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Implementation on IoT Based Traffic Management System for Emergency Vehicles

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Abstract: In many Indian cities along with those in other nations, congestion caused by traffic is a serious issue. Traffic congestion is caused by signal failure, ineffective law enforcement, and poor traffic administration. The economy, the environment, and general quality of life are all negatively impacted by traffic congestion. Therefore, it is imperative that the traffic congestion issue be managed efficiently. The proposed system's goal is to suggest a smart traffic control and management system that makes use of the Internet of Things, a decentralised strategy and algorithms to handle all traffic circumstances more precisely. The shortcomings of the existing traffic control systems will be fixed by the proposed system. To reduce traffic congestion, a forecast of upcoming traffic density will be made using an algorithm. The proposed method enables an emergency vehicle to travel directly to its location by turning all red lights on its route into green ones, thereby reducing traffic congestion. The system manages traffic signals and reduces wait times during emergencies. This makes it an endeavour that can save a life.
Keywords: Smart cities, sensors, RFID, internet of things, traffic control, and monitoring of emergency vehicles.

I. INTRODUCTION

Reduced velocities, extended travel durations, and elongated vehicle queues are among the repercussions of traffic congestion on highways. The occurrence of traffic congestion arises when the number of vehicles on a particular route surpasses its capacity. This is a prominent issue in the primary urban areas of India. Traffic congestion materialises when the demand outstrips the capacity of the highways.

In the contemporary era, rapid mobility has become ubiquitous. This has led to a surge in traffic on highways, often resulting in uncontrollable congestion and high volume. These occurrences are particularly prevalent in major metropolitan areas, forcing numerous individuals to endure extended periods of stagnation in tedious traffic jams. Furthermore, traffic congestion increases the likelihood of road accidents, impeding the response time of emergency vehicles such as paramedics, fire engines, and police cars, thus contributing to the loss of innocent lives. This project is intended for densely populated urban areas with high traffic volumes. In the city of Bangalore, for instance, traffic congestion is a prevalent issue. It is common for traffic to extend over a minimum distance of 100 metres. Under such circumstances, the sound of the ambulance siren may not reach the traffic police officers in a timely manner. Consequently, paramedics are compelled to wait until the traffic clears before proceeding with their emergency response, which could result in adverse outcomes for the patient. The implementation of this project mitigates these challenges.

This project aims to address the challenges posed by traffic congestion in densely populated urban areas with high traffic volumes, such as Bangalore. In such areas, it is common for traffic to extend over a minimum distance of 100 metres, making it difficult for the sound of an ambulance siren to reach the traffic police officers in a timely manner. As a result, paramedics may have to wait for the traffic to clear, potentially endangering the patient's life. However, our system provides a solution by automatically halting the traffic lights and granting the ambulance a green light when it approaches a traffic signal. This is achieved through an IoT-enabled device that monitors and controls traffic signals, reducing traffic congestion and providing emergency vehicles with expedited access through designated green lanes The proposed system involves the installation of Radio Frequency (RF) readers at traffic junctions, which are designed to read the Radio Frequency ID tags on approaching vehicles. Radio Frequency ID technology utilises integrated circuits to store digital data, which is transmitted to Radio Frequency readers via a small antenna embedded within the Radio Frequency ID tag.

II. LITERATURE REVIEW

1) The authors propose an autonomous traffic diversion system that utilises sensors and a computer to modify traffic signals based on vehicle volume, with an emergency override for emergency vehicles. The main aim is to enhance traffic flow and alleviate congestion. MATLAB simulations demonstrate that the suggested approach substantially boosts transportation efficiency and reduces traffic congestion.

2) The proposed solution utilises IoT technologies such as RFID, GPS, and GSM to identify approaching emergency vehicles and prioritise them in the traffic management system. A mobile application is also developed to allow emergency vehicle drivers to interact with the system and receive real-time traffic information. The system's performance was evaluated using Raspberry Pi and Arduino, and the findings demonstrate a significant improvement in emergency vehicle mobility by reducing response times in urban traffic.
3) The researchers have proposed an autonomous traffic light system that prioritises emergency vehicles, resulting in reduced response times and improved survival rates. The system employs sensors on emergency vehicles to communicate with traffic signals, thereby facilitating their passage. Additionally, the authors recommend integrating the system with GPS to calculate the most efficient path for emergency vehicles to reach their destination. Furthermore, the device can notify hospitals of the approaching emergency vehicles.
4) The paper underscores the importance of reducing emergency vehicle response times and highlights the limitations of conventional traffic management systems. The authors examined several systems that employ IoT, RFID, GPS, and wireless communication technologies to prioritise emergency vehicles while ensuring smooth traffic flow. The report evaluates the strengths and weaknesses of each approach and proposes potential areas for future research in this field.
5) The proposed method aims to alleviate traffic congestion by adjusting traffic signal timings based on traffic density. Using an IoT platform, the system communicates with traffic signal management, and the controller modifies the signal timings accordingly. The research provides empirical evidence that the proposed approach improves traffic flow and reduces congestion. However, since the study primarily focuses on visual processing for traffic density assessment, emergency vehicle recognition and priority are not incorporated into the method.
6) The article proposes a sophisticated traffic control system to address the issue of traffic congestion. The system employs sensors, cameras, and IoT devices to collect traffic flow and road condition data, which is analysed in real-time to regulate traffic flow and dynamically adjust traffic signal timing. Furthermore, a mobile application is provided for users to obtain real-time traffic updates and modify their routes accordingly. The expected outcomes of the system include a reduction in traffic congestion, shorter commute times, and improved fuel efficiency.
7) In order to enhance the effectiveness and safety of vehicle traffic, a smart traffic management system based on IoT is being developed, consisting of sensors, a microprocessor, and a web-based program. The sensors gather data on traffic density, which is then processed by the microcontroller to determine the timing of traffic signals. Internet application users can obtain real-time traffic information through the system. The system's primary objective is to improve traffic flow by decreasing wait times at traffic signals and reducing accidents.
8) The proposed system aims to mitigate congestion and enhance traffic flow by utilising real-time traffic data from sensors and cameras. It includes a sensor network, cloud-based data processing and analysis, and an end-user mobile application. Machine learning algorithms are employed to predict traffic patterns and adjust traffic signals accordingly. The authors contend that their technology has the potential to reduce travel time and improve traffic flow, making it a promising solution for smart cities.
9) The system prioritises emergency vehicles by utilising RF sensors to detect them and activate the traffic light control system. A limited-scale implementation and testing of the system demonstrated its effectiveness in managing traffic for emergency vehicles. However, the research did not address the system's ability to scale to larger regions, which could pose a drawback.
10) The article suggests a density-based smart traffic system that utilises IoT for real-time data processing to alleviate traffic congestion. Ultrasonic sensors are employed to detect vehicle density on the road, and the data is transmitted to a central processing unit (CPU) for further analysis. A decision-making process is used by the CPU to determine the optimal traffic light timings and synchronises them with nearby signals. Furthermore, a web application is provided to offer users real-time traffic statistics.

III. LITERATURE TABLE

S.No	YEAR	DESCRIPTION	LIMITATION
1.	2017	The traffic signal's microcontroller transfers data to the preceding signal to enable users to choose a diversion route instinctively. A "fourth light" is required to indicate the stopped route's direction at each traffic signal.	• The usage of pressure tubes causes roadblocks. • Ultrasonic technology raises the cost of installation.

2.	2018	The concept calls for the use of technologies such as the Raspberry Pi, Node MCU, RFID Tag, and Reader to allow traffic signals to interact with emergency vehicles and adjust signal timing accordingly.	• Lua is slower than C • MQTT has a security problem.
3.	2018	Microcontrollers, CPUs, sensors, GPS, GSM, RF, and IoT principles were used to build the system. Its major function is to alleviate traffic congestion.GPS is used since it is simple to set up and does not require any input from the driver.	• High cost • Acoustic system delay is more • GPS is inaccurate in the range of 75 m to 100 m
4.	2020	The model is primarily based on technologies that may use GPS coordinates of emergency vehicles and institutions to which the automobile is headed to clear the highways of traffic.	• GIS is very expensive • It will cause additional congestion on other paths, it will be time consuming.
5.	2019	The recommended technique would be built on calculating real traffic density along the route. For this, real-time video and image processing tools would be employed.	• Obstruction caused by fog or mist Classification and segmentation are challenging tasks.
6.	2018	The suggested system uses a hybrid method to maximise traffic circulation on the roadways, and software is developed to manage diverse traffic circumstances efficiently.	• The testing range of ultrasonic sensors is limited. • Surveillance Fog or mist might obscure the camera.
7.	2021	The technique tackles earlier obstacles in traffic management by extracting sensor data and traffic density from cameras using digital image processing technology, resulting in signal data and number plate identification.	• Cloud data is readily manipulable.
8.	2015	This study proposes IoT-based traffic management systems for smart cities, allowing on-site traffic officials to control traffic dynamically using their mobile phones or monitor it remotely and govern it via the internet.	• Due to the participation of authorities, a quick conclusion is not feasible.
9.	2019	The intelligent traffic control system for emergency vehicles prototype employs RF with normal and emergency sequencing modes. In an emergency, sends an override signal to disrupt traffic flow.	• Multiple receiving might lead to interference. • The ASK approach is ineffective.
10.	2018	This system, which runs on Raspberry Pi, employs Ultrasound Sensors and Image Processing via a live camera feed. It calculates vehicle density and sets dynamic traffic schedules.	• The inductive loop must be reinstalled. • False detection as a result of multipath propagation.

IV. PROPOSED SYSTEM

Here, we describe a ground-breaking IoT-based method for automated traffic signal monitoring that fully automates the operation of the traffic light system. The proposed system operates normally in normal traffic, but if the volume of traffic reaches a certain threshold, it can efficiently control the density of traffic signals by using an Arduino-based circuit system that uses infrared (IR) sensors to detect the volume of traffic on a particular lane. The effective management of traffic conditions on the highways is made possible by this sophisticated traffic control system, which shows the present traffic density.When emergency vehicles or other high-priority vehicles pass by, the suggested system may also change the timings of the traffic lights in real-time, making them green while maintaining the other signals red.RFID tags and a receiver work together to enable this capability.To maintain smooth traffic flow, the system uses a powerful control algorithm that can analyse the traffic density data gathered by the IR sensors and modify the traffic lights as necessary. The system connects to other city traffic light systems using IoT technology, providing effective traffic control over the whole road network.

The block diagram for the internet of things traffic management system we provide is shown below.

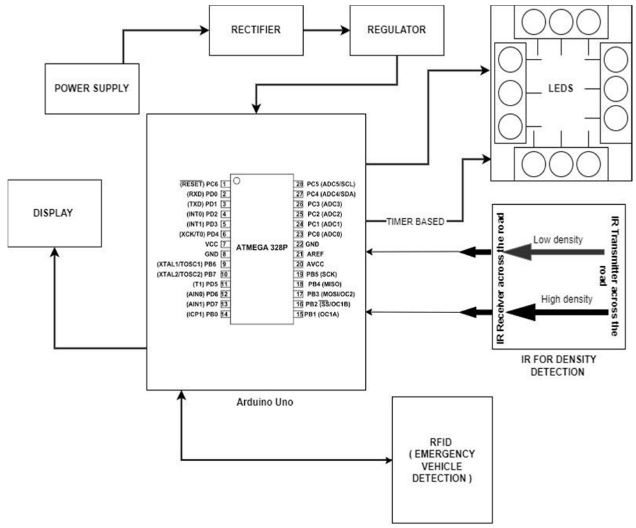

Figure 1: Block Diagram

V. MATERIALS USED

A. *Atmega 328 Microcontroller.*

It is the most crucial element since it acts as the central nervous system for all other elements. The micro-controller's components are turned on by the power source. A microcontroller board called the Arduino Uno is based on the ATmega328. It has 6 analogue inputs, a ceramic resonator running at 16 MHz, 14 digital input/output pins, a USB connection, a power jack, an ICSP header, and a reset button. The microcontroller is connected to every component, including the power supply, sensors, speech recognition module, relays, dc motors, buzzer, and others.

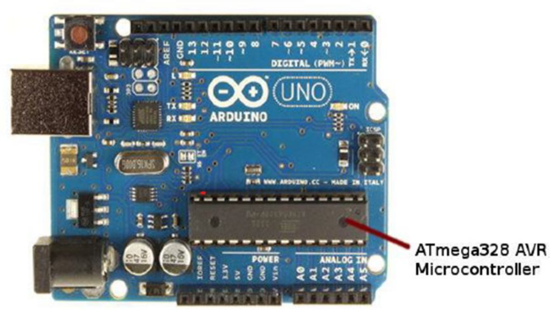

Figure 2: ATmega 328 microcontroller

B. *IR Sensors*

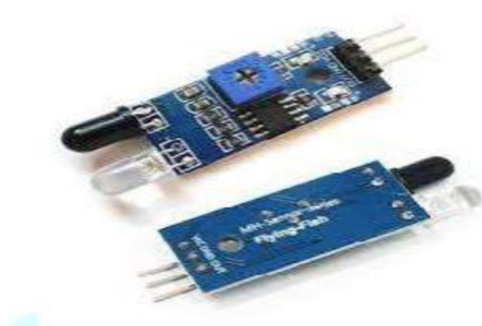

Figure 3: IR Sensor

An electrical device called an IR (infrared) sensor can be used to perceive certain aspects of its environment by either generating or detecting radiation. It can also gauge an object's temperature and spot movement. It detects items in front of them by using infrared light to map or estimate their distance.

C. EM-18 RFID

Figure 4: EM-18 Reader Module

Radio waves are used by Radio frequency identifying, often known as RFID, a wireless identifying technology, to detect the presence of RFID tags.RFID technology is used to identify the presence of persons, things, etc., just like a barcode reader.

RFID based system has two basic elements

1) *RFID Tag:* An RFID tag consists of a radio-frequency microchip placed on a substrate that has a 12-byte unique identification number.
2) *RFID Reader:* To read distinctive IDs from RFID tags, use an RFID reader. The RFID reader detects each RFID tag's unique ID as soon as it is within range and sends it serially to the microcontroller or PC.
3) *EM18 RFID Reader:* EM18 is a RFID reader which is used to read RFID tags of frequency 125 kHz.

After reading tags, it sends a serial unique ID to the PC or microcontroller using Wiegand format or UART connection on the appropriate pins.

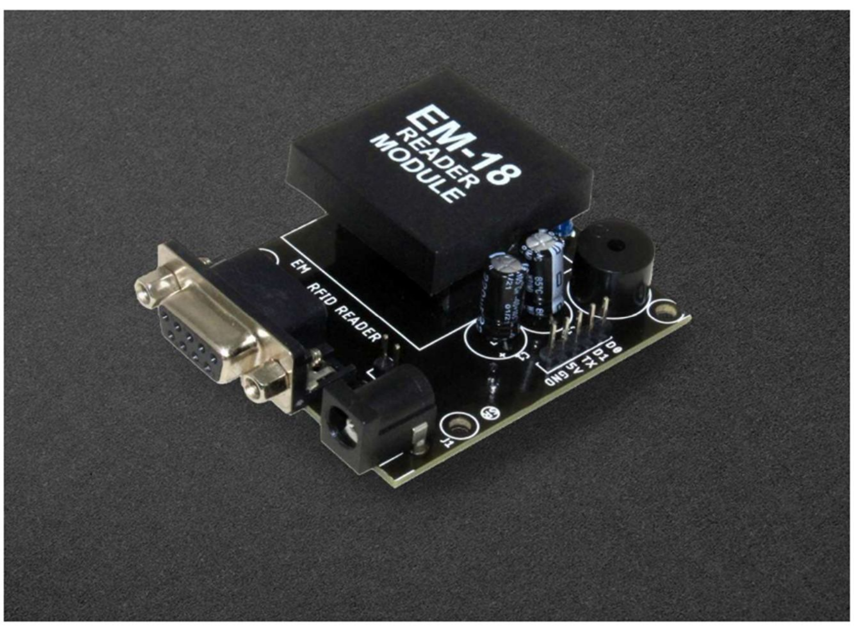

Figure 5: EM-18 RFID

EM18 RFID reader reads the data from RFID tags which contains stored ID which is of 12 bytes.

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D. Buzzer

A buzzer is an electronic device that produces a buzzing or beeping sound. It is typically used as an audible alert or warning signal in electronic devices such as alarms, timers, and electronic games. Buzzer circuits typically consist of a small electromechanical component, such as a magnetic coil or piezoelectric crystal, which vibrates to produce sound when an electrical signal is applied. The sound produced by a buzzer can vary depending on the specific circuit design and the application, but is typically a loud and distinctive tone that is easily recognizable. Buzzers can also be used in musical instruments and sound effects generators to produce specific tones or effects.

Figure 6: Buzzer

E. OLED Display

Figure 7: OLED Display

OLED stands for Organic Light Emitting Diode. It is a type of display technology used in electronic devices such as smartphones, televisions, and computer monitors. Unlike traditional LED displays, OLED displays do not require a backlight to produce images, as each pixel is self-emitting. This allows for deeper blacks, higher contrast ratios, and wider viewing angles compared to other display technologies. OLED displays also tend to have better energy efficiency, as they consume less power when displaying dark or black images. However, OLED displays can be more expensive to produce than other display technologies, and can suffer from issues such as burn-in and image retention.

F. Power Module

Figure 8: Power Module

Linear regulators are simple and easy to use, but they are not very efficient, and they generate a lot of heat, especially if the input voltage is significantly higher than the output voltage.

When choosing a power module for an IoT project, make sure to consider your power requirements, power source, and any size or weight constraints. It's also important to choose a reliable and reputable supplier for your power module to ensure the safety and reliability of your IoT project.

VI. IMPLEMENTATION

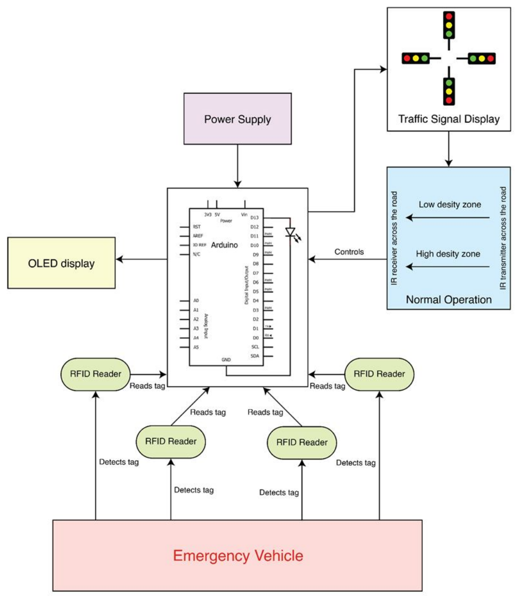

Figure 9: Overall System Architecture

A. Timer-Based Technique

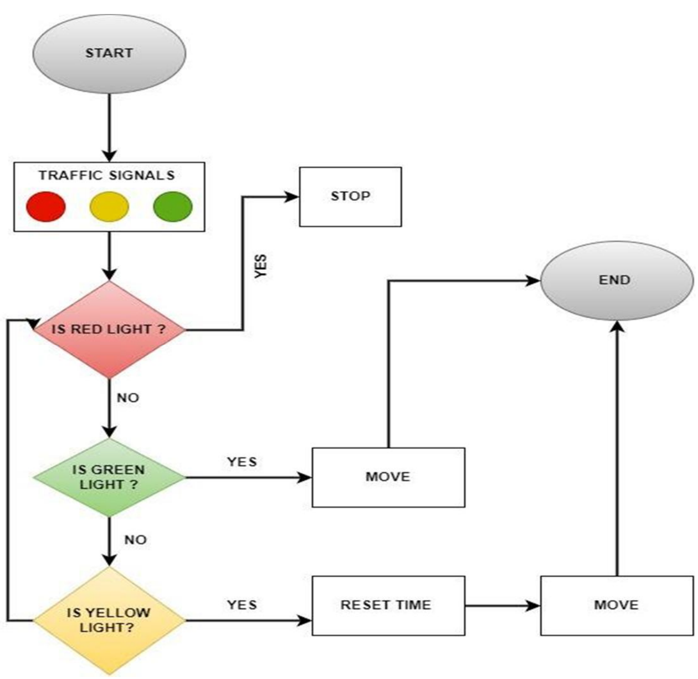

Figure 10: Flow Chart of Timer-Based technique

The timer-based traffic approach is a cutting-edge method of traffic control that is commonly used in many contemporary cities all over the world. In this method, traffic lights are timed according to a signal system, ensuring that cars may cross intersections in a coordinated manner. The timer-based traffic approach aids in ensuring a smooth and effective flow of traffic by regulating the timing and sequence of traffic lights. This in turn may contribute to lessening traffic congestion, enhancing traffic flow, and improving road safety.

The timer-based traffic control method's capacity to lower the chance of accidents is one of its main advantages. This strategy reduces confusion and avoids collisions at junctions by giving drivers clear directions on when to stop and go. Additionally, by ensuring that traffic passes intersections in an orderly and effective manner, this technique aids in maximising the utilisation of road space.

B. IR Sensors

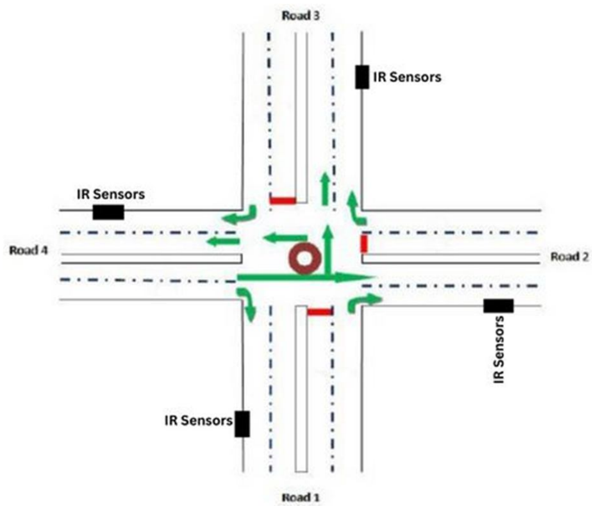

Figure 11: IR Sensors placed on road

The manner that transport authorities control traffic on roads and highways has been completely transformed by the introduction of IR sensors in traffic management systems. These sensors are able to determine the presence of cars on the road and the volume of traffic in particular lanes or regions of the road. In order to change traffic signals and flow patterns, particularly in locations with larger traffic densities, transportation authorities can use the important data that IR sensors give by tracking traffic flow in real-time.

Traffic management systems can modify traffic signals and flow patterns utilising this information to improve traffic flow and lessen congestion. For instance, if an IR sensor notices a large number of cars in one lane or area of the road, the traffic management system may give that lane precedence or change the timing of the signal to let more vehicles pass. Similar to this, the traffic management system can take proactive steps to redirect traffic or change signal timing to ease congestion if an IR sensor detects a potential hotspot for congestion.

C. RFID Technique

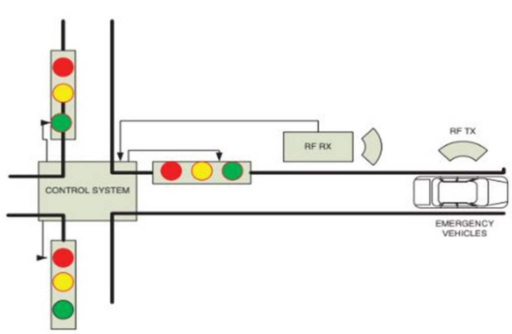

Figure 12: RFID Technique

Modern traffic control systems now frequently include the usage of RFID tags on emergency vehicles. These tags can be attached to the cars directly or integrated into already installed communication devices like radios or GPS systems. When an emergency vehicle with an RFID tag approaches a traffic light, the system instantly recognises the tag and may change the traffic signal to allow the vehicle to safely and quickly pass through the junction.

It is obvious how useful RFID technology is in emergency circumstances. The technology can assist to minimise delays in emergency response times, potentially saving lives by lowering the length of time that emergency vehicles must wait at traffic signals. Because emergency vehicles are given preference over other cars in traffic flow, the adoption of RFID tags can also serve to lower the probability of accidents involving these vehicles.

The application of RFID technology in traffic management systems can help the general flow of traffic in addition as reducing the response times for emergency vehicles. RFID technology can assist to enhance traffic flow and shorten travel times for all cars on the road by decreasing congestion and delays brought on by emergency circumstances.

VII. CONCLUSION

In conclusion, this project represents a major effort to create a more effective and efficient traffic management system. The project has focused on several key objectives, including reducing congestion and improving safety, reducing emergency vehicle response times, saving time at traffic junctions, reducing pollution, enabling timely organ transportation, and providing real-time adjustments to traffic light patterns. By incorporating these features, the system has the potential to improve traffic flow, enhance road safety, and reduce pollution levels, ultimately resulting in a better quality of life for citizens. The project is a significant step forward in the development of intelligent traffic management systems, with the potential to make a substantial impact on traffic management in urban areas. The outcomes of this project will contribute towards making the roads safer and more efficient, ensuring that traffic moves smoothly, reducing travel times, and improving overall traffic flow.

VIII. ACKNOWLEDGEMENT

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