International Journal of Scientific Research in Science, Engineering and Technology (www.ijsrset.com)
 | Volume 7 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
DOI : https://doi.org/10.32628/IJSRSET207230

Image Processing and IoT Based Dynamic Traffic Management System

Nitin N. Sakhare, Subhash B. Tatale, Dr. S. R. Sakhare, Hemant Dusaane, Mamta Puri, Pratika Girme, Rutuja Sankpal, Padmavati Ghule

Department of Computer Engineering, Vishwakarma Institute of Information Technology, Pune, Maharashtra, India

ABSTRACT

Due to rise in number of vehicles the traffic management has become a major problem. Manual traffic system is not efficient. This paper presents adaptive traffic management system using Internet of Things (IoT) and Image processing. The proposed system has capability to analyze real time data using image processing. Using cameras, different lanes are monitored constantly. The data obtained from different lanes are examined. Detection and counting of number of vehicles in each lane is done by using image processing. The count from each lane is sent to the central processing unit. According to the count of vehicles algorithm calculates waiting time for each lane, then the signal lights will be decided. This system reduces the average waiting time and increases the efficiency of traffic clearance. The system also reduces the pollution due CO_2 emission and useful in emergency situations, thus being adaptive traffic management using Internet of Things (IoT).

Keywords : Internet of Things (IoT), Adaptive traffic management system, Image processing, OpenCV, Average waiting time, Camera Sensor

I. INTRODUCTION

Currently, manual traffic control system is being used which is based on fixed time intervals for traffic lights controlling. The current traffic control system in the cities of India is inefficient due to uneven traffic density pattern throughout the day. Due to this, the vehicles have to wait for a long time even if the traffic density is very less or no vehicles at all. The average waiting time in manual traffic control system is more because of fixed time for switching lights.

India is emerging country and developing at very rapid pace. The GDP annual growth rate of India has evidently increased from 6.9% in 2013 to 7.4% in 2018 according to the World Bank Data. Economy of India is increasing, due to this there is increase in private vehicles as well as freight vehicles. This leads to traffic congestion problems. On average in Delhi, Mumbai, Bangalore, and Kolkata travelers spend 1.5 hours more on their daily commutes than their counterparts according to an April 18 report released by The Boston Consulting Group (BCG) and commissioned by Uber. In fact, peak-hour congestion in these four Indian cities is estimated at 149% which is much higher than the Asian average of 67%.

The average wait time is a very important parameter when it comes to traffic congestion monitoring. The average wasted time in traffic in 2015 according to INRIX 2015 was as high as 81 hours in United States (Los Angeles, CA) and 101 hours in Europe (London Commute Zone, UK) [3-dubey]. Economic losses due to traffic congestion in Jakarta based on research of Yayasan Pelangi in 2005 was estimated up to Rp 12,8 trillion per year, including loss of time, fuel costs, and health costs. Meanwhile, 2004 SITRAMP II showed that if there is no improvement with the transportation system until 2020, the estimation of economic losses would reach Rp 65 trillion per year [4].

Another factor related to traffic congestion problem is pollution. Urban areas have highest number of vehicles, because of this higher level of air and noise pollution is experienced in these areas. It may be surprising to know that vehicles consume more gas when they are stuck in traffic because of constant acceleration and braking. This leads to more pollutants being pumped into air. Traffic congestion also creates high noise levels. CO2 is a major byproduct of vehicular emissions. According to World Bank Data Center (IBRD; IDA) the CO2 emissions in India was 1.66 metric tons per capita [2].

The main goal is to improve the current traffic management systems. Different ways such as toll based controls systems, extending existing infrastructure are available but they are not feasible to implement and inefficient. Therefore it is more motivating to design a traffic system which can handle varying traffic density and based on that can change time intervals for traffic lights. The purpose of this system is to create a traffic management system which is adaptive to varying traffic density using Internet of Things (IoT). The project has main three parts viz. Detection of vehicles, counting the number of vehicles in different lanes, varying the signal time according to traffic density. The adaptive traffic management system reduces vehicle delays and stoppage at traffic intersections by using real time data. Optimizing traffic signal has been recognized as one of the most cost effective methods for reducing travel time and improving commuting speeds in urban transport system. As the average waiting time is reduced, this will help to reduce Co_2 emission at the traffic intersections which in turn reduce the pollution significantly.

II. LITERATURE SURVEY

1. Traffic Management for emergency Services "Adaptive Traffic management for Secure and Efficient Emergency Services in Smart Cities", this paper was published in IEEE conference (2013), and is published by Mazeiar Salehie, Soufiene Djahel, Irina Tal and Pooyan Jamshidi.

The aim of this project is to focus on traffic management for emergency services. The proposed system in this project uses Internet of Things (IoT) and Machine Learning algorithms. Cameras, controllers and networks play an important role in this system. In this system, the local traffic controller sends the information from cameras to traffic management controller. If images are in great clusters, a notification is sent to emergency vehicle and emergency service authority, so that they can take further actions.

2. Traffic Management using Image Processing "Smart Traffic Optimization Using Image processing", this paper was published in IEEE conference (2015), and is published by Pranav Maheshwari, Deepanshu Suneja, Praneet Singh and Yogeshwar Mutneja.

The main aim of this paper is to determine the volume and density of the incoming traffic by using image processing technique. Edge detection and Oriented FAST and Rotated BRIEF [ORB] algorithms are used for processing the snapped images at fixed intervals. Since the objects are not tracked in a video, the system thus has a low computational cost. After snapping the images RGB colors are captured from the image and sent to the central server, where it is converted into grayscale image which then undergoes edge detection. After edge detection, the image is then transformed into binary image. The issues faced while using edge detection algorithm is overcome by using Otsu's multiple thresholding over various pixel areas in the image. Distance is detected from the scanned image and after that this distance is multiplied with the width of road which gives the area covered by traffic. The system then extracts feature points from the image using Oriented FAST and Rotated BRIEF [ORB] algorithm, the road that is plain will not contribute towards features but the vehicles being mobile will do so. Feature matching is done further using brute force on two simultaneous images to reduce the traffic jam. Therefore, a two-fold cost saving approach is adopted i.e fuel and time cost reduction.

3. Traffic Management using Internet Of Things (IOT) "Smart Traffic Management System Using Internet of Things", this paper was published in IEEE conference (2018), and is published by Sabeen Javaid, Ali Sufian, Saima Pervaiz and Mehak Tanveer.

This paper is based on hybrid approach. It is combination of centralized and decentralized approach for optimizing flow of traffic on roads and also the developed system connects to nearby rescue departments with centralized server and extracts needed information for future road planning. The developed system is divided into three layers a)Data Acquisition and Collection layer B)Data Processing and Decision-making layer C)Application and Actuation layer. In the first layer the data is collected with the help of CCTV cameras, ultrasonic sensors, RFIDs, smoke sensors and flame sensors. Blob detection algorithm is used for noise reduction at the local server. After detecting the traffic, a local server sends the density measured to the respective microcontroller. In the second layer the system allocates time dynamically to each lane on the basis of traffic density. Moreover, if any emergency vehicle is detected, the system gives the highest priority to that lane to be green until that vehicle passes to that intersection. In the third layer, the system calculates the rush interval by using Regression Tree algorithm on the data saved at local server and also updates this report to the centralized server on the daily basis. Moreover, this system is also capable of managing emergency situations like smoke or fire if detected on the road by intimating to the nearby relevant department with the help of mobile application for further actions.

4. Improving Traffic monitoring system using (IoT) "Improvement of Traffic Monitoring System by Density and Flow Control for Indian Road System Using IoT", this paper was published in IJARIIE conference (2016) by Jasmine Jha, Karan A Shah. This paper focus to improve current traffic management system IoT based concepts.

The project is implemented in the following way. First the ultrasonic sensors are fixed on each lanes .They have used three types of sensors: High, Medium, Low .High is send on 1st priority Medium on 2nd and Low on 3rd priority respectively. Data is collected from sensors and sent to the system. Traffic density is measured and average waiting time is calculated. The prototype model was built and comparison between time taken by existing system and the proposed system was done .Thus, waiting time was decreased efficiently.

5. Analysis of Real-Time Multiple Source Video Streaming via Wireless 5.8 GHz for Intelligent Traffic Management System -Analysis of Real-Time Multiple Source Video Streaming via Wireless 5.8 GHz for Intelligent Traffic Management System is published by V.M Baskaran, S.K Tiong, M.Z Jamaludin Department of Electrical. Electronics Engineering University Tenaga Nasional, Malaysia.

The Intelligent Traffic Management System through application of artificial intelligence shows a major step forward in traffic flow control and congestion reduction for road traffic intersections. Images of traffic conditions captured by cameras are processed with advanced image processing techniques to determine traffic conditions at each direction of the junction. Data processed from these images are crunched into simple text applications as inputs into the Expert Supervisory System (ESS) based on Fuzzy Logic and Neural Networks to control the traffic conditions. These data are also transmitted to subsequent traffic intersections as means of secondary data inputs for the ESS application. The motion images captured by the cameras are streamed to a remote control Centre for surveillance and manual control options. The requirements of also include wireless communications as the medium to transmit these images to the remote Centre. Thus, studies were performed to analyze the utmost optimum solution for the outdoor wireless uplink.

6. A Machine Learning Method for Dynamic Traffic Control and Guidance on Freeway Networks - A Machine Learning Method for Dynamic Traffic Control and Guidance on Freeway Networks is published by Kaige Wen, Shiru Qu and Yumei.

The existing traffic-control technology can be improved by the machine learning techniques. In particular, the intense research on Reinforcement Learning (RL) and the success of its application in robotics, decision-making, and control have prompted its use in management and control of traffic networks. This paper is a step towards extending Distributed Reinforcement Learning techniques to the real-time control and guidance of traffic networks. This paper focuses on distributed learning strategies which provide both the traffic manager with support to decide on traffic control policies and the drivers chooses routes.

7. Vehicle Counting using Video Image Processing "Vehicle counting using Image Processing" is published in conference IJCAT (2014) by Megha C. Narhe, Dr. M.S. Nagmode.

The Project proposes vehicle classification and counting implementation scheme using Scale Invariant Feature transform (SIFT) algorithm to improve the efficiency and reliability of the vehicle counting and classification. The methodology used in this system is as follow 1.The video clip is read by one function ,then it is divided into number of frames. 2.The background subtraction is done by the second function. 3.Segmentation is performed in next step 4.Feature extraction is done using SIFT. 5.Features are matched to classify vehicles according to class 6.Finally number of vehicles are counted. The classes of vehicles are defined and by using the algorithm features matching is done and count is increased. Thus, SIFT provides image features that works over scaling, image rotation, camera viewpoint, translation giving the accurate results.

8. Intelligent Traffic Management System- "Intelligent Traffic management System" is published in IEEE Conference (2011) on Sustainable Utilization and Development in Engineering and Technology by Anil Kumar Yerrapragada, Prithvinath Manikonda and Sai Sasank Annasamudram.

This paper presents an smart traffic management system using RFID technology. The system is providing practically important traffic data which would aid in reducing the travel time for the users. Also, it can be used for other purposes like tracing of vehicles that evade traffic signals/tickets, stolen cars, toll collection or vehicle taxes etc. using RFID technology. The system consists of a passive tag, a microcontroller, an RFID reader, a GPRS module, a high-speed server with a database system and a user module. Using RFID, this system collects the required data and calculates average speed of vehicles on each road of a city under consideration.

III. METHODOLOGY

a. Working

Adaptive traffic management system that we need to implement is very large. So, we developed a prototype model which works as per the current density of vehicles at the intersection and will vary its time interval with varying traffic condition.

In this proposed system, the aim is to achieve low average waiting time or low traffic congestion. The priority will be given depending on the present situation. There are three main parts of the system which are as follows:

- Detection of vehicles:

Camera sensors are used to take live stream of traffic to measure density of vehicles. The cameras are mounted at four directions that is north, South, East and west. Camera communicated with raspberry pi using USB port. Camera continuously monitors traffic and detect the vehicles. The vehicle detection is done by using image processing. Code for image processing is written in python.

- Counting number of vehicles

In this adaptive traffic management system we experimented the idea for four lanes and we have used four camera sensor for four different lanes. These camera sensors were used in the respective four lanes for counting the no of vehicles. This ensures an approach towards reduce average waiting time. It's also been taken care of, that if there are same number of vehicles in more than one lane then logic is performed according to the priority that we have given. We used an algorithm in which data about the traffic density from different lanes in a traffic intersection is compared to each other.

- Calculate Waiting time

After taking the count of vehicles that count is used in calculating the average waiting time for traffic signal and then it sends a signal to controller which allows traffic flow for that direction for calculated time.

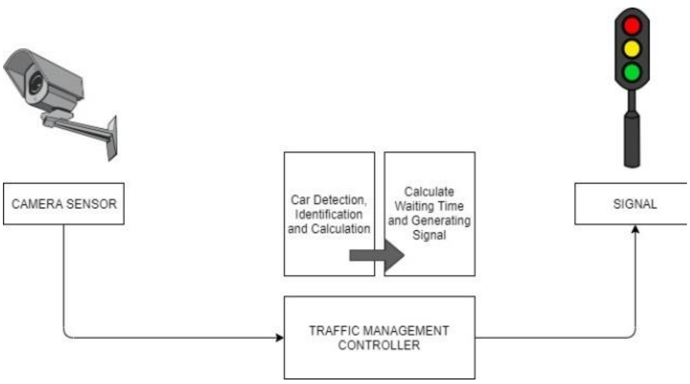

Fig. 1. Architecture Diagram

b. Algorithm

Algorithms which are used for implementation are as follows:

A. MAIN_ALGORITHM:-

1. Repeat 2 to 5.
2. Set TRAFFIC _COUNT = Find-MAX-Dir
3. Check the value of TRAFFIC _COUNT

a. If it is ZERO
   Continue in loop

b. Else
   Go to step 4.

4. Calculate the time using TIME-CAL-ALGORITHM (TRAFFIC_COUNT).
5. Send signal to microcontroller with calculated time. It will ON the traffic for respected direction for calculated time.

B. TIME-CAL-ALGORITHM:-

We are using a constant LENGTH having value 3 meter.

1. Set len = TRAFFIC_COUNT/LENGTH.
2. Set TIME = 15+len
3. Check

   a) If (TIME<= 90 second)
      Return TIME
   b) Else
      Set TIME=90 seconds
      return TIME

C. Find_MAX_Dir:-

Dir= {0, 1, 2, 3}, Set priority for each dir is 0.

1. Send the video of each Direction for process
2. Calculate the count for lane0, lane1, lane2 and lane3 by image processing.
3. Set Selected_Dir = Direction(MAX(lane0, lane1, lane2, lane3).
4. Check

   For each Direction

   a. If (Priority[Dir] = -10)
      Selected_Dir = Dir
   b. Else
      Go to Step 5.

5. Check

   a. If (Priority[Selected_Dir]<10)
      Go to Step 6.
   b. Else

Select the Max_Traffic from Remaining 3 Direction

Set Selected_Dir =Direction (Max_Traffic).

6. For Each Direction
   a. If (Selected_Dir = Direction)
      Set Priority[Dir] =Priority[Dir] +5
   c. Else
      Set Priority[Dir] = Priority[Dir] – 5
7. Return Count of Selected_Dir.

Algorithms which are used for implementation are explained as follows:

Main Algorithm:

When the system initializes first time, it starts with the main algorithm. It then calls Find_MAX_Dir which returns the traffic count for particular direction, it store the count in TRAFFIC_COUNT. Then it check the count value is zero or not, if count is zero it continue with loop otherwise it will call Time calculation algorithm and this algorithm returns calculated the time for the traffic signal and then it sends a signal to controller to ON the traffic light for that direction for the calculated period of time.

Time_Cal_algorithm:

Time Calculation algorithm makes use of the traffic density count for a particular direction. It returns calculated time in second to main algorithm. It calculates time in such a way that the least time for any direction is 15 second and maximum time for a direction is 90 second. It adds seconds to initial time based on the count of vehicles.

Find_Max_Dir:

The algorithm calculates number of vehicles in each lane using image processing and return count of vehicles to parent procedure. It starts with setting the priority value to zero for all lanes. Then use image processing to calculate the vehicle count for all lanes. It then select the lane with maximum count of vehicles and by checking priority, it selects another lane if it is more appropriate and return it to main procedure with vehicle count.

To give fair time for each lane priority scheme is used so that no lane has to wait too much with giving more preferences to heavy traffic lane. The priority scheme selects particular lane if the lane has highest vehicle count and the priority is less than 10 otherwise it will select lane is from remaining lanes having maximum vehicle count. The priority value is increased by 5 every time a lane is selected and priority value of remaining lanes is decreased by 5. This mechanism allows an effective management of traffic by giving fair chance to each lane. It helps to reduce time for the lane with low vehicle count.

IV. EXPERIMENTAL RESULTS

After having reference to different IEEE papers and books, the results are:

1. Traffic congestion is monitored and calculated by vehicle detection as shown in the following fig.

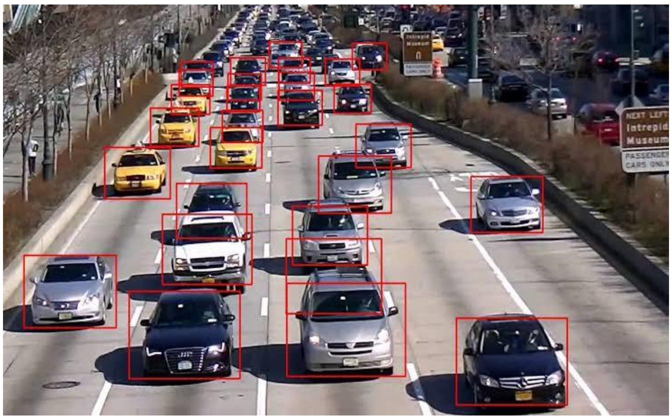

Fig 1. Vehicle Detection

As shown in above figure the local host at the traffic intersection with the display of the image captured from the CCTV cameras at the local screen 1

2. Vehicle Counting using Video Image Processing
   After detection of vehicles, number of vehicles are counted which are in Region of Interest(ROI).

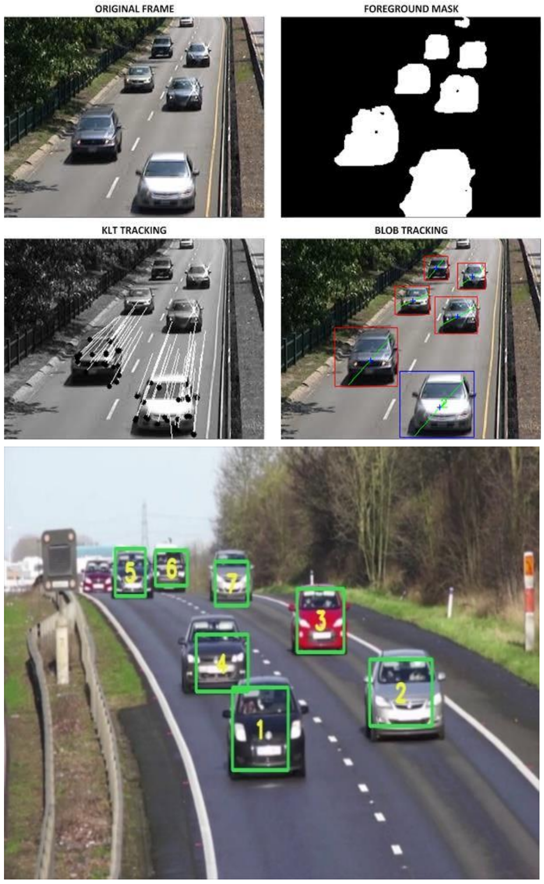

Fig 2. Vehicle counting

3. Manipulating signal based on traffic density
   The vehicle count is used to calculate the waiting time for lane and the controller sends appropriate signal to traffic light according to algorithm.

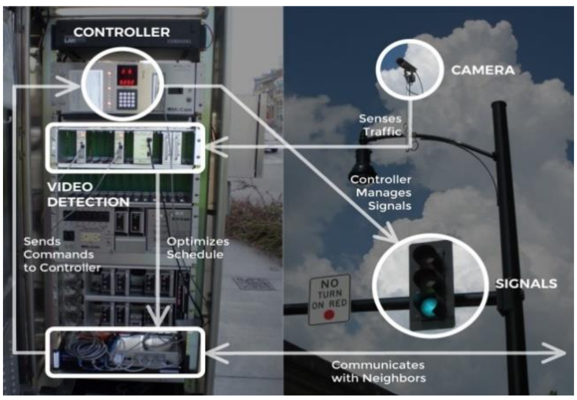

Fig 3. Signal processing

V. CONCLUSION

This paper presents a system which is based on Internet of Things (IoT) and image processing. This system uses camera sensors as an input system to take real-time data. By analyzing the data system calculates average waiting time for each lane. Proposed system provides feasibility by making it adaptive. The system provides low average waiting time and reliability. Due to low average waiting time the air pollution rate decreases and the use of fuel also decreases. Proposed system decreases traffic congestion. Proposed system provides a more economical and feasible approach towards changing the current traffic management system and making it adaptive and intelligent.

VI. FUTURE SCOPE

To enhance the reliability of the system the following features can be added:

1. The system will be helpful for emergency vehicles like ambulance. Lets take an example that Lane A has ambulance but it is turn of Lane D. Turn red light within 4 seconds for Lane D and make Lane A green. Once the lane A-ROI is crossed by ambulance within 5 seconds make red light ON for lane A and start again with lane D (As per algorithm).
2. A system which is being developed can mail or send messages directly to hospital in case any accidental situation.
3. The system will also detect the vehicle when they cross the traffic signal there RFID tags are scanned and the report is send to the police station.
4. The System will automatically detect the vehicles crossing the stop line during red signal and generates penalty.

VII. REFERENCES

[1]. Yadav, Aditi & More, Vaishali & Shinde, Neha & Nerurkar, Manjiri & Sakhare, Nitin. (2019). Adaptive Traffic Management System Using IoT and Machine Learning. International Journal of

Scientific Research in Science, Engineering and Technology. 216-229. 10.32628/IJSRSET196146.

[2]. Ankit Dubey, Mayuri Lakhani, Shivansh Dave, Jignesh J. Patoliya, “Internet of Things Adaptive Traffic Management System as a part of Intelligent Transportation System (ITS)”, IEEE 2018.

[3]. Zahra Zamani, Mohammad Hossein Saraee, Mahmoud Pourmand ,” Application of Data Mining in Traffic Management: Case of City of Isfahan”, IEEE 2010

[4]. M. F. Rachmadi et al., "Adaptive traffic signal control system using camera sensor and embedded system," TENCON 2011 - 2011 IEEE Region 10 Conference, Bali, 2011, pp. 1261-1265.

[5]. S. S. Dorle and P. Patel, "Implementation of Adaptive Traffic Light Control System Based on Radio Propagation Model in Vanet," 2013 IEEE International Electric Vehicle Conference (IEVC), Santa Clara, CA, 2013, pp. 1-5.

[6]. P. Manikonda, A. K. Yerrapragada and S. S. Annasamudram, "Intelligent traffic management system," 2011 IEEE Conference on Sustainable Utilization and Development in Engineering and Technology (STUDENT), Semenyih, 2011, pp. 119-122.

[7]. K. Wen, S. Qu and Y. Zhang, "A Machine Learning Method for Dynamic Traffic Control and Guidance on Freeway Networks," 2009 International Asia Conference on Informatics in Control, Automation and Robotics, Bangkok, 2009, pp. 67-71.

[8]. Y M Jagadeesh, S Karthik, G. Merlin Suba and K Yokesh, “Smart Autonomous Traffic Light Switching by Traffic Density Measurement through Sensors” ,IEEE 2015.

[9]. Misagh Ketabdari, Luca Studer and Giovanna Marchionni, “Analysis of Adaptive Traffic Control Systems Design of a Decision Support System for Better Choices”, IEEE 2015

[10]. Sonali P. Kshirsagar, Priyanka H. Mantala, Kalyani G. Teke, Gayatri D. Parjane, “Internet of Things (IoT) based Intelligent Traffic Management “,IEEE conference 2015.

[11]. Vincenzo Pasqual eGiofr`e, Giuseppe Guido, Vittorio Astarita, lessandro Vitale,”The Use of Adaptive Traffic Signal Systems Based on Floating Car Data ”, IEEE 2017

[12]. Pranav Maheshwari, Deepanshu Suneja, Praneet Singh, Yogeshwar Mutneja,”Smart Traffic Optimization Using Image processing”,IEEE 2015

[13]. Mazei ar Salehie, Soufiene Djahel, Irina Tal and Pooyan Jamshidi, “Adaptive Traffic Management for Secure and Efficient Emergency Services in Smart Cities”, IEEE 2013.

[14]. Dr.M.S.Nagmode, Megha C. Narhe,” Video Image Processing based Vehicle Counting ”,IJCAT conference 2014.

[15]. A.Kanthimathi, K.Ranjin, Y.Yasmine ,”Design of Adaptive Road Traffic Control System through Unified Modeling Language”,IEEE 2017.

[16]. Pramodini Bidhar , Prabira Kumar Sethy , Jagamohan Padhi ,4Santi Kumari Behera ,”Realtime Implementation of Odd-Even Traffic Control Formula Using Arduino “,ICPCIT-2016.

[17]. Jasmine Jha2, Karan A Shah,”Improvement of Traffic Monitoring System by Density and Flow Control for Indian Road System Using IoT ”.

[18]. Fadhlan H. K. Zaman , Ruhaizan Fazrren Ashraff Mohd Nor ,Shamry Mubdi,”Smart Traffic Light for Congestion Monitoring using LoRaWAN”,IEEE 2017.

[19]. Mayuri Lakhani, Ankit Dubey , Shivansh Dave, Jignesh J. Patoliya,” Adaptive Traffic Management System) based on Internet of Things (Iot as a part of Intelligent Transportation System (ITS)”, IEEE 2017

[20]. Mohammad Hossein Saraee, Zahra Zamani, Mahmoud Pourmand ,” Application of Data Mining in Traffic Management: Case of City of Isfahan”, IEEE 2010

[21]. Syunichi SEKI, Takashi NAKATSUJI, Syuestu SHIBUYA, Terutoshi KAKU, "Artificial Intelligence Approach for Optimizing Traffic Signal Timings on Urban Road Network" ,IEEE 1994
[22]. Shiru Qu, Kaige Wen and Yumei Zhang, "A Machine Learning Method for Dynamic Traffic Control and Guidance on Freeway Networks", IEEE 2009
[23]. S.K Tiong, V.M Baskaran, M.Z Jamaludin, "Analysis of Real-Time Multiple Source Video Streaming via Wireless 5.8 GHz for Intelligent Traffic Management System" ,IEEE 2005
[24]. Baher , Celine Jacob, "Abdulhai Integrated Traffic Corridor Control Using Machine Learning", IEEE 2005.
[25]. Abbas Khosravi, Sahar Araghi, Michael Johnstone, Doug Creighton,"Intelligent Traffic Light Control of Isolated Intersections Using Machine Learning Methods" ,IEEE 2013.
[26]. Deepanshu Suneja, Pranav Maheshwari, Praneet Singh, Yogeshwar Mutneja, "Smart Traffic Optimization Using Image Processing" ,IEEE 2015.

Cite this article as :

Sh

Nitin N. Sakhare, Subhash B. Tatale, Dr. S.R. Sakhare, Hemant Dusaane, Mamta Puri, Pratika Girme, Rutuja Sankpal, Padmavati Ghule, "Image Processing and IoT Based Dynamic Traffic Management System", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 2, pp. 180-188, March-April 2020. Available at doi : https://doi.org/10.32628/IJSRSET207230
Journal URL : http://ijsrset.com/IJSRSET207230