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IOT Based Polyhouse Farming with Controlled Environment and Monitoring

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ABSTRACT
Polyhouse farming, integrating IoT and cloud computing, addresses agricultural challenges in India through optimized irrigation schedules based on real-time environmental data. Employing sensors and bots for automated actions like precise watering and fertilization, alongside smartphone connectivity for remote monitoring, promises to revolutionize agricultural practices. This approach enhances water conservation, soil management, and early disease detection, offering a pathway to sustainable growth in India's agricultural sector. This research holds potential for impactful paper publication. The purpose of this research is to revolutionize agricultural practices in India through the implementation of smart polyhouse farming techniques. By integrating IoT, cloud computing, and automated systems, the aim is to optimize irrigation schedules, enhance water conservation, improve soil management, and enable early disease detection. Ultimately, the goal is to contribute to sustainable growth and advancement in India's agricultural sector. The methodology for this study involves a comprehensive exploration of existing literature on smart polyhouse farming, IoT applications, and agricultural methodologies. Subsequently, a smart polyhouse farming system will be conceptualized, integrating IoT sensors, cloud computing, and automated irrigation techniques. This system will then be deployed in real polyhouse farming environments, gathering data on critical parameters such as temperature, humidity, soil moisture, and crop growth. Through rigorous data analysis, the efficacy of the system in optimizing irrigation schedules and improving crop yields will be assessed and compared against conventional farming practices. The results obtained will demonstrate the system's capability in enhancing water management, soil health, and disease detection, potentially revolutionizing agricultural practices in India. The study's conclusion will underscore the transformative potential of smart polyhouse farming technology in addressing the challenges faced by Indian agriculture, emphasizing the need for further research and widespread adoption to realize its full benefits.

Keywords— IOT, Polyhouse farming, Controlled Environment and Monitoring.

I. INTRODUCTION

Agriculture is the primary source of income in India for the vast majority of its citizens. Agriculture is the most diverse economic sector in India, and it has made a significant contribution to the country's development. Our country is also giving importance for technological advancements. By combining technology with Agriculture more positive results can be achieved. The traditional method of growing necessitates a significant amount of time, human work, and constant monitoring. In the traditional way of production, there are various issues such as uncertain weather conditions and the plants' vulnerability to pests and diseases. A polyhouse is a climate-controlled habitat in which plants are cultivated on a regulated platform, regardless of temperature or location. With the help of bamboo wrapped with the sheets called as ultra violet sheet, Polyhouse building is made. These sheets are of a specific thickness. The crop decided the thickness of the ultra violet sheet. A very good solution is provided by Polyhouse which is dependable and vital means of increasing earnings. Essentially, it is an automated system that modifies physical parameters in favors of the crop's plantation and growing process. Polyhouse is a method of increasing the speed with which crops and plants are produced while still adhering to the crop's growing requirements. The polyhouse approach allows plants to develop without interference from the outside world. Harvesting a single crop requires the least amount of further applications and inputs, allowing for optimum productivity and profits. Plants of higher quality can be cultivated in a polyhouse. Plant development is primarily influenced by a few factors such as temperature, CO2 levels, soil moisture content, light intensity, humidity. By controlling all of the above-mentioned elements, we will get the proper output in terms of an appropriate plant growth, which results in proper crop yield by boosting the plant's development potential and creating optimum conditions for plant growth. However, it is very difficult to control and monitor this in an open atmosphere. Important and the basic concept is to cultivate in a contained atmosphere, such as a polyhouse, while monitoring and controlling all of the needed factors. Any change in one climatic parameter can have an impact on the others, necessitating ongoing monitoring and control action to ensure that the requirements are met. The plant's 8 normal growth may be hampered by insufficient and unknown environmental conditions. In order to achieve a high yield, eco-friendly conditions should be carefully monitored and controlled. Controlling these characteristics through some type of control action may lead to proper plant growth and crop. Several articles are already published giving the need for polyhouse cultivation and the benefits of various methods. With the help of appropriate sensors, the important parameters data is gathered within the polyhouse and delivered to the controlling unit. This data is communicated to the controlling unit. Microcontroller process this data and determines the appropriate controlling action to do with the purpose of maintaining proper plant growth. A polyhouse is an enclosed structure designed to protect crops from external weather conditions and pests. It is a controlled environment where farmers can grow crops year-round, regardless of the external climate. A smart polyhouse agriculture system integrates IoT technology with the polyhouse environment to improve crop yields and reduce Labor costs. In this research paper, we present a working model of an IoT embedded smart polyhouse agriculture system. The system comprises sensors to collect data on environmental parameters, microcontrollers to process the data, actuators to control the environment, a cloud platform to store and analyse the data, a mobile app for remote monitoring and control, an alerting system for critical environmental changes, and data analytics for generating insights. The proposed system can help farmers to optimize crop management by providing real-time data on environmental conditions and enabling remote monitoring and control. The system can also reduce Labor costs by automating tasks like watering and ventilation. We believe that our proposed system can be a significant step towards sustainable and efficient food production. Other than conventional agricultural practices, technique, and methods like usual agricultural operation (pre-harvest and post harvest), one component which separates a Polyhouse from a traditional farm is the control and monitoring of the process parameters. In this study, a remote irrigation monitoring and control system was evaluated for precise control irrigation in water-scarce locations. In India, there are currently very few businesses as well as service providers engaged in the control, supervision, and automation of polyhouses; in the states of Maharashtra, Gujarat, and Tamil Nadu has the major example. The acceptance of Polyhouses will automatically lead to a big leap in demand for better control and automation. To offer more automated supervision, multiple greenhouse climate and crop models have been designed. In prior 9 research, a summary of present-day greenhouse climate models is provided. An outline of greenhouse crop models and modelling methodologies are offered in previous research. Dynamic crop and greenhouse climate models have been utilized to establish set points automatically and replace grower decision-making. Automated algorithms can regulate greenhouse climate as well as crop growth if climate and crop simulation models are coupled and connected to a greenhouse's sensors and actuators. In Netherlands, similar studies with tomatoes and sweet peppers have been carried out successfully. In this experiment, climate simulations were done using actual weather conditions and projections. In order to forecast future crop growth and improvement for various sets of setpoints, crop growth simulation was conducted concurrently with the cropping cycle. The best set was then automatically used in the greenhouse. The computations were performed daily basis, though this, crops were cultivated using an optimum management approach. Various tomato experiments also have been carried out in the recent past for this research point of view.

II. Literature Review

Author concluded that the system proposed uses a microcontroller (Node MCU) which has a Wi-Fi module (ESP32) over it. Smartphones with blynk are used as a user interface. Soil moisture sensor, humidity and temperature sensor (DHT11) and rain detection sensors along with DC motor and deck robot are used. This DC motor is connected to a water pump which pumps water to the crops when the DC motor is ON. The soil moisture sensor senses the moisture level in the soil. Depending on the level of moisture, Node MCU decides whether to water the crop or not. By using appropriate function sand conditional statements in the code written for the Node MCU functioning, the watering of the crop starts by Node MCU making DC motor ON when the moisture content is below a threshold value and is made OFF when there is enough moisture content in the soil. The humidity and temperature sensor gives the humidity and temperature values of the atmosphere which determine whether the crop is suitable for growth. Some crops grow only in particular weather conditions and some give better yield only for a particular temperature range. The raindrop sensor measures the intensity of rain. If there is enough rainfall to provide soil with required water, the crops are not watered. Even after raining, if the crops are not having sufficient water then water is pumped again by turning the DC motor ON. Data reaches the blynk cloud from Node MCU through Wi-Fi from the Wi-Fi module present on Node MCU. Polyhouse farming is a relatively new approach to agriculture, and there is limited literature available on the topic. However, here is a brief literature review of the available research: "Polyhouse Farming: A Review" by S. S. Kulkarni and S. S. Patil: This paper provides an overview of smart polyhouse farming and its potential benefits. The authors discuss the various systems involved in smart polyhouse farming, such as the irrigation system, lighting system, and temperature control system, and how they can be automated to optimize plant growth. They also discuss the potential benefits of smart polyhouse 22 farming, such as increased crop yields, reduced water usage, and minimized use of pesticides and fertilizers. IOT based polyhouse Farming: A Review of Technologies and Applications by G. S. Mahajan, et al.: This paper provides a detailed review of the various technologies and applications involved in smart polyhouse farming.

The authors discuss the use of sensors to monitor various parameters such as temperature, humidity, light levels, and soil moisture levels, and how this data can be used to automate systems such as the irrigation system, lighting system, and temperature control system. They also discuss the potential benefits of smart polyhouse farming, such as increased crop yields, reduced water usage, and minimized use of pesticides and fertilizers. IOT based Polyhouse Farming: A Sustainable Approach to Agriculture by K. R. Patil and V. S. Patil: This paper provides an overview of smart polyhouse farming and its potential as a sustainable approach to agriculture. The authors discuss the potential benefits of smart polyhouse farming, such as increased crop yields, reduced water usage, and minimized use of pesticides and fertilizers. They also discuss the potential challenges of smart polyhouse farming, such as the high initial investment costs and the need for skilled labor. Overall, the available literature suggests that smart polyhouse farming has the potential to revolutionize the way we produce food by creating a more sustainable and efficient approach to agriculture. However, more research is needed to fully understand the potential benefits and challenges of this approach. Polyhouse with automation is latest trend which is taking long strides towards its inclusion in farming. More return on investment has become need of an hour in today's technological era not only in farming society but in all fields of the world. as described below explores the findings by different authors during their research work. The research findings by Kuthada (2018) emphasize the critical influence of relative humidity on photosynthesis and leaf growth in crops, highlighting the need for precise control of environmental conditions through sensor-based monitoring and fogging systems. Similarly, Kulkarni et al. (2020) underscore the efficacy of fully automatic greenhouse setups equipped with IoT systems in quickly and efficiently responding to climatic changes, thereby reducing errors and ensuring rapid adaptation. Raja et al. (2018) focus on the benefits of sensor-based irrigation and IoT technologies in enabling remote monitoring and control of greenhouse conditions, relieving farmers of physical presence and enhancing efficiency in managing temperature, humidity, and moisture levels. Kumari et al. (2021) advocate for the adoption of automatic irrigation systems utilizing soil moisture sensors and microcontrollers to mitigate issues like over-irrigation and leaching, offering improved water regulation through mobile-controlled devices. Finally, Ahonen et al. (2008) propose comprehensive parameters for greenhouse management, emphasizing the controlled environment's enhanced outcomes through precise monitoring and signal-based interventions.

III. PROBLEM STATEMENT

The problem addressed by the IoT-based Polyhouse Farming Monitoring System lies in the inefficiencies and challenges faced by traditional agricultural practices. Conventional farming methods often lack real-time monitoring and control of crucial environmental parameters such as temperature, humidity, and soil moisture, leading to suboptimal crop growth, increased water wastage, and reduced yields. Additionally, manual intervention in irrigation and fertilization processes can be labor-intensive and prone to errors, resulting in resource inefficiencies and environmental degradation. Furthermore, the escalating demand for food production amidst changing climatic conditions necessitates innovative solutions to optimize crop cultivation while minimizing environmental impact. Therefore, the problem statement revolves around the need for an integrated monitoring and control system that leverages IoT technology to provide farmers with actionable insights, automate farming processes, and enhance overall agricultural productivity and sustainability. Objective of the IoT-based Polyhouse Farming Monitoring System is to significantly enhance crop production efficiency and minimize waste by providing real-time data on crop conditions to farmers. This system aims to optimize farming operations by continuously monitoring crucial parameters such as water quality, temperature, and humidity, empowering farmers to make informed decisions regarding irrigation and fertilization practices. Additionally, the system endeavours to improve yield production, reduce water wastage, and alleviate the workload of farmers by automating critical tasks. By offering live data on essential parameters including temperature, humidity, and soil moisture, controlling climate conditions, and dynamically adjusting water supply, the system promotes sustainable and efficient agricultural practices. Smart polyhouse farming, through the utilization of cutting-edge technology, aims to optimize plant growing conditions, amplify crop yields, minimize resource consumption, and elevate produce quality, thereby contributing to the establishment of a more efficient and environmentally sustainable food production system.

IV. Methodology

The methodology of IOT based polyhouse farming involves the use of technology to optimize the growing conditions of plants. The following are the steps involved in the methodology of smart polyhouse farming:

1. Design and construction of a polyhouse structure: The polyhouse structure is designed to provide an enclosed environment that can be used to control the growing conditions of plants.
2. Installation of sensors: Sensors are installed in the polyhouse to monitor various parameters such as temperature, humidity, light levels, and soil moisture levels.
3. Automation of systems: Based on the data collected by sensors, various systems such as the irrigation system, lighting system, and temperature control system are automated to provide the ideal growing conditions for plants.
4. Data analysis: Data collected from sensors is analysed to optimize the use of resources such as water and fertilizers.
5. Dashboard Creation: A custom dashboard is created using custom app, which allows the user to monitor and control the growing conditions of plants remotely.
6. Crop management: The crops are monitored regularly, and any issues such as pests and diseases are addressed promptly. 7. Harvesting: The crops are harvested when they are ready, and the quality of the produce is evaluated. Overall, the methodology of IOT based polyhouse farming involves the use of technology to create an efficient and sustainable approach to agriculture. By providing the ideal growing conditions for plants, smart polyhouse farming can help to increase crop yields, reduce water usage, and minimize the use of pesticides and fertilizers.

V. Experimentation/ Result:

1. Design and Construction of a Polyhouse Structure: The polyhouse structure is designed to provide an enclosed environment that can be used to control the growing conditions of plants.

Fig 1. Design and construction of a Polyhouse Structure.

2. Installation of Sensors: Sensors are installed in the polyhouse to monitor various parameters such as temperature, humidity, light levels, and soil moisture levels.

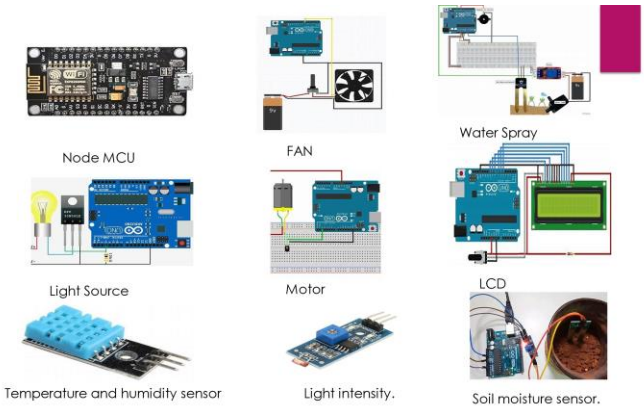

Fig 2. Installation of Sensors.

3. Automation of Systems: Based on the data collected by sensors, various systems such as the irrigation system, lighting system, and temperature control system are automated to provide the ideal growing conditions for plants.

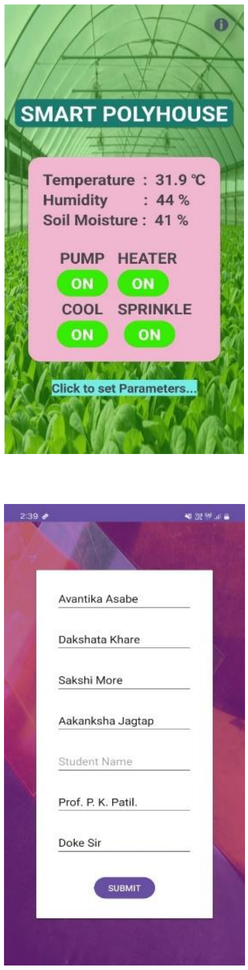

Fig 3. Automation of Systems

4. Data Analysis: Data collected from sensors is analysed to optimize the use of resources such as water and fertilizers.

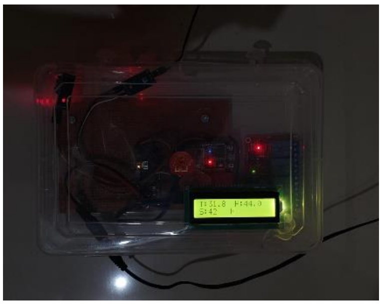

Fig 4. Data analysis

5. Dashboard Creation: A custom dashboard is created using custom app, which allows the user to monitor and control the growing conditions of plants remotely.

Fig 5. Dashboard Creation

6. Crop Management and Harvesting: The crops are monitored regularly, and any issues such as pests and diseases are addressed promptly and the crops are harvested when they are ready, and the quality of the produce is evaluated. Overall, the methodology of smart polyhouse farming involves the use of technology to create an efficient and sustainable approach to agriculture. By providing the ideal growing conditions for plants, smart polyhouse farming can help to increase crop yields, reduce water usage, and minimize the use of pesticides and fertilizers.

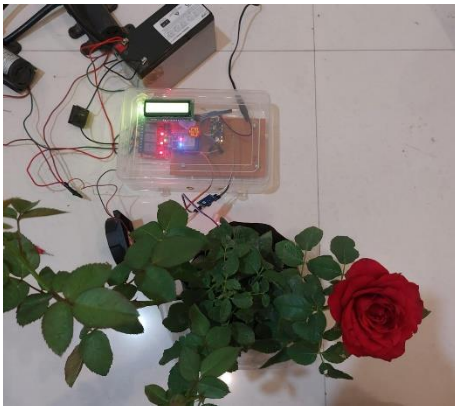

Fig 6. Crop Management and Harvesting

VI. CONCLUSIONS

It is an innovative technique that uses sensors, automation, and artificial intelligence to provide a controlled environment for plants to grow. The objectives of smart polyhouse farming are to reduce water usage and pesticide/fertilizer use, increase crop yield, and improve crop quality. By addressing the problem of growing crops in unpredictable and changing environments, smart polyhouse farming has the potential to revolutionize agriculture and help feed an ever-growing population.

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polyhouse farming and controlled environment agriculture that may include IoT applications.

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[10]. Agri-Tech East: Agri-Tech East is a UK-based organization focused on promoting innovation in agriculture. They publish articles and reports on various agricultural technologies, including IoT applications