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A COMPREHENSIVE URBAN TRAFFIC MANAGEMENT SYSTEM FOR ENHANCED SAFETY AND EFFICIENCY(USING NODE MCU AND OPEN CV)

Vempati Venkata Sai Anudeep[1] Mrs.K.Papayamma[2], Nagulakonda Prathyusha[3], Gorijilli Venkat Naga Sai Dinesh[4]

[2] Assistant Professor, Department of Computer Science & Engineering, Raghu Engineering College, Vishakhapatnam, Andhra Pradesh

[1,3,4,] Student of B-TECH, Raghu Engineering College , Vishakhapatnam, Andhra Pradesh

Email:- anudeepvk3@gmail.com, tejaswinipadma@gmail.com, puppysrnp23@gmail.com, , gvnsdinesh776@gmail.com

ABSTRACT

Our approach to traffic management involves utilizing unique intelligence to calculate traffic density in real time through image processing, using road photos captured by webcams or IP cameras at traffic intersections. In order to lessen traffic congestion on the roads, which will help reduce the number of accidents, it also focuses on the algorithm for adjusting traffic signals based on the density of vehicles on the road. As a result, it will save fuel usage and waiting times while also ensuring safe transportation for people. Significant data will also be provided, aiding in future study and planning for roads. In later phases, synchronizing several traffic lights can help reduce traffic congestion and improve traffic flow. of traffic. The vehicles are detected by the system through images instead of using electronic sensors embedded in the pavement. There will be a camera next to the traffic signal. It will record video clips. A more effective method for managing the traffic light's status change is image processing. It demonstrates that it can lessen traffic jams and prevent time wasted by a green signal on a deserted road. Because it makes use of real traffic photos, its estimation of the presence of vehicles is also more accurate. There must be clever solutions for today's traffic congestion. In order to satisfy important urban needs, this study suggests an advanced traffic management system (traffic density) that uses proactive interventions, real-time data processing, and extensive vehicle information recording. This system offers a safer, smoother, and more efficient traffic flow for all users by incorporating cutting edge technologies.

Keyword: - traffic density, IOT, nodemcu, traffic density

1. INTRODUCTION

A city is a complex system which consists of many interdependent subsystems where traffic system is one of its important subsystems. A study says; it is the cornerstone of the world's economy. Moreover, it is also declared as one of the major dimensions of the smart city. With the rapid growth of the population of the world, the number of vehicles on roadways is increasing consequently, the rate of traffic jams is also increasing in the same manner. Traffic jams are not just wasting time but, in some cases, it is witnessed that criminal activities like mobile snatching at traffic signals also happen in metropolitan cities. On the other hand, it is not only affecting ecosystem badly but the efficiency of industries is also being affected. It is, therefore, identified that active traffic management is a necessity. In majority countries, traffic is managed through fixed time signals whereas, in large cities of some developed countries, traffic is managed through centrally controlled systems. The paradigm of the Internet of Thing (IoT) has been introduced in traffic management systems. To the best of our knowledge, it is identified that till date the current traffic management systems are centralized. In case of networking issues, such systems may crash. In addition, there is less focus on fluctuations in traffic flow. Therefore, the proposed system manages the traffic on local and centralized servers by exploiting the concepts of IoT and Artificial Intelligence together. The representation of traffic data in statistical form can also be helpful to authorities for real-time controlling and managing traffic. Moreover, it may also be helpful for future planning. Smart traffic management control systems represent a multifaceted solution to modern urban transportation challenges. Their primary purpose lies in enhancing the efficiency and safety of roadways. By employing real-time data collection and analysis, these systems enable dynamic adjustments to traffic signals, optimizing the flow of vehicles and reducing congestion. This not only improves the overall driving experience but also enhances safety by minimizing the risk of accidents. Furthermore, these systems contribute to environmental sustainability by reducing fuel consumption and emissions through smoother traffic flow. Beyond these core objectives, smart traffic management systems serve as invaluable tools for urban planning, providing insights into traffic patterns and facilitating the integration of various transportation modes. Ultimately, their implementation aims to create more accessible, efficient, and safer transportation networks that benefit both individuals and communities alikeThe scope of smart traffic management control systems is extensive, encompassing various aspects of urban mobility and transportation infrastructure. At its core, these systems utilize advanced technologies such as sensors, cameras, and data analytics to monitor and manage traffic flow in real-time. This scope extends beyond simply regulating traffic signals; it involves coordinating traffic patterns across intersections, highways, and urban areas to minimize congestion and optimize the efficiency of roadways. Moreover, smart traffic

management systems can integrate with other urban systems, such as public transportation networks and emergency services, to enhance overall city functionality. They also facilitate data-driven decision-making for urban planners, providing insights into traffic patterns, congestion hotspots, and transportation demand. Additionally, the scope of these systems includes considerations for safety, environmental impact, and accessibility, aiming to create inclusive, sustainable, and safe transportation environments for all users. As technology continues to advance, the scope of smart traffic management control systems is likely to expand further, incorporating innovations such as autonomous vehicles, smart infrastructure, and predictive traffic modeling to further improve urban mobility and quality of life.

2. LITERATURE SURVEY

2.1 DENSITY CONTROL USING IR SENSORS

Density, speed, and flow are the three critical parameters for road traffic analysis. High-performance road traffic management and control require real-time estimation of space mean speed and density as input for large spatial and temporal coverage of the roadway network. In Adaptive Traffic Control System which receive information from vehicle such as position and speed and then it utilizes to optimize the traffic signal. The system specifies the use of onboard sensors in vehicle and standard wireless communication protocol Specified for vehicular applications. They implement various traffic Signal control Algorithms [1]. Intelligent traffic system for VANET suggest that creation for smart city framework for VANET consisting of Intelligent Traffic Lights which transmit warning messages and traffic statistic. In That System Various Routing Protocol Has Been Discus and Compare. They suggest that AODB is best suited for Intelligent Traffic Light [2]. Author suggests in reference [3] the data forecasting model for transmitting data from one to other. This article studied about the dynamic traffic control system and based on radio propagation model for predicting path loss &link. The author suggests in reference [7] Intelligence Road Traffic signaling System. In that system OBUs used. OBUs used destination information for calculating load traffic on road for reducing the conjunction on road. The general belief is that it is more difficult to estimate and predict traffic density than traffic flow in Intelligent Traffic Light and Density Control using IR Sensors and Microcontroller [4] the author propose that the delay of Signal not depend on traffic density. The Author optimizes the traffic using microcontroller this system reduces traffic jams problem cause by traffic light to extent. The system contains IR Transmitter and IR Receiver. IR count the vehicles on the road Microcontroller generates the result. [8] Priority Based Traffic Lights Controller Using Wireless Sensor Network the author implements Adaptive Traffic control System based on (WSN) wireless sensor Network. In that System Time manipulation Used for controlling Traffic Light. These System Control Traffic over Multiple intersections. As such, it is becoming very crucial to device efficient, adaptive and cost-effective traffic control algorithms that facilitate and guarantee fast and smooth traffic flow that utilize new and versatile technologies. An excellent potential candidate to aid on achieving this objective is the Wireless Sensor Network (WSN). Many studies suggested the use of WSN technology for traffic control. In, a dynamic vehicle detection method and a signal control algorithm to control the state of the signal light in a road intersection using the WSN technology was proposed. In this paper, an intelligent traffic light control system based on WSN is presented. The system has the potential to revolutionize traffic surveillance and control technology because of its low cost and potential for large scale deployment.

2.2 DENSITY BASED TRAFFIC SIGNAL SYSTEM USING LOAD CELLS AND IR SENSORS

Surveillance systems and video monitoring [1] have been utilized for traffic control in recent years. A lot of innovations have been made for inspecting the density of the traffic based on image processing [4, 5]. But these techniques require the good images whose quality depends on various factors such as rain, fog and so. Historically, there exist various vehicle detectors such as radar, ultrasonic [2], and microwave detector. But these sensors are expensive, with less capacity, difficult to maintain, difficult to implement and extra maintenance charges will be there. Radar sensors are affected by metal barriers near road. Sensors like Passive acoustic detector array, Piezoelectric, Photoelectric, Inductive loop detector, magnetic detectors [11], etc are employed in the field of traffic monitoring and management systems. These sensors are less accurate [3]. Traffic congestions that occur in urban areas cannot be properly controlled by using existing fixed signal timing system. When the traffic density increases more than a limit on a particular road, it needs larger green light duration to reduce the traffic flow. The major problem of the existing traffic light system is that the transition timing slots are fixed in software and unnecessary waiting time is being wasted when no vehicles are present on opposite route. Our system uses Arduino Mega that is interfaced with IR sensors [6, 8]. Three IR transmitters and receivers are placed on each road. When an automobile passes between the IR sensors, the photodiode is activated and the object is detected. According to this, there are three modes of lighting transition slots: the soft traffic mode, the normal mode and the traffic jam mode. The shifting between these three modes is done dynamically using software. [7]. In addition to this, our system also uses load sensor cells which detect vehicles by their weights. A load cell is a sensor that is used to measure the weight of an object. It basically contains two major components, a spring element and one or more strain gauges. Spring element serves as the reaction for the applied load and focuses the effect of the load into a strain-field. In a cantilever load cell, the spring element is a part of the cantilever itself – the beam stores elastic potential energy as the live end is deflected from the equilibrium position. [9, 10]. e-ISSN: 2582-5208 International Research Journal of Modernization in Engineering Technology and Science Volume:02/Issue:06/June-2020 www.irjmets.com www.irjmets.com @International Research Journal of Modernization in Engineering, Technology and Science [1096] Our system also has a

feature to clear the way for emergency service vehicles such as ambulance, fire fighting vehicles etc. An RFID tag will be mounted under each emergency service vehicle. The basic idea behind the proposed system is that the RFID tagged emergency service vehicle is detected on the way using RFID reader mounted on the road [12]. Whenever there is any malfunctioning in the system, it automatically sends the message to the operating.

2.3 Road Traffic Signal Control and Management System

from the past few decades, technology is out breaking with its significant application in each and every field. Gradually, technology is becoming integral part of human life and effectively used to address many societal issues. One such issue is traffic in urban areas that leads to elongated waiting time at road intersections. An Intelligent Traffic Signal System (ITSS) can mitigate the urban traffic congestion. Already many researchers are working towards and proposed various solutions or techniques. The solution involves combination of different technologies such as Fuzzy Logic, Wireless Sensor Network, Machine Learning, Artificial Neural Networks, Internet of Things, Microcontrollers and high-level computing environments. The proposed ideas are capable of adapting to the traffic demands based on real time situations on the road, resulting in efficient utilization of the available road infrastructure. In this paper, an attempt has been made to classify the traffic control signal system deployed at the intersections based on technology adopted and various research contribution for developing ITSS are also summarized.

2.4 Traffic Management System using IOT for Emergency Vehicles

With the growing number of individuals and vehicles within the populated area, traffic jam has become a serious problem and a challenge in big cities. Slow cars not only drive trips, but even have an impression on the environment by polluting the air, the economy by wasting working hours and fuel, and private health by increasing the extent of stress. It also can be life-threatening when emergency vehicles attempt to undergo traffic jams. In addition to the economic impact, traffic jams can severely disrupt services provided by ambulances, firefighters, and emergency services, hampering their efforts to satisfy target reaction time and maintain quality of service. Table 1 shows that emergency services like the Metropolitan Fire and Emergency Services Board (MEFSB), Country Fire Authority (CFA), State Emergency Service (SES), and Ambulance Victoria (AV) have a way shorter time interval than their corresponding reaction time (travel time). There are many ITS recommendations within the literature, most notably Green Wave, ITS Integration model, application-based model, Smart traffic signal system (STLC), and Smart Congestion avoidance (SCA). In these activities, researchers are discussing a process to scale back the danger of green traffic jam. These programs contain many smart devices which will communicate with traffic infrastructure (e.g., road signal), off-road vehicles, and other smart traffic devices using wireless communication systems. Since wireless communication is susceptible to cyber-attacks, it's also can be compromised. Such attacks may increase the danger of life-threatening traffic jam within the event of an emergency vehicle being suffering from an ITS hack or unreliable robots. Existing ITS programs don't have the means to hack and reduce their impact. As a result, these systems cannot guarantee the reliability of the road signal system and are therefore completely unreliable

3. IMPLEMENTATION STUDY

PROPOSED METHODOLOGY

1. NodeMCU (ESP8266) Modules: NodeMCU is a low-cost open-source IoT platform that can be programmed using the Arduino IDE. Multiple NodeMCU modules can be deployed at various points within the traffic system.

2. Traffic Sensors: NodeMCU modules can be equipped with various sensors such as infrared sensors, ultrasonic sensors, or cameras to detect the presence of vehicles and monitor traffic density.

3. Traffic Light Control: The NodeMCU modules can communicate with traffic lights to control their operation based on real-time traffic conditions. They can adjust signal timings dynamically to optimize traffic flow.

4. Data Communication: NodeMCU modules can communicate with each other and with a central control system using Wi-Fi or other wireless communication protocols. This allows for real-time data exchange and coordination between different components of the system.

5. Central Control System: A central control system, possibly hosted on a cloud server or a local server, aggregates data from all NodeMCU modules and performs advanced traffic analysis and control algorithms. It can provide insights into traffic patterns, predict congestion, and optimize traffic flow across the entire network.

6. Traffic Monitoring and Reporting: The system can generate real-time traffic reports and alerts for traffic authorities and commuters. This can include information about road conditions, congestion levels, and recommended alternate routes.

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7. Smart Intersection Management: By analysing traffic patterns and vehicle movements, the system can optimize traffic signal timings at intersections to minimize waiting times and reduce congestion.

8. Emergency Vehicle Priority: The system can detect and prioritize the passage of emergency vehicles by automatically adjusting traffic signals to give them green lights and clear the way.

9. Integration with Other Systems: The proposed system can be integrated with other smart city systems such as public transportation networks, parking management systems, and environmental monitoring systems to create a holistic approach to urban management.

10. Scalability and Flexibility: The system should be designed to be scalable and flexible, allowing for easy expansion and adaptation to accommodate changes in traffic patterns and infrastructure.

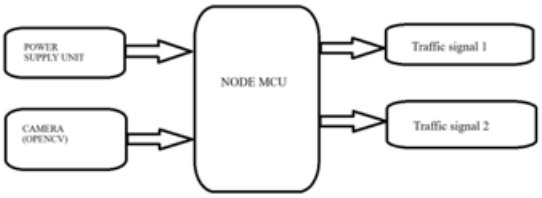

Fig1:-proposed semantic diagram

4. METHODOLOGY

[1]. NodeMCU Modules:

- Utilizes NodeMCU (ESP8266) modules as the core hardware component.
- NodeMCU offers a low-cost, open-source IoT platform programmable via Arduino IDE.

2. Traffic Sensors:

- Equips NodeMCU modules with various sensors (e.g., infrared, ultrasonic, cameras) to detect vehicle presence and monitor traffic density.
- Sensors gather real-time data on traffic conditions at specific locations.

3. Traffic Light Control:

- NodeMCU modules communicate with traffic lights to dynamically adjust signal timings based on traffic conditions.
- Optimizes traffic flow by minimizing wait times and reducing congestion.

4. Data Communication:

- NodeMCU modules communicate wirelessly with each other and a central control system.
- Utilizes Wi-Fi or other wireless protocols for real-time data exchange and coordination.

5. Central Control System:

- Centralized system aggregates data from NodeMCU modules.
- Performs advanced traffic analysis, predicts congestion, and optimizes traffic flow across the network.
- Hosted on a cloud server or local server.

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6. Traffic Monitoring and Reporting:

- Generates real-time traffic reports and alerts for traffic authorities and commuters.
- Provides information on road conditions, congestion levels, and recommended alternate routes.

7. Smart Intersection Management:

- Optimizes traffic signal timings at intersections based on traffic patterns and vehicle movements.
- Minimizes waiting times and congestion.

8. Emergency Vehicle Priority:

- System detects and prioritizes the passage of emergency vechicles.
- Automatically adjusts traffic signals to give them green lights and clear the way.

9. Integration with Other Systems:

- Integrates with other smart city systems (e.g., public transportation networks, parking management, environmental monitoring).
- Creates a holistic approach to urban management.

5 Results

Fig 2:- calculating the number of vehicles based on density

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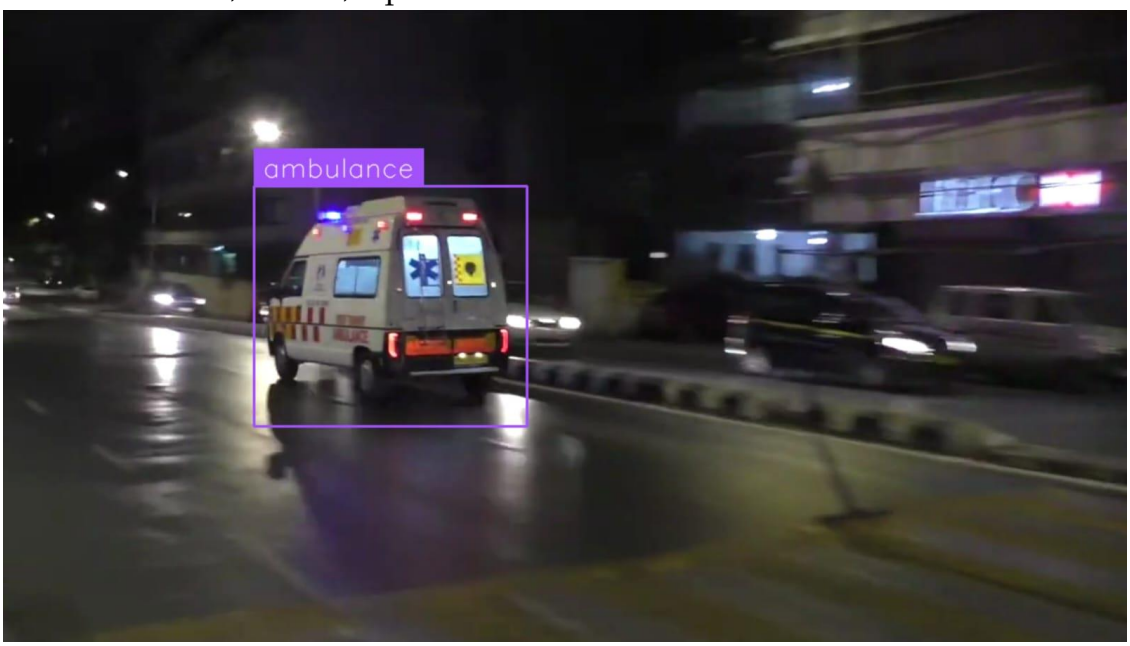

Fig 3:- identifying the object using proposed model

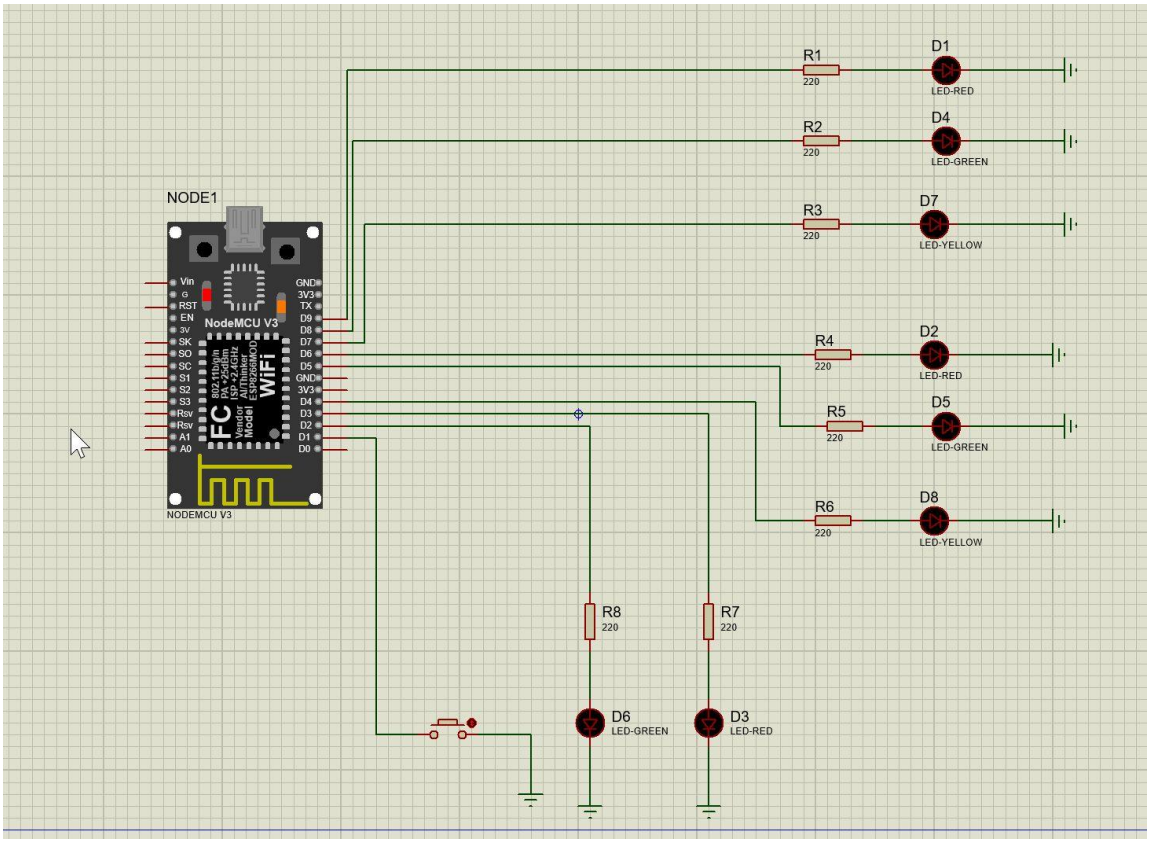

Fig 4:-proposed model semantic model

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6 CONCLUSION

The development of the Smart Traffic Management System made use of several IoT hardware component features. Using an IoT platform, traffic optimization is accomplished by efficiently allocating different amounts of time to each traffic signal based on the number of vehicles that are currently on the route. The Smart Traffic Management System is used to reroute traffic at intersections and effectively address the issue of congestion. This study offers a workable answer to the ever-increasing problem of traffic flow, especially in large cities where traditional methods are unable to keep up with the volume of traffic. A smart traffic management system is suggested in order to more effectively and efficiently handle traffic conditions on the roads while taking into account the most recent advancements in traffic management techniques . It also implements the license plate detection and ambulance detection.

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