounding environment. The mean value replaces the intensity value of the centre pixel. As a result, the picture is free of noise and has smooth edges. Any filtered data point may be mathematically represented as the average of the latest  $N$  recorded data points for a filter of length  $N$  as The mean filter may alternatively be thought of as a

convolution of the measured signal with a vector of  $N$  constant coefficients, each equal to  $1/N$ . Open-CV package is used to get a mean filter for the picture while applying this filter in Python. Median Filter results are shown in Fig. 2.2.1

## 2) Median Filter

If you use the median filter, it scans the whole picture using a  $3 \times 3$  matrix and recalculates each pixel's value by simply replacing it with its median value. Because median filter generates a more robust average than the mean filter, it is the primary benefit.

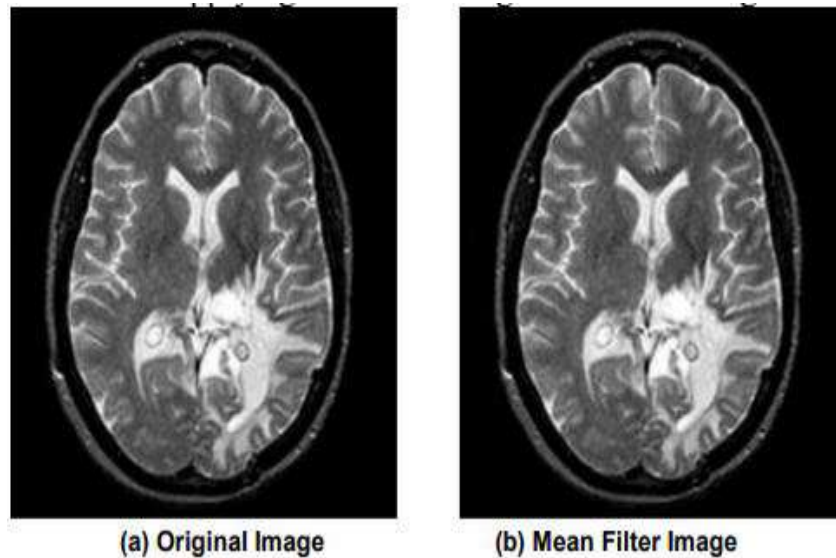


FIGURE 2.1 An example image of Mean Filter

Any pixel value in the vicinity of the neighbouring pixels is considered to be the median. As a result, it will not be able to produce pixels with unrealistic values, which are necessary for pictures to maintain their crisp edges. In terms of brain tumour imaging, this is a very important aspect.

$$X[p, q] = \text{median}\{y[i, j], (i, j) \in Z\}$$

This neighbourhood of pixels is set by the user and centred on a certain place in the picture, which is represented by  $Z$ . Figure 2.2 shows the effect of using a median filter.

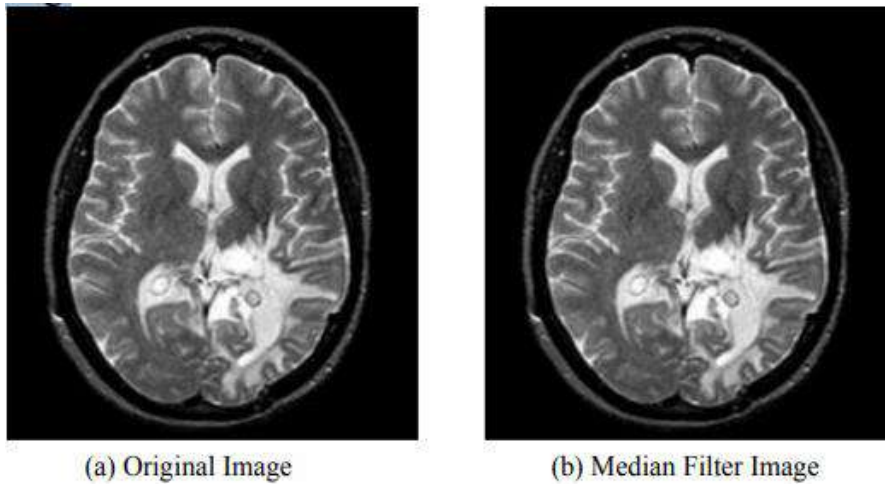


FIGURE 2.2. An example image of Median Filter

1) **Conservative Filter**

The picture may be smoothed and the noise in the image reduced using a cautious smoothing filter. It operates by figuring out the nearest grid cell's lowest and maximum value. Any pixels whose intensity is higher than the computed maximum value are substituted in the final picture with the higher value. The picture should be shown in a window with a resolution of 4 x 4. Take the midpoint of 4 4.

$$out_{img} = \begin{cases} \text{if } mid > max; max \\ \text{if } mid < min; min \end{cases}$$

Similarly, if it is less than the minimum value then it is replaced by the minimum value in the output image. The parameters which are used in conservative filter are neighborhood size, or filter size, is specified in the m and n dimensions. These dimensions should be odd, positive integer values (for example: 3, 5, 7, 9, etc.). Fig. 3.3 shows the resultant of applying the conservative filter.

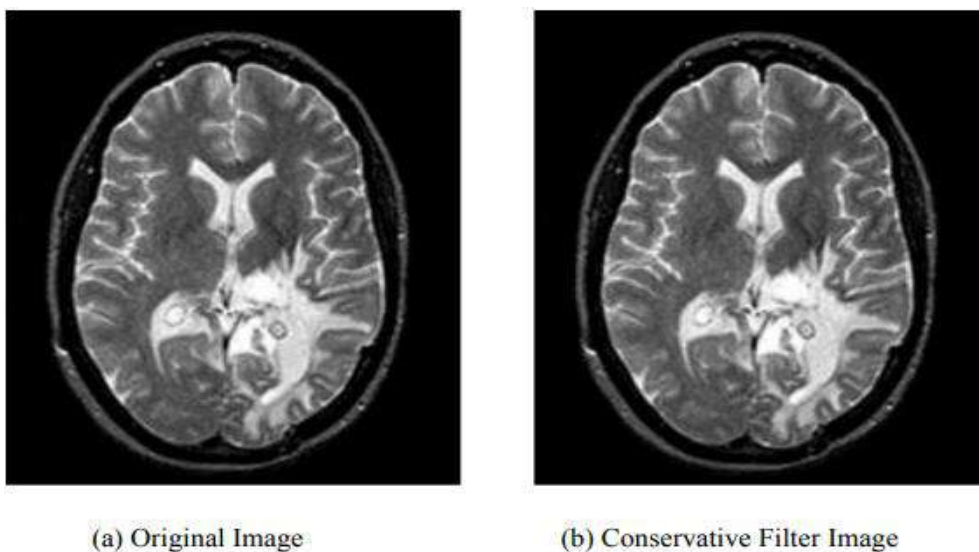


FIGURE 2.3. An example image of Conservative Filter

## 2) Crimmins Speckle Removal

Speckle noise is removed from images using the Crimmins algorithm. The intensity of a pixel in an image is compared to the intensities of its eight neighbours in this technique. Neighbors are considered in four sets by the method (N-S, E-W, NW-SE, NE-SW). P, q, and r are three separate pixels. The algorithm then follows: Follow these instructions for each new iteration.

Each of the four orientations may have its dark pixels adjusted.

1) Apply the following rule to the whole brain image: if  $p > q+2$ , then  $q = q+1$ .

2) Apply the following formula to the whole brain image:  $q = q+ 1$  if  $p > q$  and  $q > r$

If  $r > q$  and  $q > p$ , then  $q = q+ 1$  for the full brain picture. 2) If  $r > q+ 2$ , then  $q=q+ 1$ ; else,  $q=q+ 2$ ;

It allows you to modify the brightness of individual pixels in each of these four directions

If  $p > q > 2$ , then  $q$  is equal to the square root of the square root of  $q+ 1$ .

If  $p > q$  and  $q > r$ , then  $q = q+ 1$  for the full brain picture.

If  $r > q$  and  $q > p$ , then  $q$  Equals  $q+ 1$  for the full brain picture. 4) Apply the following rule to the whole brain image: if  $r > q+ 2$ , then  $q = q+ 1$ . Crimmins Speckle Removal's final product is seen in Figure 2.4.4.

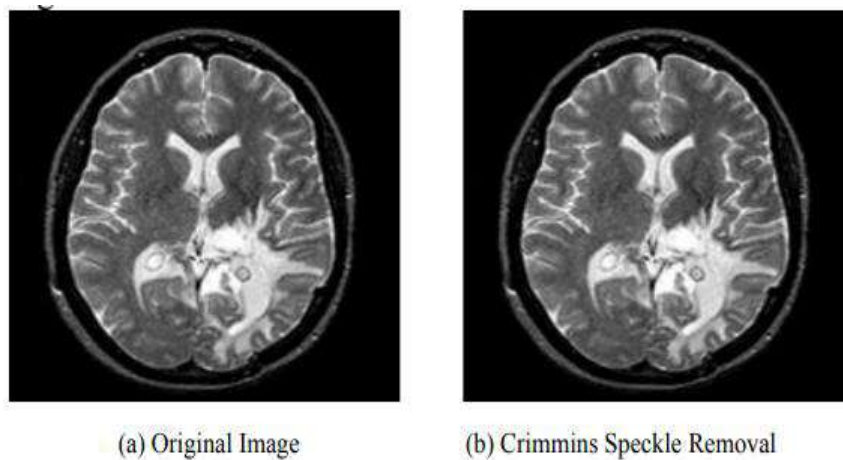


FIGURE 2.4. An example image of Crimmins Speckle Removal

## B. Feature Extraction

The main issue in CBIR is to extract the features which include texture, shape, etc. of the brain image efficiently and then represent them in a particular form to be used effectively in the matching of images. In our proposed work, we implement texture feature extraction by using hybrid of Gabor Walsh-Hadamard Transform (GWHT) technique. Gabor is a multi-scale, multi resolution filter. In Gabor filter pixel value  $x$  and  $y$  denotes the position of the image. Here  $\omega$  denotes center frequency,  $\theta$  denotes the Gabor's orientation of direction and  $\sigma$  shows that standard deviation of Gaussian function with  $x, y$  axis of the image.

$$g(x, y, \sigma) = e^{-\frac{(x-x_0)^2}{2\sigma_x^2} - \frac{(y-y_0)^2}{2\sigma_y^2}} e^{j(\omega_{x0}x + \omega_{y0}y)}$$

Where,

$\omega_{x0}, \omega_{y0}$  – Center frequency of  $x$  and  $y$  directions of the image.

$\sigma_x, \sigma_y$  - standard deviation of the Gaussian function with  $x$  and  $y$  axis or direction.

$x, y$  - Position of the image in pixel format.

Replace the Equation as

$$\varphi(x, y, \omega, \sigma, \theta) = e^{-\frac{(x \cos \theta_k - y \sin \theta_k)^2}{2\sigma_x^2} + \frac{(-x \sin \theta_k - y \cos \theta_k)^2}{2\sigma_y^2}} e^{j(\omega_{x0}x \cos \theta_k + \omega_{y0}y \sin \theta_k)}$$

$$x\theta_k = x \cos(\theta_k) + y \sin(\theta_k)$$

$$y\theta_k = x \sin(\theta_k) + y \cos(\theta_k) .$$

In this work, applied the orientation  $\theta$  of Gabor direction as  $0^\circ, 20^\circ, 40^\circ, 60^\circ, 120^\circ$  with their frequency values of 60, 80, 120, 140. After applying the Gabor Transform to the brain image, the texture features are extracted, in this output applying the Walsh-Hadamard Transform (WHT) to get more accurate and efficient result. WHT is based on correlation between local pixels of the brain image. Walsh transform matrix can be defined as  $WT_i, i = 0, 1, \dots, N - 1$ . The properties of WT are given below:

1. The values of Walsh Transform matrix is(  $WT_i$  ) +1 and -1.
2.  $WT_i[0] = 1$  for all  $i = 0, 1, \dots, N - 1$
3.  $WT_i \times WT_j^T = 0$ , for  $i \neq j$ .
4.  $WT_i \times WT_j^T = N$  for  $i = j$ .

The Walsh transform matrix's row is equal to the row of Hadamard matrix and it is defined by index value of Walsh which is range from 0 to N-1. The Walsh transform matrix's row is equal to the row of Hadamard matrix and it is defined by index value of Walsh which is range from 0 to N-1.

The properties of Hadamard matrix are given below:

1.  $HD_n \cdot HD_n^{-1} = nId_n, Id_n - Identity Matrix$  and

$HD_n$  is the Hadamard matrix.

2.  $|HD_n| = HD_n^{\frac{1}{2n}}$



$$3. HD_n \cdot HD_n^{-1} = HD_n^{-1}HD_n$$

To change the order of Hadamard matrices by permuting rows and columns and also multiplying by the value - 1 in rows and columns. The 4 × 4 matrix is defined as

$$HD_4 = \begin{bmatrix} HD_2 & HD_2 \\ HD_2 & -HD_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

Walsh Hadamard Transform (WHT) is defined by sparse factorization of Walsh transform matrix and each factor value is referred as stage. In the WHT the input and output value of each stage is defines as factor value of decomposition. The sparse factorization of identity matrix is obtained from *HD* matrix with its inverse function.

$$HDR^n = Ra^n(HDR^n)^{-1}$$

Where

*HDR<sup>n</sup>* - Walsh Hadamard Transform with radix R

*Ra<sup>n</sup>* - Factorization of radix Ra

n - Number of input element

The WHT consists of Fourier and Cosine Transforms in the basic functions that are a set of orthogonal sinusoidal waveforms. The WHT applied in Squared size gallery space images generating M×M blocks from each image for texture feature extraction. Here we are using 4x 4 blocks. Instead of considering the whole pixels of the image selectively choose the super pixels by using clustering method. These selected pixels are considered as kernel of M×M blocks. The texture features are extracted by projecting sum of selected kernels {*k<sub>0</sub>, k<sub>1</sub>, k<sub>2</sub>, k<sub>3</sub>, … k<sub>15</sub>*} of WHT on the blocks of the image. The diagonal kernels are {*k<sub>0</sub>, k<sub>5</sub>, k<sub>10</sub>, k<sub>15</sub>*}are selected for extracting the texture features of the image.

$$k_0 = \frac{1}{4} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

$$k_5 = \frac{1}{4} \begin{bmatrix} 1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ -1 & -1 & 1 & 1 \\ -1 & -1 & 1 & 1 \end{bmatrix}$$

$$k_{10} = \frac{1}{4} \begin{bmatrix} 1 & -1 & 1 & 1 \\ -1 & 1 & -1 & 1 \\ -1 & -1 & 1 & 1 \\ 1 & -1 & 1 & -1 \end{bmatrix}$$

$$k_{15} = \frac{1}{4} \begin{bmatrix} 1 & -1 & 1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & 1 & -1 \end{bmatrix}$$

To extract the texture feature and gives more clarity to the values by sum of the selected kernel values with projected onto the blocks of the image. These projection of selected kernel values for the blocks of the image is computed as following:

$$\begin{aligned}
 p_1 &= \sum_{i=1}^m b_i * k_0, \\
 p_2 &= \sum_{i=1}^m b_i * k_5, \\
 p_3 &= \sum_{i=1}^m b_i * k_{10}, \\
 p_4 &= \sum_{i=1}^m b_i * k_{15},
 \end{aligned}$$

where  $b_i$  is the  $i^{\text{th}}$  block of the image.  $p_1, p_2, p_3, p_4$  are projection of selected kernels  $\{k_0, k_5, k_{10}, k_{15}\}$  of the blocks of the image. The sum of all projected kernels of the blocks image is calculated as follows:

$$\begin{aligned}
 s &= p_1 + p_2 + p_3 + p_4 \\
 &= \sum_{i=1}^m b_i * k_s,
 \end{aligned}$$

where  $s = 0, 5, 10, 15$  are the diagonal kernel values of the image.

#### Algorithm 1: Gabor and Walsh-Hadamard Transform (GWHT)

Suggestion: a brain tumour discovered through an MRI scan

An option to include texture in the output. The removal of brain tumour tissue

The first step is to read the binary representation of the brain picture from the data collection.

In this step, we use Equation to apply a two-dimensional Gabor filter on the picture.

3rd step: apply the Fourier transform to each block's picture, with a size of 16 x 16. Then choose the Gabor size of 8 x 8 with 5 orientations and 4 scale values from the Fourier converted Gabor picture.

Divide each picture into equal-sized blocks of 4 x 4 using the Walsh-Hadamard transform in step 4.

This specifies how many blocks there are.

Step 5: Using the diagonal kernel values for extracting the texture feature of the picture is the last step in the process.

Project WHT kernels on blocks  $4 \times 4 = \sum_{i=1}^n$

My heart goes out to Nbl i.

$k_n$  represents the  $n^{\text{th}}$  kernel of the block  $bl$ , and  $k_i$  represents the  $i^{\text{th}}$  block  $bl$ .

When calculating the image's texture strength, use the formula  $T = |k_n| - |bl_n|$ . For each  $n^{\text{th}}$  block of the  $bl$  picture, the pixel intensity value and the  $k$  denote projected kernel values.

Repeat the steps 6 and 7 for each of the image's blocks to compute the image's texture strength.

A pixel is defined as a block's texture strength multiplied by its number of pixels in the picture.

A Gaussian adjacency matrix A and a Diagonal Matrix D are constructed by taking into account the image's super pixels  $s_1, s_2, s_3, \dots, s_m$  as pixels.

Step 11: Using the Gaussian adjacency matrix A and the diagonal matrix D, construct the Laplacian matrix LM.

Step 12: Denormalize the matrix LM to generate a unit matrix k.

Step 13: Create a cluster for each row of the K-means clustering matrix. When the pixel value closest to the cluster centroid is found, that's where it belongs.

Step 14: Gather all of the K-cluster pixel values.

The pixel values gathered in step 15 are regarded as brain tumour tissues..

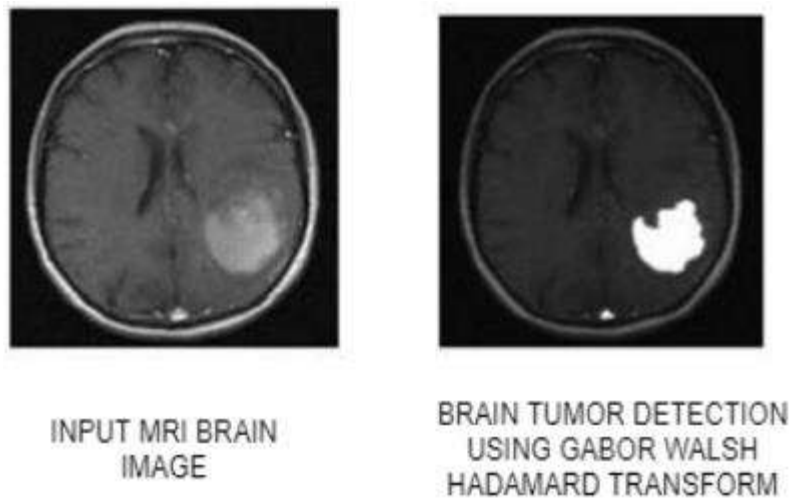


FIGURE 2.5. Result of Proposed Method (GWHT)

### C. Retrieval of Brain Glioma Tumor Image From MRI Database

In this work we used Fuzzy C-Means (FCM) algorithms with Minkowski distance to retrieve the similarity Glioma tumor images from the large image dataset. Main objective of using this algorithm is, it minimizes the Euclidean distance between the data and cluster center. The FCM is stated by:

$$(U, X, \{A_i\}) = \sum_{i=1}^k \sum_{j=1}^N (\mu_{ij})^m D_{ij}^2 A_i,$$

$$\text{Where, } U = [\mu_{i,j}]_{K \times N} \in [0,1]$$

$$X = I^{n \times N}$$

where, U is partition matrix,

$A_i$  is optimization variable used in local norm of matrix, X is set of non-labelled data,

$\mu_{ij}$  is the membership degree of data object  $x^k$  in cluster  $k_i$

$$\mu_{ij} = \frac{1}{\sum_{l=1}^k \frac{d_{ij}^{m-l}}{d_{il}^2}}, i = 1, 2, \dots, k; j = 1, 2, \dots, n$$

Minkowski distance is used.

$$\left(\sum_{i=1}^n |X_i - Y_i|^p\right)^{1/p}.$$

By using Fuzzy C means with Minkowski distance. The most common method for comparing two images in content-based image retrieval is by using an image distance metric measure. For example, a distance of 0 signifies an exact match with the query. The retrieved images are ranked in ascending order based on their relevance.

#### IV. CONCLUSION

Researchers in contemporary image processing have found it difficult to implement content-based picture retrieval. GWT feature extraction is the basis of our novel CBIR strategy for retrieving brain tumours, which we describe in this study. An improved performance of 97% accuracy is achieved by the suggested approach for obtaining medical images. The examination of the results demonstrates that our suggested method is better to other methods in terms of accuracy and recall. It also required less time to extract features using the suggested technique compared to previous methods of feature extraction. Predicting real positive outcomes as soon as feasible is made easier by retrieving the most recent picture. The problem is that we can't separate out false positive photos if there is a lot of similarity between the pixels in the photographs. The initial stage in medical diagnosis is to find the appropriate picture based on its attributes. It is feasible to anticipate illness onset by using this approach and subsequent processing techniques.

#### V. IMPROVEMENTS FOR THE FUTURE

Some semantic-based similarity computation algorithms may be able to overcome this restriction in the future. The great similarity of pixels in a picture cannot be categorised as a false positive, hence an optimization technique in Artificial intelligence or swarm intelligence may be used to address this constraint.

#### VI. CONCLUSION

The control circuit components are selected to meet established construction and performance requirements. The proposed UL listing standard includes details of such requirements and methods for them to be evaluated. The severest hazard being mitigated by the SIE for connected equipment circuits is electrocution; thus, the overall design requirements

of the SIE device would be for it to achieve the required behavior of safety-related parts to category 4. In order for the internal circuits and components of the SIE device to achieve the safety performance of category 4, they have to be designed so that the following are achieved.

- 1) A single fault in any of the safety-related parts does not lead to a loss of the safety function.
- 2) The single fault is detected at or before the next demand upon the safety functions, such as

immediately, at switch on, or at the end of a machine operating cycle. If this detection is not possible, then an accumulation of faults shall not lead to a loss of the safety function.

3) If the detection of certain faults is not possible, for reasons of technology or circuit engineering, then the occurrence of further faults shall be assumed. In this situation, the accumulation of faults shall not lead to the loss of the safety function. The present designs for the SIE involve circuits and equipment that can be evaluated in a deterministic fashion, and thus, the use of safety performance categories is the present practice. If future systems develop beyond the usefulness of deterministic evaluation, then probabilistic methods would be required.

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# A New Hybrid TLPD Algorithm for Task Scheduling in Cloud Computing

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## ABSTRACT

In this paper we have designed the hybrid approach of combination of credit based task length & priority algorithm and credit based deadline algorithm as well as compare the results with FCFS, SJF and task length & priority scheduling algorithms. When we use the credit based task length & priority scheduling algorithm to schedule the task without knowing the deadline of the task, it will cause the dead of the least deadline task. The deadline credit is also included so that assigning number of resources to the tasks in such a way that there will be maximum resource utilization and minimum processing time achieved. This paper presents the simulation results of the proposed methodology implemented with the help of Cloudsim and Net beansIDE8.0 and analysis of results.

Keywords: Task length & Priority, Hybrid TLPD, FCFS, SJF, Cloudsim

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## I. INTRODUCTION

Cloud computing is a distributed computing environment that provides on demand services to the users for deploying their computational needs in a virtualized environment without the knowledge of technical infrastructure [1].

Resource Allocation strategy (RAS) in the cloud is all about the scheduling of tasks or requests by cloud provider in such a manner to balance the load over all the servers and provide high Quality of Service to clients. It also includes the time required to allocate the resources and the resources available. The main aim is to improve the utilization of resources and complete the entire request within the deadline and with least execution time [1].

In this paper we describe in Section 1 Introduction Section 2 Concept of scheduling Section 3 Simulation Tool Section 4 Traditional task scheduling algorithm Section 5 Proposed Hybrid TLPD Scheduling Algorithm Section 6 QOS parameters Section 7 Simulation Setup Section 8 Results and Analysis, section 9 Conclusion, Section 10 Acknowledgement, and Section 11 References.

## II. CONCEPT OF SCHEDULING

The key aim of scheduling is to optimize resource efficiency while minimizing the effect on cloud resources. Currently, cloud computing uses the internet to provide complex services such as software, data, memory, bandwidth, and IT services. The

dependability and efficiency of cloud services are influenced by a number of factors, including task scheduling. Scheduling can take place at the job, resource, or workflow stage. Scheduling is done based on a number of criteria in order to maximize overall cloud performance [3].

The main focus of this paper is on cloud resource scheduling. Users request services on demand, and the cloud provider is responsible for allocating the necessary resources to the customer in order to prevent Service Level Agreement violations (SLA). The Task Scheduling process instructs the scheduler to obtain tasks from users and requests information from the cloud information service (CIS) on available resources and their assets. The scheduler schedules user-submitted jobs on different resources according to the availability of resources and the Task Scheduling algorithm. The cloud scheduler is in charge of assigning multiple virtual machines (VMs) to various tasks.

## I.SIMULATION TOOL

Cloudsim is a simulation program that allows you to conduct cloud computing experiments. CloudSim is a simulation framework that allows for seamless cloud computing and application service modeling, simulation, and experimentation. CloudSim also helps you to model cloud system components like data centres, virtual machines (VMs), and resource allocation policies, as well as their system and behaviour. Cloudsim uses generic device provisioning strategies that are simple to extend and require little effort. The datacenter, which acts as the cloud's backbone and includes a variety of hosts and virtual machines, is depicted in the diagram below(s) [5].

## II.TRADITIONAL TASK SCHEDULING ALGORITHMS

(A) First Come First Serve Algorithm: FCFS is a cloud resource-saving scheduling policy that is quick, reliable, and error-free. It employs nonpreemptive

scheduling, in which tasks are automatically queued and distributed in response to incoming requests. [8].

(B) Shortest Job First Scheduling Algorithm: Tasks are sorted based on their priority. Priority is given to tasks based on tasks lengths and begins from (smallest task = highest priority). Jobs are queued in order of execution time, with the shortest execution time placed first and the longest execution time placed last and given the lowest priority. [9].

(C) Task Length & Priority Algorithm: The credit based method takes into account two factors: task length and user priority. The credit scheme is used in the algorithm. Each assignment is given a credit depending on the duration and priority of the task. These credits will be taken into account when the job is scheduled. The final step in the algorithm is to find out the total credit based on task length and task priority. Finally task having highest credit will be scheduled first. But this scheduling algorithm based on task length and task priority has the problem of treating tasks with similar priority with similar credits [10].

## III. PROPOSED HYBRID TLPD SCHEDULING ALGORITHM & FLOWCHART

### Algorithm Hybrid TLPD

- Initialize the Cloudsim package by creating the datacenter, broker, virtual machines and cloudlets
- Initialize the virtual machines list
- Initialize the task list.
- Sort the virtual machines using QOS parameters (MIPS and Granulaity size).
- Sort the task list using priorities calculated using credits by using following procedure:
- In this credit to task is assigned using 3 parameters which are credits based on task length, priority of the task, deadline of the task.

$Total\_Credit_i = Credit\_Length_i * Credit\_Priority_i * Credit\_deadline_i$

Calculate  $Total\_Credit_i = Credit\_Length_i * Credit\_Priority_i * Credit\_deadline_i$   
End For

**Procedure 1: Credit based on Length of task[8]**

For all requested tasks in the set;  $T_i$   
 Task\_length\_difference ( $TLD$ ) = absolute\_value  
 (average\_length – task\_length)  
 If  $TLD \leq value1$   
     then credit =5  
 else if  $value1 < TLD \leq value2$   
     then credit =4  
 else if  $value2 < TLD \leq value3$   
     then credit =3  
 else if  $value3 < TLD \leq value4$   
     then credit =2  
 else  $value4 > TLD$   
     then credit =1  
 End For

where

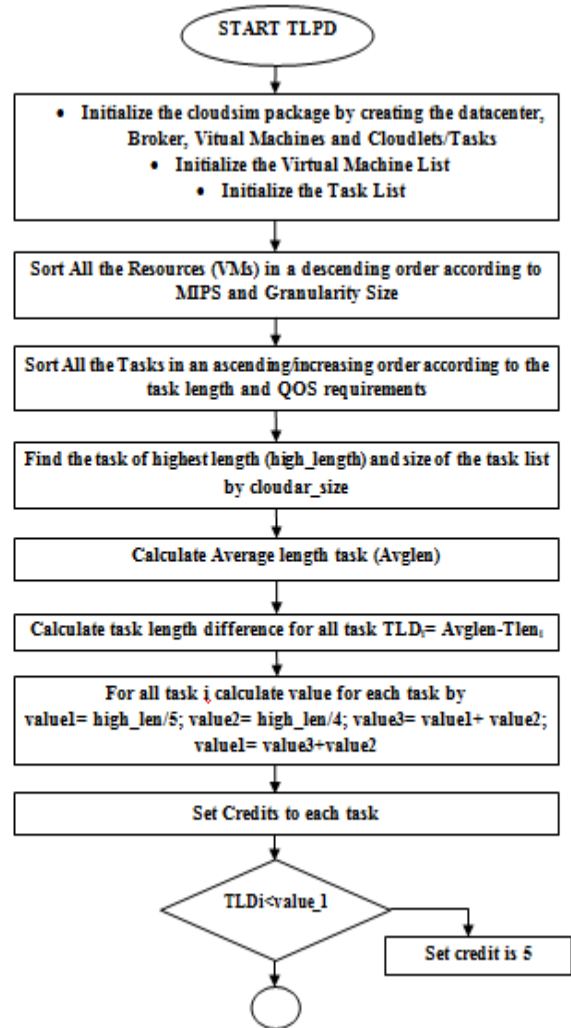
$value1 = high\_len / 5;$   
 $value2 = high\_len / 4;$   
 $value3 = value2 + value1;$   
 $value4 = value3 + value2;$

**Procedure 2: Priority credits assigning to task [8]**

For all requested tasks in the set:  $T_i$   
 Find out highest priority task  
 (Priority\_Number)  
 Choose division\_factor\_value  
     For priority of each task ( $T_{pri}$ )  
         Calculate  $Pri\_frac_i = T_{pri} / division\_factor$   
         Set priority credit as  $Pri\_frac$   
 End For  
 End For

**Procedure 3: Deadline of the task**

For all requested tasks in the set;  $T_i$   
 Find out MAXMIPS of the VM from the  
 virtual machine list  
 $Deadline\_Task_i = (Credit\_Length_i * Credit\_Priority_i) / MIPS_{MAX}$





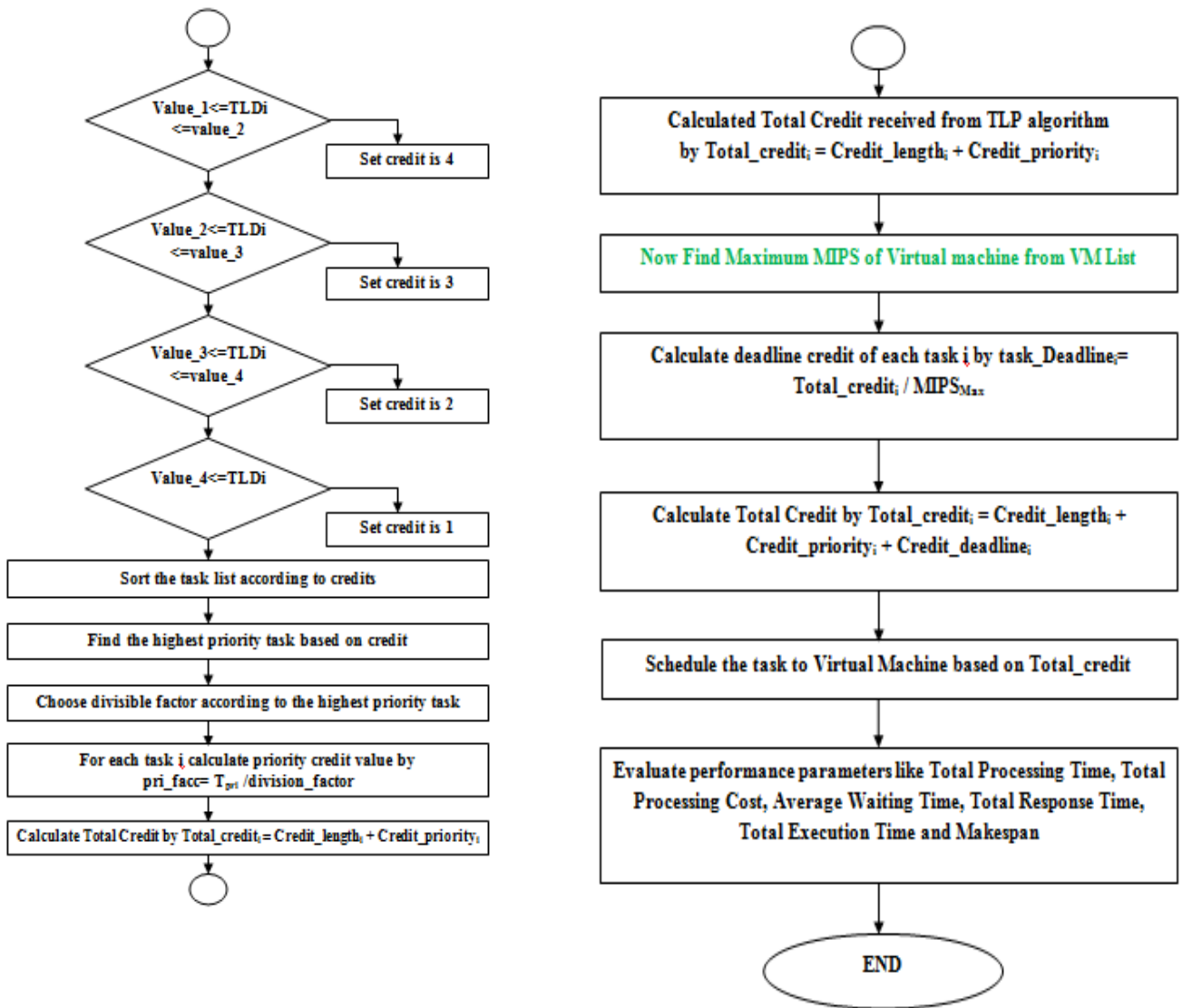


Figure 1 : Flowchart of proposed Hybrid Task length, Priority and Deadline scheduling algorithm (TLPD)

#### IV.QOS PARAMETERS

In this paper I have considered Makespan QOS parameter in analyzing the performance of scheduling algorithms. Makespan: The amount of time, from start to finish for completing a set of tasks. The makespan is the maximum time to complete all jobs. For better performance of the system makespan of scheduler must be minimum. A good scheduling algorithm always tries to reduce the Makespan.

$$\text{Makespan} = CT_n$$

**V. SIMULATION SETUP**

The configuration of host contains 5 numbers of Hosts, size/processing speed is 5000 (in MIPS), RAM is 5048 (in MB). Configuration of virtual machine contains varying number of virtual machines from 5, 10, 20, 25 and 30 implemented respectively for varying number of cloudlets 30, 50, 100, 150, 200. The details of general simulation parameter are depicted in Table I.

Finding QOS parameter is Makespan. The experimental data are shown in tables as well as graphs.

TABLE I SIMULATION PARAMETER VALUES

S.N o.	Parameter	Value
<b>A</b>		
1	Data center architecture	X86
2	Data center OS	Linux
3	VMM	Xen
<b>B</b>		
1	No of Hosts	5
2	MIPS	5000 (in mips)
3	RAM	5048 (in MB)
4	Storage	1000000 (in MB)
5	Bandwidth	500000 (in mbps)
<b>C</b>		
1	No of VMs	5, 10, 20, 25, 30
2	Size/speed of processing	10000 (in mips)
3	MIPS	250 (in mips)
4	RAM	256 (in MB)
5	Bandwidth	1000 (in mbps)
6	No of PEs	1
<b>D</b>		
1	No of Cloudlets	30, 50, 100, 150, 200
2	Length	5000-10000 (in MIs)

3	File Size	100-1000 (in MB)
4	Output Size	300 (in MB)
5	No of PEs	1

**VI.RESULT AND ANALYSIS**

This section presents the simulation results of the proposed methodology implemented with the help of Cloudsim and Net beansIDE8.0. In this paper, we tested and evaluated the traditional and proposed algorithms using different scenarios where varying number of cloudlets (jobs/tasks) are mapped to varying number of virtual machines (VMs). The performance of the proposed algorithms (TLPD) is evaluated against the traditional algorithm FCFS, SJF and Task Length & Priority and the comparative analysis is described.

When number of virtual machines are 5, 10, 20, 25 and 30 and number of cloudlets are 30, 50, 100, 150, 200 assigned respectively. Evaluating Parameter is Makespan.

TABLE 2: COMPARISON OF HYBRID TLPD SCHEDULING ALGORITHM WITH TRADITIONAL ALGORITHMS IN DIFFERENT SCENARIOS- EVALUATING PARAMETER MAKESPAN

Datase t	Makespan			
	FCFS	SJF	Priority	Proposed Hybrid TLPD
[30,5]	405.63	405.64	405.88	405.65
[50,10]	996.31	910.41	888.07	806.85
[100,20]	3288.73	4640.97	4158.03	3013.09
[150,25]	6090.75	6670.7	7618.01	5147.34
[200,30]	10145.46	9643.88	9027.98	7612.7

This table shows the resultant values of the proposed algorithm Hybrid TLPD and traditional algorithms FCFS, SJF and task length & priority. The table

contains different datasets of cloudlets and virtual machines. The performance analysis is further illustrated using two different Line chart and PIE chart graphically:

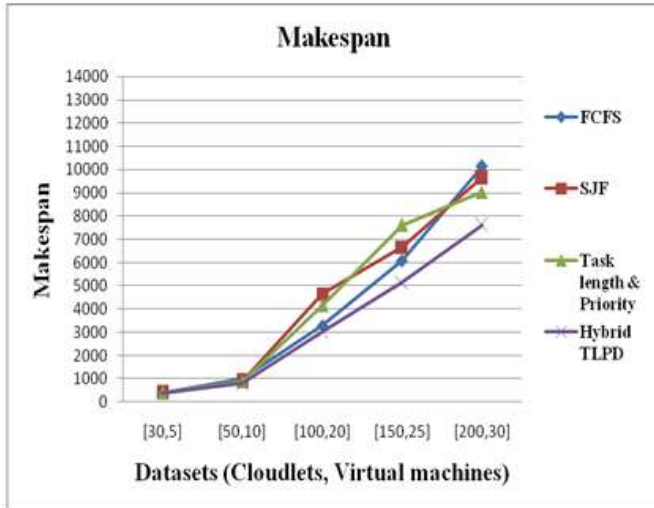


Figure 2 Comparison of Hybrid TLPD Scheduling Algorithm with Traditional Algorithms - Makespan

In this graph, cloudlets number and virtual machines is represented in the X-axis. In the Y-axis Makespan of cloudlets is represented. From the analysis of the resultant graph it is cleared shows that the proposed approach performs better result at each steps and evaluated result shows minimum Makespan at different scenarios.

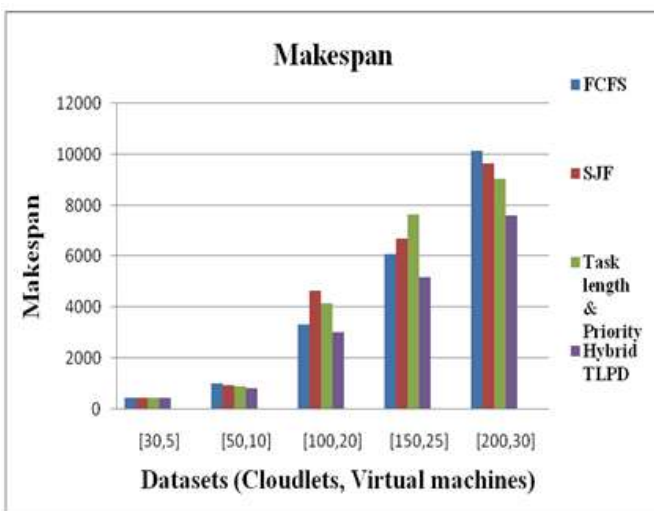


Figure 3 Comparison of Hybrid TLPD Scheduling Algorithm with Traditional Algorithms - Makespan

In this graph we have analyzed that in TLPD algorithm where we have proposed a hybrid approach with adding the concept of deadline constraints in traditional TLP algorithm, we have found the minimum Makespan compared with TLP algorithm and other traditional algorithms.

### III.CONCLUSION

In this paper, traditional and proposed scheduling algorithms are presented. The traditional algorithms we analyzed the FCFS, SJF and task length & priority in different scenarios. The proposed hybrid approach works on both task length & priority and task deadline (Hybrid TLPD). From the results it is concluded that, the proposed hybrid TLPD algorithm works efficiently than the other traditional methods. Makespan of the task are lesser when compared with the other algorithms. In future we can add load balancing method for getting more efficient of resources allocation and resources utilization.

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## IoT Enabled Smart Home and Health Monitoring System

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### ABSTRACT

Hospital patients have a big impact on their health and are more likely to get various ailments if they don't get prompt and effective care. In recent years, it may have been challenging to observe patients. Consequently, a reply is needed. Anytime, wherever, keep track of the patients of your doctor. The solution to this is expected to be invented, according to recent Web of Things (IoT) device events. After our days, health is of the biggest significance. Researchers and practitioners in this field will benefit from this job since it will help them comprehend the enormous potential of IoT in the medical industry and pinpoint significant IoT difficulties. A good level of health is necessary for efficient everyday job. The goal of the project is to create a sensor that can be used with an IOT-enabled smartphone to vividly track a patient's heart rate. This article offers a portable framework that continuously monitors a patient's heart rate, temperature, and various other room-related metrics using a Wi-Fi module. Health monitoring systems and smart homes with IOT capabilities have been presented. Based on the output numbers obtained, the precise sickness from the doctor, even from a distance, and some settings, the system offers access to approved personal data via any IOT platform. The Wi-Fi module can be used to control the space. Users can control appliances from anywhere in the globe thanks to the Internet of Things (IoT).

Keywords: Web of Things (IoT), Internet of Things (IoT) and Building Automation Systems(BAS).

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## I. INTRODUCTION

Nowadays, the Internet has impacted most people's daily lives and has become an essential component of life. Evidently, a smartphone with sophisticated features hits the market every second. He makes the case that internet users are following the explosive

growth in smartphone use, which is happening daily. Therefore, the ultimate goal of this initiative is to connect everything that humans own to the internet and then monitor and control more through cellphones. IoT refers to a set of networks that interact with effects, results, and actions by sending and receiving data over the internet.

Everything is connected in this place without the need for human participation, allowing the automatic determination of scheduled actions. IoT makes it easier to identify and communicate information in an open computer network, distribute sensor data via a wireless network, and operate systems openly. With the help of modern technology, the objects we use on a daily basis become intelligent, but this is not enough until we connect them so that they can react to the environment as it changes and provide results. From one machine to another, each with its own internet connection.

The development and upkeep of a public transportation system, the intelligent distribution of electricity, water, and gas, waste management, and the maintenance of city infrastructure like roads and public parks are some of the challenging tasks that require assistance in a dynamically changing urban area. We think IoT technology is the most effective way to manage these complicated systems. Smart cities powered by IoT technology are gaining popularity. Connecting physical objects to the Internet was the initial aim of the Internet of Things. Then the Web of Things (WoT) was created to make it simple to connect sensors to the internet, collect data, and share device-generated data online. To completely comprehend the idea of IoT technology, we read a number of periodicals, research, conference papers, and project reports. Similar to that, we looked at an IoT-based project. There have been numerous IoT designs and developments in the past. The following are a few of the suggested and actual smart city platforms.

Four cities are participating in the STAR-CITY project: Dublin, Bologna, Miami, and Rio. To forecast traffic congestion, they make use of semantic web technology. Information is gathered from six distinct sources, including weather data, Dublin bus streaming, social media feeds, road maintenance and upkeep, and city events. To identify high traffic volumes, they employ

rules from the Semantic Web Rule Language (SWRL). The project's main area of interest is traffic analysis.

As humans continue to advance in terms of technology, health is always a top priority. Health care is a subject that has gained importance, much like the recent Corona virus outbreak that contributed to China's severe economic crisis. Given how extensive the pandemic is, it is always preferable to check these people's health remotely. Right now, the solution is IoT-based health monitoring systems. Patients can be seen outside of the typical clinic settings by using remote patient monitoring (e.g., their home). In order to increase accessibility to offices for human services while lowering costs, this project intends to develop a smart patient health tracking system.

## II. BUILDING AUTOMATION SYSTEMS

The conditions of the interior environment are automatically controlled by BAS. The automation of heating, ventilation, and air-conditioning systems is the traditional and still crucial component of BAS. The system's primary goal is to significantly cut expenses and increase energy efficiency. Enhancing energy efficiency will also contribute to environmental protection. Due to this, appropriate laws and standards in developed nations require the use of BAS (Kastner et al. 2005).

In order to achieve the goal of a "smart/smart building," it is currently popular for BAS to incorporate data from all different types of building systems. Smart buildings have the potential to lower energy consumption, save construction and running costs, and improve home comfort because of their increased knowledge of what is happening within and outside the structure and their capacity to respond appropriately (Bertez 2010). Different BASs have been implemented in Albania over the past ten years, primarily for automating the HVAC systems of large functional buildings like office buildings, commercial centres, and businesses, hospitals, warehouses,

department stores, etc. Smart systems are also on display at significant shopping malls. The system is imported through a licence purchase or foreign direct sales from well-known multinational BAS and integrators or increased knowledge of what is happening both within and outside the building and their capacity to respond appropriately. The contracts are typically built on turnkey agreements. Despite the numerous benefits that these technologies offer and the fact that they are now more affordable, the market in Albania for the construction of private structures is particularly wary of such investments. BAS are generally not seen by construction company management as strategic in the face of competition, and as a result, they are generally unwilling to invest in them. According to a recent study, bad management culture and a lack of updating with current technology knowledge are the most significant factors affecting BAS investment reluctance (Zavalani 2009a). The Albanian government has energy efficiency as one of its main objectives, just like other European nations. This objective is being brought into compliance with the European Community Directive 2001/77 and the Treaty Establishing the Energy Community's energy efficiency principles. Plans to increase the effectiveness of electric energy consumption, particularly in the residential sector, have been developed under the National Energy Strategy and the National Energy Efficiency Law (Ministry of Industry and Energy, 2003). However, there is no provision in the action plan to promote BAS investment (Zavalani 2009b).

The Albanian government has energy efficiency as one of its goals, just like other European nations. This objective is consistent with the Energy Community Treaty and European Community Directive 2001/77 regarding energy efficiency. Plans to increase electrical energy efficiency, particularly in residential areas, are included in the National Energy Strategy Package and the National Energy Efficiency Act (Ministry of Industry and Energy, 2003). However, it was

impossible to anticipate that would boost investment in BAS in the action plan (Zavalani 2009b). We think that the following arguments account for such decisions:

1. Lack of updating modern technology knowledge officer
2. Lack of technically qualified human resources
3. Gaps between academic knowledge and public industry needs
4. Lack of experience and participation in "high-tech" transfer procedure
5. Brain drain
6. Low number of knowledge-based businesses
7. Lack of public programs to promote technology transfer and innovation.

### III. LITERATURE SURVEY

Fig1. shows the design of an ESP32-based home monitoring system. I don't think so. ESP32 is an open-source architecture that uses Arduino microcontroller.

The Arduino platform offers an integrated development environment (IDE) for microcontroller programming that is based on the Processing project and supports the C, C++, and Java programming languages. The Arduino Uno and the Arduino Mega are two different models of Arduino. Both the Arduino Uno and the Arduino Mega have 80 input and output pins each, allowing you to connect a sizable number of home appliances. The Arduino Uno has 20 input and output pins. The processor is faster than other processors because it is built on the ARM architecture. Using data from both sensors, the IR sensor will tally the number of individuals present.



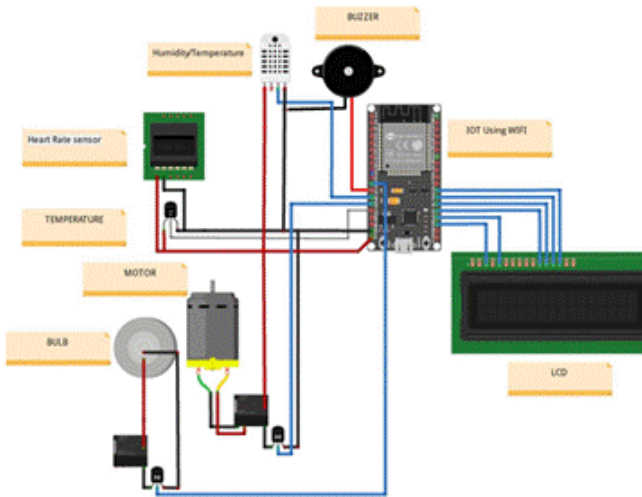


Fig 1: Design of IOT enabled Smart Home and Health Monitoring System.

The count will be increased when a human is detected by both sensors. The LCD panel will display the number of persons in the room. It will be obvious that someone entered the room if the second sensor's timer is longer than the first sensor's timer. A person has left the room if the first sensor's timer is longer than the second sensor's timer, which is a necessary condition. As soon as the person enters the room, the light bulb in the room begins to illuminate, and when the room is empty, the light bulb stops lighting. As a result, the system conserves energy by turning off the light bulb when the room is empty.

The system provides a security-based feature as the alarm will start ringing whenever someone enters the room. The piezo buzzer is used for alarm in the system. One of Tirana's tallest homes, with 21 floors above ground and 3 below, recently underwent design and application of an Intelligent Building and Management System (IBMS). The structure houses parking, offices, VIP apartments, restaurants, bars, a high-end shopping mall, and other amenities. The period is imported from Italy via a flip key agreement that is entirely based on a design that was developed by our team. The IBMS is designed to provide complete integration of all engineering and security components of the building through an open, transportable, and interoperable

system. The goal is to give managers access to all information in a control room inside the building (through a reliable Intranet) or via remote access via a standard Web Browser over the Internet. The IBMS is also designed to provide monitoring, control, alarm, and operational services that are entirely based on pre-established algorithms or scenarios.

#### IV. BLOCK DIAGRAM

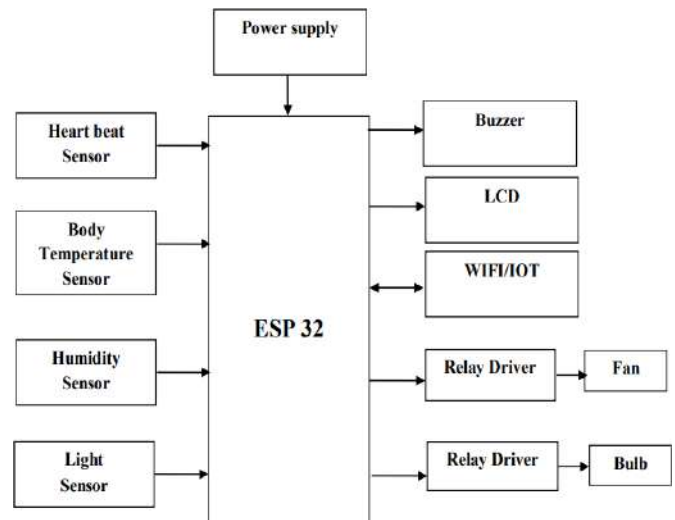


Fig 2: Block Diagram

#### V. FLOW CHART

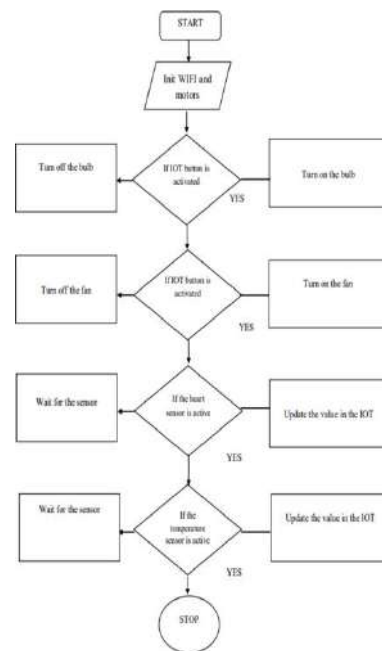


Fig 3: Flow Chart

## VI. WORKING MODEL

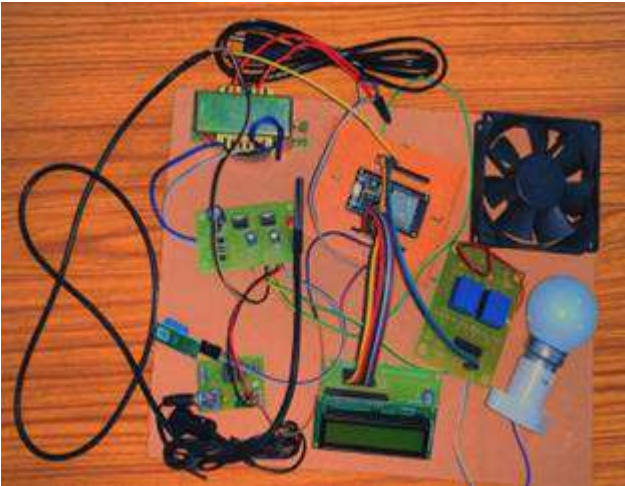


Fig 4: Working Model

## VII. CONCLUSION

The "IOT-enabled Smart Home and Health Monitoring System" project has been designed and tested successfully. The software is built to benefit from the capabilities of every piece of hardware when it is combined. Each module's presence has been thoughtfully considered and strategically positioned to enhance the unit's performance. A developing technology was also used to accomplish the project successfully, including sophisticated integrated circuits and sensors.

Users can specify their health parameters on an IoT-based device, which can help them improve their health over time. Finally, if necessary, the sufferer can get medical attention. They can quickly and simply share with doctors the data from one app on their health parameters. IoT is currently regarded as one of the most attractive technologies for health monitoring, as we are all aware. It guarantees that the parameter data is secure inside the cloud, and most crucially, it enables any doctor to remotely check on any patient's health. The device will measure the body's temperature, heart rate, humidity, and SpO2 level, then use Bluetooth to transmit the information to an app. Additionally, the LCD screen receives this data,

enabling patients to see their present health more rapidly. Elderly patients, asthmatics, COPD patients, chronic patients, COVID-19 patients and diabetics will be able to monitor their health over time with the system we have developed.

## VIII. FUTURE SCOPE

One of the primary sources of useful information is the use of IoT devices to gather data. Researchers need to focus on storing, accessing, transmitting, and processing the enormous amount of data they will produce from the massive acquired case history data. The deployment of appropriate communication protocols still requires research. For example, establishing multiple IoT standards to promote interoperability, scale the cost of IoT objects, and evaluate risks and uncertainties. IPv6 is also used to address things individually. Therefore, in the future, we must create new protocols. We can get security as technology expands. We can gain deep knowledge about overcoming obstacles. Things are simple to programme, monitor, and regulate. The Internet of Things allows us to can secure our house or place from anywhere.

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# Improved Detection of Retinal Diseases using Deep Boltzmann Machine

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## ABSTRACT

Lot of retinal fundus diseases drives the blindness for the people due to the bloodline vessels interweavement in the individual eye. In the present system the poor quality retinal fundus images are refined for the identification of eye diseases. But the method is failed to expose the different diseases in terms of severity. And also the coordination compound structure of the model also extends to higher computations delay due to repetitive procedures. Primary objective of the method is to discover the retinal disease in effective manner, and to determine the disease severity of different disease admitting the glaucoma in accurate manner. The proposed model is developed to determine the assorted eye diseases and its significance using the effective categorization model. The first step in image validation is to segment the objects introduce in the de-noised and enhanced image. Segmentation subdivides an image into its substantial parts in terms of objects. In general, self-directed segmentation is one of the hardest tasks in image computations. It acquires the various disease image data set as input and develops the model for each diseases. In order to generate the effective categorization model, the scheme is being designed using the Boltzmann algorithm which provides the high accuracy.

**Keywords** : Deep Boltzmann Machine, image manipulation operations, Segmentation, Preprocessing, Classification.

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## I. INTRODUCTION

The retinal images are plays the significant role in the covering, diagnosis, handling and evaluation of different ophthalmologic diseases. In objective practice, the retinal fundus images are manually refined by the ophthalmologists. The automated computations of

these images are employed in the medical image computations. It primarily focuses on capturing the images and computations it for the diagnostic and therapeutical purposes.

Involvement in the potential of digital images has expanded tremendously over the last few years, fuelled at least in part by the fast growth of imaging on the

Internet. Users in many professional fields are exploiting the opportunities offered by the ability to access and manipulate remotely-stored images in all kinds of new and exciting ways. Advances in computer and multimedia technologies allow the construction of images and large repositories for image storage with little cost. This has led to the size of image collections increasing rapidly. As a consequence, image content is becoming a major target for data mining research. Mining images is very difficult since they are unstructured. It has been an active research area, e.g., supervised image classification and unsupervised image categorization, etc. In general, to perform image mining, low-level features of images are first of all extracted, such as color, texture, shape, etc.

The derived features as feature vectors are then accustomed to constitute image content for image mining. In image classification, a learning machine or classifier is trained by using a given training set which contains a number of training examples and each of them is composed of a pair of a low-level feature vector and its associated class label. Then, the trained classifier is able to classify unknown or unlabeled low-level feature vectors into one of the trained classes. It is generally believed that our human visual system uses textures for recognition and interpretation. The early computation performs spatial frequency validation and consequently, responds to different frequencies and orientations.

In imaging science, image computations is the method of handling of pictures utilizing numerical activities by utilizing signal computations for which the information is the image and its corresponding progression or chain of images. The set of characteristics, boundaries, and parameters associated with the image is obtained as the output of the image computations. A two-dimensional signal is considered as the input to the most image-computations techniques and the regular signal computations steps are applied to the input image. The system also supports the three-dimensional signal which represents the color and its intensity.

In medical image computations, the captured image is operated and validated in a multi-stage operation. This multi-stage operation includes the Image Preprocessing (De-noising and Image Enhancement), Segmentation, Identification of required Features, Extraction of features and applying the object classification operation. The classification operation of the cancer region differentiated from the normal region.

To acquire better performance, every stage operation must be performed with highly significant algorithms. In the step of cancer detection, image pre-computations is the essential step which removes the noise pixel in the image and also improves the image quality by applying the image enhancement. The filtering methods are mainly distributes the pixel values based on the covered pixel region. In the covered region, the corresponding pixel value is computed by applying either probabilistic non-linear distribution. During the pixel value distribution, the relative value of each pixel is compared and the significant value is identified to fill the corresponding pixel.

This imaging-based identification can be enhanced by comprising the Image computations methodologies. In image computations, the pre-computation is applied at the lower-level abstraction. It removes the unwanted noise pixel present in the image which also distributes the pixel values based on the specific distribution method. Neural Network is learning and computations engine which mainly used to create cognitive intelligence in various domains.

## II. RELATED WORK

In the recent few years, the data computations and information extraction system has significant growth in agriculture field. The information extraction provides the eminent computations of data using the digital imaging system. The data computations system in digital images has emerged extremely due to the

increasing development in digital imaging over the internet. The mechanism of accessing and extracting the information is simplified because of the emerging technology such as Big Data. The digital imaging is enhanced by the Visual Modality Technology (VMT) which is known as vision technology (Gonzalez et al, 2019) that handles the extraction of information from the digital images. Computer based Visual Modality Technology (CVMT) is illustrated as the operation of automating and combining the largest range of techniques and illustrations for visualization. VMT accomplishes unique operations such as image identification & selection, restoration, recognition, feature extraction and decision making.

### ***IMAGE ENHANCEMENT***

Bhandari et al, 2020 developed the method for contrast enhancement based on the cuckoo search optimization algorithm with DWT. The decomposition of image input into frequency sub band is operated by the DWT by obtaining the singular value matrix. The computed matrix contains the low threshold sub band image which is used to reconstruct the enhanced image with the help of IDWT. The extracted intensity information of the input image are handled by identifying the changes in terms of mean, standard deviation, variance and the spatial content related to the pixel value of intensity.

Apply the image computations operations in the satellite images taken during the remote sensing is discussed by M.Hasmadi et al, 2019. The image enhancement operation with the band combination is applied to improve the quality of captured image. The visual interpretation is adequate to expand the range of brightness value in the image in both colour and gray scale. The enhancement of the pixel value is discriminated by using the inter-class classifier agreement with the kappa statistic. The confusion diagonal matrix is subtracted during the ground verification operation with the help of kappa coefficient.

The dominant brightness level validation for contrast enhancement was proposed by Eunsung lee et al, 2019. The method mainly obtains the adaptive intensity transformation for the image captured in the remote sensing. By using the low frequency luminance component, the intensity transfer for brightness-adaptive is computed. The author overcomes the problem of exhibiting the saturated artefacts in the low and high intensity region by performing the discrete wavelet transform. And also the knee transfer function and gamma adjustment function are applied in each larger of decomposed discrete wavelet.

Bedi et al, 2020 studied the various methodologies for improving the visual appearance of the image in terms of image enhancement. The log normal methodologies such as log reduction magnitude with logarithm transform, histogram shifty, content classification are discussed for vision based monitoring application. The histogram modification, content adaptive algorithm and discrete cosine transform with the retinex theory was deliberated for the image and video compression operation.

### ***OPTIMIZATION***

The optimization process in the image denoising algorithm are discussed by Ling et al, 2021. The spatial domain methods such as local feller, Gaussian filter, anisotropic filter to avoid the blur effect are discussed by the authors. The transform domain methods for denoising the image using the discrete cosine transform, wavelet, wedgelets, curvelet and steerable wavelet are applied for significant improvement in the image filtering operation. The Bayes least square with the Gaussian scale mixture used to remove the visual artifact which creates the disturbance in image pixel value. The principle component validation for the spatial filter is evolved to characteristic the multi resolution sparsity and edge detection operation during the denoising operation.

The development of CAD system in multidisciplinary application such as fashion and dress pattern handling

using image manipulation was discussed by Author Joyce et al (2021). The system allows the image drawing techniques and image scaling operation to increase the degree of accuracy. The system allows the image drawing techniques and image scaling operation to increase the degree of accuracy. The illustration and image pattern drawing operation one applied by using the texture library with less difficulty.

### ***LEARNING AND CLASSIFICATION***

Hitashi et al (2020) presents a framework to detect the abstract design for architecting the products with number of subsystems and components. These components are comprise the properties of the hierarchical system with multidisciplinary of the design. The system mainly forecasting on the decomposition of the hierarchical design with the management of consistency. It contains the functional level description and product level description with the image development. The rapid prototyping with the CAD technology for the operation of tomography using the image computations technology is developed. The methodology was facilitated for the medical application such as surgical therapy planning for treatment operation.

Wenzhi et al (2021) proposed the classification methodology based on the classification methodology based on the spectral-spatial features in the dimension reduction using deep learning operation. The author develops a framework by using the balanced local discriminant algorithm with embedding technology to extract the features by stacking the spectral and spatial relationship. In the image classification operation, multi feature based classifier is used with training operation. The Convolutional Neural Network (CNN) is utilized with the structural and contextual information of the image in spatial domain. The dimension reduction is evolved by performing the Principal Component Validation (PCA) feature with the coordinated reference data to derive the deep features of the image. The framework combines the

spectral domain and spatial domain features to train the CNN in both geometrical and discriminate structures, the affinity matrices of the images are formed with heat kernel parameter which maximizes the local margin of the input sample. This trained sample significantly achieves the better performance in the classification operation.

### **RETINAL DISEASE DETECTION**

In Artificial Intelligence (AI), the cognitive model is mainly performed with the assistance of neural networks. Neural Network is the abstract level collaboration of neurons, which contains the information. In a simple neural network, three layers are organized to produce the required computations output. Input layer, Hidden layer and Output layer are the functional controls of the NN. And predictive modeling is applied to perform the adaptive control of the neural network. Advanced digital computations in the images is applied by utilizing the compute and mathematical algorithms. These algorithms are applied in the digital images by considering the input pixel as signals. Digital image computations is the subcategory of digital signal computations which has a wider range of advantages over analog image computations.

It also permits a lot more extensive scope of calculations to be applied to the info information. The noise and signal distortion related problems are avoided during the computations of the images. In the existing system the low quality retinal fundus images are operationed for the detection of eye diseases. But the system is failed to exhibit the various diseases in terms of severity. And also the complex structure of the system also leads to higher computations delay due to iterative operations.

### **III. EXISTING SYSTEM**

In the image enhancement operation, the clipping and scaling are decided with the best combination of tuning parameter in object classification is developed. The opportunity cost method for image enhancement

is involves the identification trade-off between clipping and scaling. The objective estimation is done by considering the peak signal to noise ratio as key factor for image quality. The image classification is employed with the help of pyramid structured wavelet transform by convolving the image with both low pass and high pass filters. Based on the estimation covariance, the sub band if the image objects are classified with the average entropy value.

The lateral inhibition coefficient of the pixel to the central pixel which created the "Region of Interest" is computed as distance coefficient. The competing coefficient with the receptive field is computed and updated in each iteration with the global optimum solution. The regeneration of next iterative solution is operated from the random set of solution with the local optimum value. The maximum valued fitness solution is selected as the global optimum to perform the image matching operation.

### ***PROPOSED SYSTEM***

In the proposed system, the input image is applied to the precomputations operation using the Cross Median Filter (CMF) which eliminate the noise pixel values effectively. In the low quality image, Gaussian noise is added to distribute the pixel values in the image. Then the CMF filtering is applied to remove the noise values present in the image. In the filtered image, the object detection is performed using the Boltzmann algorithm. During the operation of the object detection, the pixel correlation is identified in the form of image features such as shape and object boundaries. This will used to determine the shape difference between the available object in the image. And also the color variations are used to collect the relative structure in retinal regions. And also the non-linear transformations are applied to differentiate the objects in effective manner.

It formulates the neural network by collecting various features such edge, color distribution, shape and histogram. Then the disease pattern classification is applied by the deep boltzmann machine. It formulates

the pattern for various diseases in the training stage. By performing the pattern matching, the disease pattern in the input image is compared against the trained pattern. If the feasible match is found then the disease region mapping is applied to detect the severity of the disease in the image object.

This mainly refers to initial computations of raw image. The image captured are transferred into computer, these are converted to digital image. Digital images are digits which are readable by computer and are converted to tiny dots or picture elements representing the real objects. In some cases, pre-computations are done to improve the image quality by removing the undesired distortions referred as noise and to enhance the details.

Image segmentation is operation of cutting, adding and feature validation of images aimed at dividing an image into regions that have a strong co-relation with objects or area of interest using the principal of matrix validation. The main objective is to partition an image into mutually exclusive and exhausted region so that each Region of Interest (ROI) is spatially contiguous and the pixels within the regions are homogeneous with respect to a predefined criterion. In the proposed system, the segmentation is performed using Superpixel.

The filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. One of the major problems with the median filter is that it is relatively expensive and complex to compute.

### **IV. METHODOLOGY**

The most important technique for removal of blur in images due to linear motion or unfocussed optics is the



Wiener filter. Blurring due to linear motion in a photograph is the result of poor sampling. Wiener filter performs denoising by means of linear time invariant filter operation. Instead of low pass filtering operations wiener filter determines the upper bound and lower boundary points for the filtering model. Once these boundary points are identified then the pixel values are compared with the boundary limits and the values lies outside the boundary points are marked as noise pixel points and hence filtered out from the image.

Gaussian filter performs low pass filtering operations and it is achieved by identified the relationship between the pixel value of the image. It takes impulse response by means of Gaussian function. It estimates the relationship parameters named as standard deviation of the pixel points to perform the denoising operation. After computing this relationship value the pixel value is compared and greater values are eliminated.

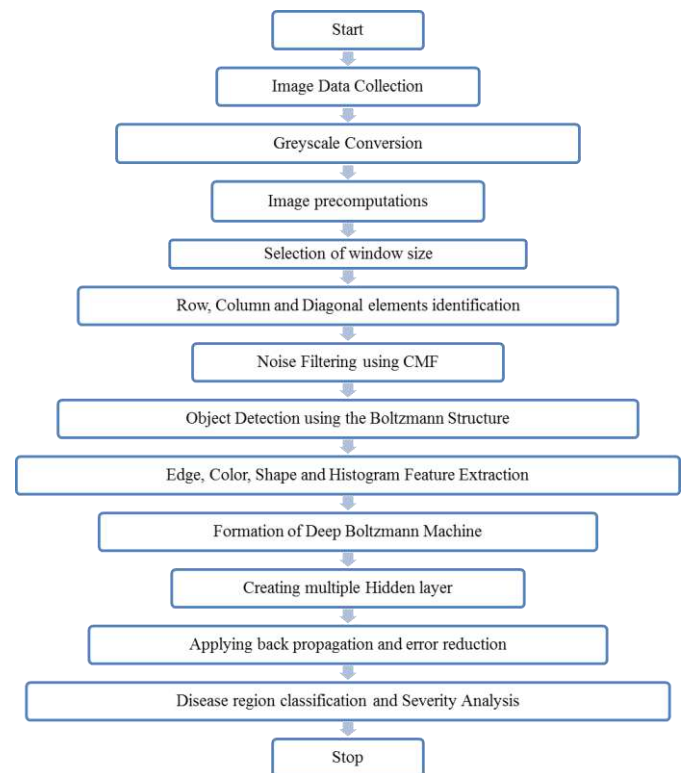
The function initializes a Superpixel object for the input image. It sets the parameters of superpixel algorithm, which are: region\_size and ruler. It preallocate some buffers for future computing iterations over the given image. The number of levels in num\_levels defines the amount of block levels that the algorithm use in the optimization. The initialization is a grid, in which the superpixels are equally distributed through the width and the height of the image.

### **FEATURE EXTRACTION**

Feature is defined as the point of concern for image description. In computer vision and image computations the feature entity is used to represent a piece of data entropy which is crucial for resolving the computational task affiliated a particular application. Features can concern to the consequence of a general locality cognitive operation as feature extractor or feature detector applied to the image, specific structures in the image itself, ranging from the

structures such as points or boundaries to the more composite structures such as objects. Feature Extraction is used for extracting the important data from the Entire data. It is a type of multi-dimensional simplification that efficiently represents concerning components of an image. Feature extraction is very dissimilar from Feature selection, the feature extraction consists of translating an absolute data, such as images, into quantitative features. This operation is a machine learning technique which is applied to derive the important components of an image

Component Validation seeks to decay a multivariate signal into the amount of autonomous non-Gaussian points. The Color Autocorrologram method takes out the Color correlative entropy from the color correlation feature matrix as a modern characteristic signifies and aggregates Corrologram to generate a composite characteristic. The foregrounds of this component feature are to include spatial correlation with relativity, circular distribution of localized connectivity relationship of colors.



**Figure 1.** Flow Diagram

The input image pixel points are divided into N number of grouped structures with MxM matrix. These N groups are operationed individually to identify the co-relationship between the input matrix. For each group, the Gaussian spatial relationship is estimated in terms of mean, variance and Gaussian function. This value is estimated in three directions and the value is marked as the upper bound value of the comparison. For lower bound value, the maximum variance value is identified by comparing the input signal value and estimated mean value. The absolute difference between these two values is marked as the lower bound value of the band pass filtering system.

### ***SEGMENTATION & CLASSIFICATION***

Center distance is drawn out from the Euclidean distance between cluster centroid and pixel data points. This length value is selected as the input for the negative exponential with the splitting ratio of the sigmoid function. This Sigmoid function is the logistic function which divides the Euclidean distance. Center distance is used to amend the selection probability of the cluster centroids. The stage of membership is estimated based on this Cognitive distance with the Euclidean distance. If the centroid has two or more dimensions, then the degree of membership function initially estimates the Euclidean distance between the cluster centroid and data pixel point. If it has a single dimension, then the absolute difference between the pixel point and the centroid is calculated as distance.

Once this distance is estimated then the value is passed as an argument to the kernel distance estimation function. This kernel distance defines the logistic function as sigmoid values. After computing the kernel distance value, the objective estimation function is invoked to calculate the degree of membership for the cluster centroid and its corresponding cluster pixel points. From the degree of membership and the set of cluster centroids new cluster centroids are found as a next iterative solution.

Component Validation seeks to decay a multivariate signal into the amount of autonomous non-Gaussian points. The Color Autocorrologram method takes out the Color correlative entropy from the color correlation feature matrix as a modern characteristic signifies and aggregates Corrologram to generate a composite characteristic. The foregrounds of this component feature are to include spatial correlation with relativity, circular distribution of localized connectivity relationship of colors.

Support vector machines are best case supervised learning method which is based on associated learning algorithms that is used to analyze data and recognize patterns, used for classification and regression validation. There are two phases are executed in the classification operation. This classification operation is executed in the form of non-probabilistic binary linear classification. It observes the replication, relativity connectivity and missed points. It formulates the group which consists of the linear representation for each row represents the class. This corresponds to the logical class for each row generalized.

Support Vector Machines are based on the concept of decision planes that define decision boundaries. A First normal formal form of SVM with optimization is modeled as Quadratic Programming (QP) SVM. It is purely based on quadratic programming optimization. QP-SVM is a kernel based classifiers which accumulate the quadratic operations. The objective of this Quadratic programming has to solve the given problem by means of quadratic function which takes the decision based on the variable and constraints are a linear function of the variables It estimates the portfolio optimization variance based on the sum of the variances and covariance of individual values and the linear constraints which indicates the lower and upper boundary points. The objective of the quadratic function is convex that decides the problem to be easily solvable. It uses semi-finite convex with the best objective function value.

**V. RESULTS AND DISCUSSION**

The performance evaluations for the filtering, segmentation and classification operations are conducted using the Matlab software by taking the captured digital images as input. The distortions removal is achieved by adding “Salt and pepper” noise to the input images and thereby evacuating it utilizing suitable filters. The pattern matching input points for the classification is identified by using the proposed operation. Based on the designed learning system, the classification operation is performed to detect the retinal disease region in the image.

The methodologies are evaluated using the performance measures including the Mean Square Error (MSE), Mean Absolute Error (MAE), Peak Signal to-Noise Ratio (PSNR).

**MSE**

In analysis MSE of an estimator and the predictor calculates the normalized value of the squared value of errors. It produces the error value by summing up the squared pixel value of all the pixel images and it is divided by the total pixel count. For a good filtering output the MSE must be minimum value. It is evaluated by the following formula.

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (I(i,j) - K(i,j))^2 \tag{1}$$

m=Number of rows; n=Number of columns; I=Input image; K=Reconstructed image;

**MAE**

MAE is used to measure the average magnitude of the error. It provides the accuracy of the observation. Instead of squaring the value in MSE absolute summation of error is calculated and is divided by the total pixel points. MAE must be lower for the better filter output.

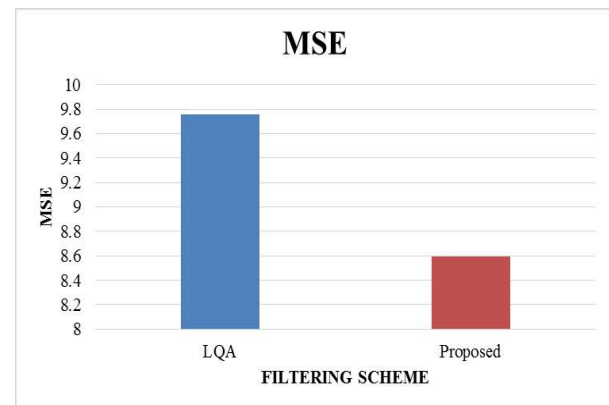
$$MAE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [|I(i,j) - K(i,j)|] \tag{2}$$

m=Number of rows; n=Number of columns; I=Input image; K=Reconstructed image

**PSNR**

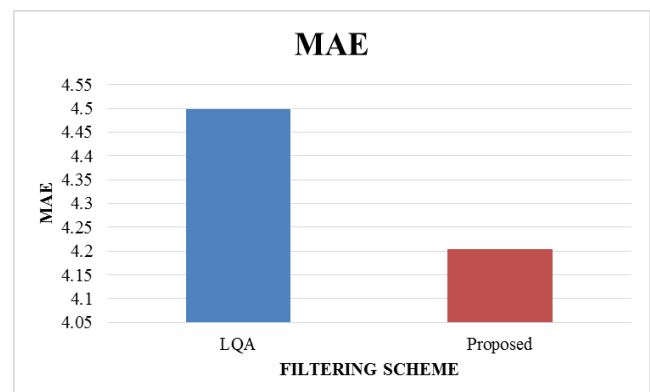
Peak Signal to-Noise Ratio outcomes the relationship between the signal and noise pixels of the image. It is inversely proportional to the MSE value and directly proportional to the logarithm of data pixel value. For the optimum filtering output the PSNR value needs to be higher.

$$PSNR = 20\log_{10} (MAX) - 10\log_{10} (MSE) \tag{3}$$



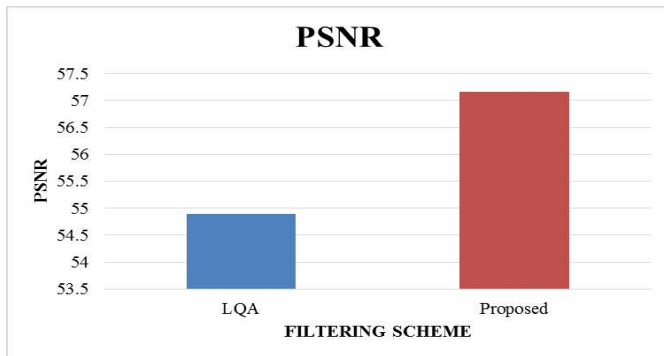
**Figure 2. MSE**

Figure 2 depicts the Average performance of filters in terms of MSE. In this comparison the proposed filter generates the lowest MSE value of 8.6. Lowest MSE ensures the better filtering noise.



**Figure 3. MAE**

Figure 3 depicts the Average performance of filters in terms of MAE. In this comparison, the proposed consequences the lowest level of MAE value and that is 4.2 for samples.



**Figure 4. PSNR**

In Figure 4, the Average performance of filters is depicted in terms of PSNR. In this comparison, the proposed filters ensure the highest level of PSNR value is obtained as 7.2. The higher the PSNR value authenticates the better noise filtering.

The proposed cognitive system provides the performance improvement with the learning capability by considering the significant constraints in the system. The evaluation showed that the proposed methodologies achieved better performance compared to existing methodologies. The proposed system achieved 15-25% improvement in the disease detection process.

## VI. CONCLUSION

The input image converted into greyscale image and salt & pepper noise is added. The image precomputations are applied to distribute the pixel ranges based on selected window size. The proposed system is designed to identify the various eye diseases and its severity using the effective classification model. It takes the various disease image data set as input and formulates the pattern for each diseases. In further, the object detection is being applied using the Boltzmann structure after the filtering is completed. The features are being extracted for the identified objects and the

disease regions are classified in the classification engine.

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# Design and Analysis of Steel Tension Members with Bolted End Connections

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## ABSTRACT

The purpose of this work is to investigate the effect of connection eccentricity and connection length on failure capacities of steel tension member with bolted end connection. Tension members are frequently used for lateral bracing and as truss elements. Such members have normally eccentric connections which results in bending of tension member. It is often permitted by, current design specifications, to neglect this eccentricity in the design of member. The present study is focus on examining the effect of varying connection eccentricity and connection length on the ultimate capacity of bolted tension member. In present study connection length is increased by increasing the pitch between the holes instead of increasing the number of bolts. In this work six experimental tests are carried out on Tension members fastened with bolts, to calculate the failure capacity and also to trace the entire load versus deflection path. In this work finite element analysis of tension members carried out. Results of finite element analysis are compared with experimental results. The failure capacities predicted by FEA are in close agreement with the experimental observed failure capacities of the tension member subjected to tensile loading.

Keywords — Tension members, Bolts, Tensile Testing, FEA, Failure Modes, UTM

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## I. INTRODUCTION

1.1 Structure - Structure is a free-standing, immobile outdoor construction. Typical examples include buildings and non-building structure ones such as bridge and dams. Some structures are temporary, built for some events such as trade shows,

conferences or theatre, and often dismantled after use. Temporary structures have fewer constraints relating to future use and durability. Some structures are permanent.

1.2 Truss - Truss is a structure, comprising one or more triangular units constructed with straight members whose ends are connected at joints referred to as nodes. External forces and reactions to those

forces are considered to act only at the nodes and result in forces in the members which are either tensile or compressive forces. A planar truss is one where all the members and nodes lie within a two dimensional plane, while a space truss has members and nodes extending in to three dimensions.

1.3 Tension Member - Tension members are structural elements or members that are subjected to axial tensile forces. Fig. 1.1 shows a member under tension. They are usually used in different types of structures. Examples of tension members are: bracing for buildings and bridges, truss members and cables in suspended roof systems.

In an axially loaded tension member, the stress is given by:

$$F = P / A$$

Where, P is the magnitude of load and A is the cross-sectional area.

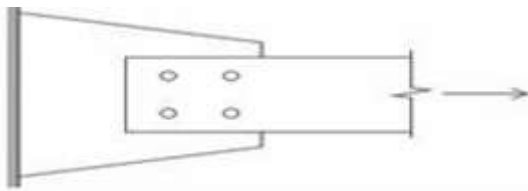


Fig. 1.1 Member under tension

1.4 Design of tension member - In order to design tension members, firstly, it is important to analyze how the member would fail under both yielding (excessive deformation) and fracture which considered the limit states. The limit state that produces the smallest design strength is considered the controlling limit state; which also prevent the steel structure from failure. Using AISC (American Institute of Steel Construction), we could obtain the recommended load and resistance factor design approaches. In the design of a tension member, secondly, it is important to select which type of member and the size of the member is required. The type of member is usually dictated by the location where the member is used. In the case of roof trusses, for example, angles or pipes are commonly used.

Depending upon the span of the truss, the location of the member in the truss and the force in the member either single angle and double angle may be used in roof trusses.

Tensile testing - The mechanical properties of a material describe the behavior of material due to physical forces. Mechanical properties occur as a result of the physical properties inherent to each material, and are determined through a series of standardized mechanical tests. One of them is tensile test. A tensile test, also known as tension test, is probably the most fundamental type of mechanical test performed on material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, it can be quickly determined how the material will react to forces being applied in tension. As the material is being pulled, strength can be calculated along with how much it will elongate. The results of tensile tests are used in selecting materials for engineering applications. Tensile properties frequently are included in material specifications to ensure quality. Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behavior of a material under different forms of loading. Stress-strain curves generated from tensile test results help engineers gain insight into the constitutive relationship between stress and strain for a particular material. The stress-strain curve can also be used to qualitatively describe and classify the material [13].

1.5 Objective - The purpose of the present work is to investigate the effect of connection eccentricity and connection length on the failure capacities of tension members with bolted end connections. In this the connection length is increased by changing the pitch not by increasing the number of bolts. Besides the strength of the member, strain distributions at the critical section corresponding to stress and the deformations of the specimens corresponding to load

were also examined. A total of six specimens were tested. Only one line of bolts was considered. All tests were performed at HSBPVT Parikrama Polytechnic, Kashti using 1000 KN Universal Testing Machine.

**II. SPECIMEN GEOMETRIES**

The experimental testing consists of two sets of tension members (specimens) fabricated from rolled steel. There are total six specimens each of 600 mm length. The testing consists of two sets of specimens with same eccentricity but different connection length, i.e. 50 mm and 75 mm. Connection length was decreased or increased by varying the pitch. All specimens are fastened, with a single row of 15 mm A490 bolts, through their webs at both ends, shown in Fig. 2.1 [13] and Table. 2.1. The end distance and number of bolts for each specimen are held constant at 42 and 3 respectively. Holes for the 15 mm A490 bolts were specified to be drilled to a 16 mm diameter.

Common Dimensions for all Tension Members (specimens) No. of bolts- 3

End distance- 42 mm

Specimen depth (d) – 90 mm

Flange thickness ( $t_f$ ) – 5 mm

Web thickness ( $t_w$ ) – 4 mm

Hole diameter ( $d_h$ ) – 16 mm

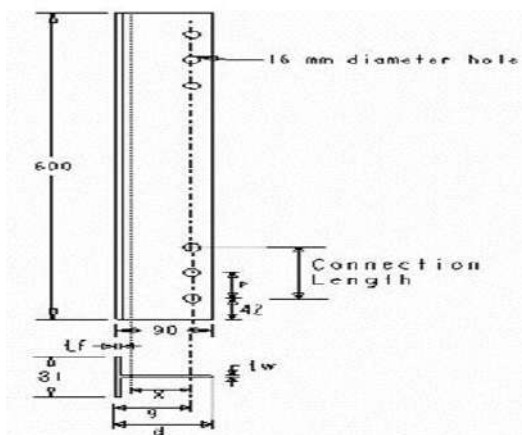


Fig. 2.1 Typical specimen’s configuration

Table 2.1 Specimen dimensions and material strength (All Dimensions in mm)

Spec . No.	Con n. Len gth L	Gage Dista nce G	Bolt lin e Eccentri cit y X	Tensi le stren gth (Mpa)	Tensi le Stren gth (Mpa)
1	100	70	48.6	250	460
2	100	58	36.6	250	460
3	100	46	24.6	250	460
4	150	70	48.6	250	460
5	150	58	36.6	250	460
6	150	46	24.6	250	460

**III. EXPERIMENTAL SET UP**

The experimental tests were carried out using Universal Testing Machine. After the appropriate grips were fastened to the specimen-grip assembly was then placed and centered in the UTM and then secured fast grips in the UTM grippers shown in Fig. 3.1. Each specimen was tested to failure by steadily increasing the applied load. With all instrumentation zeroed, the tensile load was then applied in control with strain rate of 1.8 mm per minute. Stress-Strain and static load- deformation readings were obtained. Sigma plot was used to monitor the stress versus strain and load versus elongation behavior of the test. Bar stock grips, are used to transfer the load from a 1000 KN universal testing machine (UTM) to a specimen. They are fabricated from mild steel bar stock and had 14 mm diameter holes drilled at the appropriate pitch. Two sets of bar stock grips were used in this study.

**IV. SPECIMEN MODE OF FAILURES**

The typical specimen failures (specimens: 1, 2, 3, 4, 5, 6) consists of a partial rupturing of the net section. Tests were stopped when the peak load was reached. The peak load was reached before fracturing of the full net section, but after rupture of the partial



net section. Fracturing of a specimen's web initiated at the lead bolt hole and propagated to the web's outside edge. Necking down of the tension plane area preceded fracture.

Specimens with small eccentricities exhibited a significant amount of bolt whole deformation. However, it was observed that the amount of deformation decreased with increasing eccentricity. Those specimen with the largest eccentricities demonstrated very minor whole deformation except at the lead and last bolts [13]



Fig. 3.1 Specimen grip assembly in TM

Table 3.1 Experiment results for specimen 1

Force (KN)	Displacement	Stress	Strain
5	1.22	5	0.0014
25	5.25	25	0.0058
75	9.70	110	0.0180
110	12.60	150	0.0220

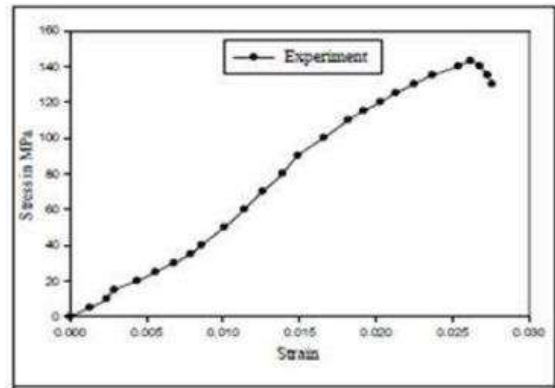


Fig. 3.2 Experimental graph for specimen 1 (Stress Vs Strain)

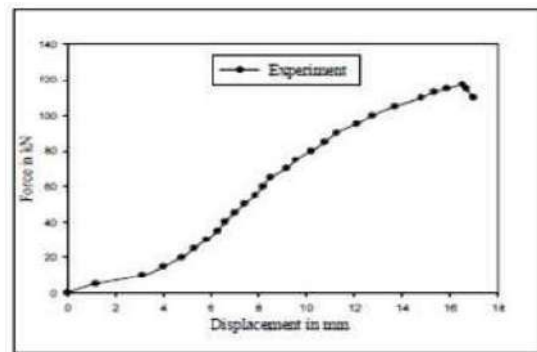


Fig. 3.3 Experimental graph for specimen 1 (Force Vs Displacement)



Fig. 4.1 Partial net section ruptures, with small eccentricity



Fig. 4.2 Partial net section ruptures, with large eccentricity

### V. FINITE ELEMENT ANALYSIS

The finite element model was prepared in ANSYS Workbench. The main objective of the FEA is not only to estimate the failure loads of the specimens but also to trace the entire load versus deflection path. The specimen grip assembly used in ANSYS is shown in Fig. 2.1. The typical mesh used in the Finite Element Analysis is shown in Fig. 5.1 and Fig. 5.2 shows the stress (MPa) and strain contour for specimen 1.

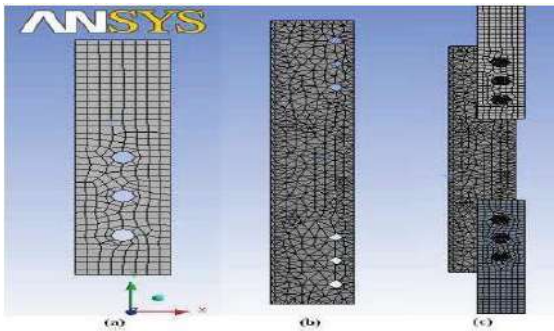


Fig. 5.1: Typical Finite Element mesh (a) Gusset plate (b) Specimen (c) Full assembly

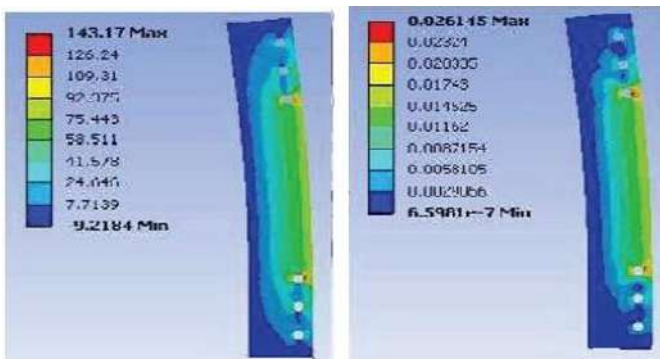


Fig. 5.2 Stress contour and strain contour of specimen specimen 1

Table 5.1 Simulation results for specimen 1

Force (KN)	Displacement	Stress	Strain
5	1.15	5.05	0.0015
25	4.75	26.25	0.0069
75	10.15	101.35	0.0186
110	14.75	139.26	0.0240

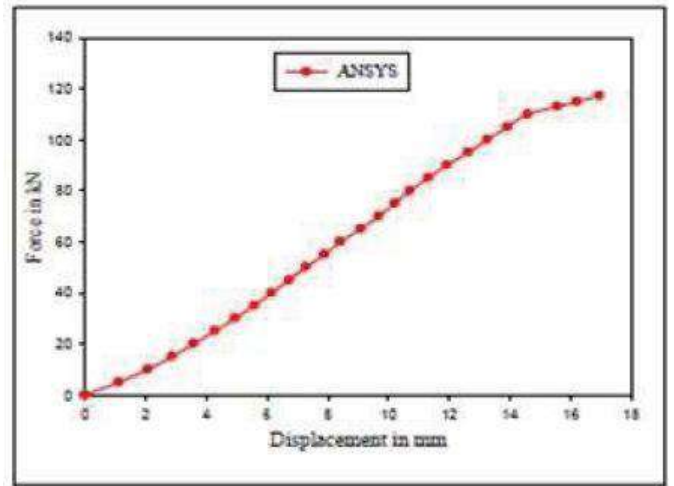


Fig. 5.4 Analytical graph for specimen 1 (Force Vs Displacement)

### VI. RESULTS COMPARISON EXPERIMENTAL VS ANSYS FOR SPECIMEN 1

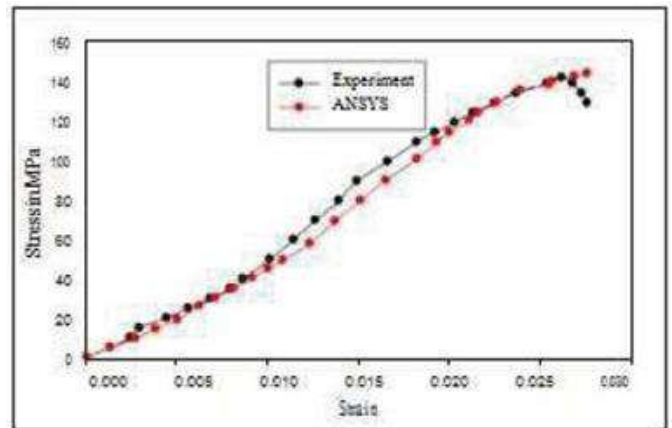


Fig. 6.1 Comparison of Experimental Vs ANSYS for specimen 1 (Stress Vs Strain)

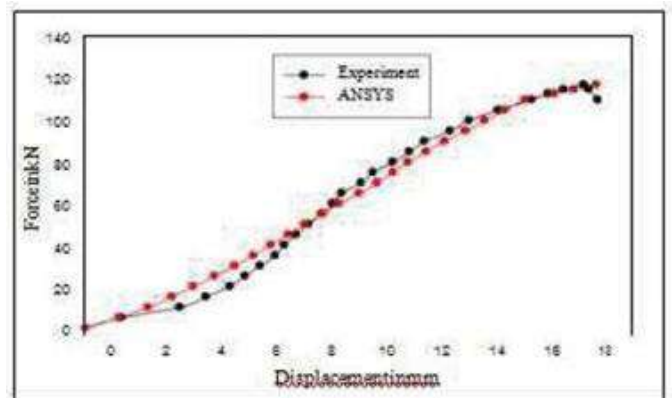


Fig. 6.2 Comparison of Experimental Vs ANSYS for specimen 1 (Force Vs Displacement)

## VII. CONCLUSION

The study focused on examining the effect of varying connection eccentricity and connection length on the ultimate capacity of the bolted tension members. Here the connection length is increased by increasing the pitch between the holes instead of increasing the number of bolts. In all of the specimens, failure is caused due to the partial net section rupture of the connected leg adjacent to the lead bolt hole. The Finite Element Analysis presented here is capable of not only predicting the failure capacities but also in tracing the entire load versus deflection path. The analysis indicated an excellent agreement with the experimental failure capacities of the specimens with large connection eccentricities. In addition, these models are able to accurately capture the partial net section rupture failure mode observed in the experimental specimens.

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