Smart Traffic Management System

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by

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CERTIFICATE

This is to certify that the project work entitled **"Smart Traffic Management System"** is carried out by

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students of **2nd Semester**, MCA, Ramaiah Institute of Technology, Bangalore, in partial fulfilment of the course **MCAE15, Programming IoT**, during the year 2022- 2023.

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ABSTRACT

This project explores the advancement of Smart Traffic Management System using the Internet of Things (IoT). It works as middleware on the foundation of the IoT and augments the idea of the smart city through the traffic light control, congestion control, and emergency vehicle detection. The main objective of this project is to design an adaptive traffic light signals using IR sensors and to design an effective method to overcome the ambulance delay problem by using the RF modules. Traffic light controlling becomes major issue with increase in automobiles which causes congestion and it also became a major reason for the ambulance delay. This requires a smart system to handle traffic signals and to reduce ambulance delay. Using this system development at traffic junction we need not to worry about handing the traffic manually and also consumes less time as compared to the conventional traffic system. It also reduces the ambulance delay time.

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1. INTRODUCTION

One of the biggest issues in major cities around the world is urban traffic congestion. Along with the amount of time spent in traffic, there is also the issue of carbon dioxide emissions. The longer vehicles are stuck in traffic, the longer their engines are left running at idle. Due to traffic jams in large cities, emergency vehicles like ambulances and fire trucks are also affected. As a result, many people could lose their life as a result of an ambulance delay. By resolving this problem, we not only improve the quality of life for city people but also have a positive impact on the environment.

When there are more vehicles in a lane at a junction than rest of the other lanes, then the green traffic light time is increased for that lane compared to others and red for the other sides until the other lanes are clear. Which would improve traveller comfort and driving safety while also facilitating efficient traffic flow. The traffic light system has also been given an emergency mode, which gives ambulances priority to pass through traffic lights so they can get to patients and hospitals without incident.

A smart traffic management system utilizing sensor data, communication and automated algorithms is to be developed to keep traffic flowing more smoothly. The aim is to optimally control the duration of green or red light for a specific traffic light at an intersection. The traffic signals should not flash the same stretch of green or red all the time, but should depend on the number of cars present. When traffic is heavy in one direction, the green lights should stay on longer. Due to traffic jams in large cities, emergency vehicles like ambulances are also affected, as a result many people could lose their life. The traffic light system has also been given an emergency mode, which gives ambulances priority to pass through traffic lights.

This system is being smart because it can run automatically. Without human intervention using timer circuits designed using Arduino board or can be turned to allow human intervention at certain circumstances using remote control. Arduino board designs use variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits.

1.1 Overview

The traffic management system of a metropolitan city is a keystone for urban mobility. With the rise of the population, the demand for vehicles grows up and hence the requirement of transportation has also increased. Infrastructural development becomes an indispensable part of complementing the population growth to augment urban mobility. But the traditional traffic management system is shown not only ineffective for accompanying the increased number of vehicles with the use of police control and traffic light system but also incompetent enough to handle this growth of traffic on road systems. This traffic congestion consequentially consumes precious working time for being incapable of handling extensive traffic congestion and eventually leads to the environmental pollution for an extended period of vehicle emission. Adequate pre-measures and proper planning can help to reduce the number of traffic problems and manage an increased number of vehicles on the road.

Traffic system utilize the concept of automation with IoT is called as “Smart Traffic”. Smart Traffic Management System is an advanced and integrated solution designed to optimize traffic flow, reduce congestion, enhance road safety, and improve overall transportation efficiency within urban or metropolitan areas.

- This system relies on various sensors placed strategically throughout the road network to monitor traffic conditions
- The system can control traffic signals at intersections dynamically based on real-time traffic data.
- Adaptive traffic signal systems adjust signal timings to minimize waiting times and reduce idling
- Reducing congestion and energy consumption at intersection.
- Ensuring immediate clearance for emergency vehicles. Facilitating safer and shorter commute time.
- The traffic light system has also been given an emergency mode, which gives ambulances priority to pass through traffic lights.

1.2 Existing System

There is a continuous increment in the traffic demand and with a high rate of urbanization, there is an extra load on current infrastructure in terms of managing the road transportation. Traffic jam turns out to be key crisis in these days. Traffic jam mainly occurs in urban areas. Due to traffic jam, there are several problems arise such as increase in noise pollution, air pollution and delay in travel time etc. Nowadays congestion in traffic is a serious issue. Malfunctioning of the traffic lights and various other dysfunctionalities has led to traffic congestion which hurts the economy, environment, and overall quality of life. The traffic congestion can also be caused by large red-light delays. With the boom in the built environment leads to the shortage of habitable shape in work surrounding and people have to move out for buying their budget home. This new trend is also putting extra pressure on the infrastructure because they have to come to the city for their jobs and go back home in the evening. Lack of sufficient and sustainable public transportation also one of the major and significant catalysts for traffic congestion. A majority of the people using private or own vehicle for their office, outing, dining, and other activities. Due to the ever-increasing traffic demand, modern societies with well-planned road management systems, and sufficient infrastructures for transportation still face the problem of traffic congestion. Traffic congestion results into loss of productive time, loss of fossil fuels, adds to the high level of pollutions and economic losses. The present traffic signals deployed in all parts of the cities are not enough to solve above mentioned problems because these have specific pre-determined time for red and green signals. In this view various attempts were done for traffic lights to behave smartly based on density of vehicles on the road. Therefore, many techniques have been used in traffic control systems.

India, a nation with over 1.3 billion people, is known for its diverse culture, rich heritage, and bustling cities. However, it also grapples with the significant challenge of managing traffic on its roads. With rapid urbanization and a rising number of vehicles, traffic congestion, and air pollution have become pressing issues.

1.3 Proposed System

A prototype is proposed for a traffic management system using Ultrasonic sensors, Arduino, and LED displays. The density of the traffic is measured by placing the Ultrasonic sensors (HC-SR04) at the 4-lane junction after a certain distance. The data collected from sensors is used to dynamically change the sequence of green lights as well as to dynamically change the green light delays. The proposed road traffic management system is implemented in the proteus software. For high traffic zone, a higher green light delay is given whereas for low density zone, the duration of the green light delay is reduced. The system is also designed in such a way as to give preference to the lanes which have no vehicles/very few vehicles by providing the least green light delays.

Also there will be radio frequency reader on roadside to read the radio frequency tag on an ambulance or fire-extinguisher truck and immediately open the barricade irrespective of what the signal is for that road. Red LED indicates CLOSED and green LED indicates OPEN. Arduino board and radio frequency reader placed on roadside will be used for this purpose. This reader will read and scan the radio frequency tag placed on the emergency service vehicles and signal the Arduino board to halt its normal operation and open the right lane barricade so that the intended emergency vehicle can pass the road junction. This will also reduce the number of accidents occurring due to violation of traffic rules by passing the road junction during the stop signal.

For implementation, we are using Arduino-Mega and RFID technology. The system has the ability to open a complete lane for such emergency cases. As a result, the system will guarantee the fluency of traffic for the main vital streets and paths that require fluent traffic during peak hours of the day and the traffic density. This system is being smart because it can run automatically. Without human intervention using timer circuits designed using Arduino board or can be turned to allow human intervention at certain circumstances using remote control.

2. LITERATURE SURVEY

- **Traffic Management System using IoT**

  Sanjay Kumar Sahu, Atul Basant, Taman Vasudev, Kusagra Khati, Nikhil Lawrence

  Working on the basis of IoT and its embedded network and it is taking real time data as the input to track the traffic management system and giving output in terms of time assigned to traffic lights on the basis of density.

- **A Review of IoT Application in a Smart Traffic Management System**

  Md Khurram Monir Rabby, Muhammad Mobaidul Islam and Salman Monowar Imon (2019).

  This research presents an IoT-based control system uses real-time traffic information for controlling the traffic loads by changing the traffic signals. The mounted sensors and cameras at strategic traffic junction collect vehicle density of the roads and divert the vehicle direction by changing the traffic signals frequently.

- **Smart Traffic Control using Arduino UNO and RF module.**

  Syed Arshad Basha, Deep Rakesh, Chirag, Mahesh, Prof. Satish Kumar

  It is developed with integration of all hardware components Utilizing an IR sensor and RF technology, to effectively reduce the delay time for emergency vehicles.

- **Smart Traffic Management System Using Arduino and RFID Tags**

  Harshal Gunda, Rishikesh Waghunde, Suraj Malwatkar, Aditya Desai, Pallavi Baviskar, (2018).

Using this system, there will be fewer chances for disobeying of traffic rules and number of accidents. Also, time delay for vehicles of emergency services to reach their destination will be less.

- **IoT based Dynamic Road Traffic Management System**

  Pendurthy Bhavana, Pediredla Likhitha, Chiluvuri Manoj, Lakshmi Sutha (2022).

  In this paper, road traffic management system is designed using the IR sensors, Arduino Uno, 74HC595 and traffic lights. The system is simulated in the Proteus software. The sequence and duration of the GREEN signal is varied based on the density of the roads which is measured with the help of 4 IR sensors.

- **Smart Traffic Congestion model in IoT**

  K. Ramesh, A Lakshna, and P. N. Renjith (2020).

  To minimize the traffic congestion in a certain area by diverting or redirecting the upcoming vehicles into the shortest path or alternate path. To predict and prevent the traffic in smart cities, Sensor-based techniques are started using normal traffic cameras in which IoT plays an important role. Some other techniques using signals from vehicles through Wi-Fi, Bluetooth, Zigbee from the smart devices used in vehicles and data used to analyze the traffic pattern by vehicle count.

- **Traffic Management System Using IoT**

  Omid Avatefipour, Student Member, IEEE, Froogh Sadry, Student Member, IEEE Electrical and Computer Engineering Department, University of Michigan – Dearborn.

  In this paper, several intelligent traffic management systems were reviewed. These included utilization of RFID readers and tags, Green Wave Systems, smart phones and wireless communication with Big Data centre. Applications, pros and cons of each method were discussed and summarized briefly in Tables 1 and 2. The technique of IoT has been used in order to gather data which related to traffic congestion more quickly and more accurately.

- **Intelligent Traffic Monitoring System (ITMS) for Smart City based on IoT Monitoring**

  Arman Syah Putra, Bina Nusantara university and Harco Leslie Hendric Spits Warnar, BINUS Graduate Program - Doctor of Computer Science

  In this paper, with intelligent monitoring, many help the government and officers work, with proper tracking the community can measure the distance travelled so that they can arrive quickly at the destination, and reduce accident in the road. The proposed Internet of Thing (IoT) monitoring which applied such as motion sensor monitoring, ultrasonic sensor monitoring, Passive Infra-Red (PIR) sensor monitoring and speed sensor monitoring.

- **An Internet of Things (IoT) based Smart Traffic Management System**

  Abdul Kadar Muhammad Masum, Md. Kalim Amzad Chy, Iaamanur Rahman, Mohammad Nazim Uddin, Khairul Islam Azam

  This paper proposed a smart TMS to control traffic situation more effectively and efficiently. By analysing sensor data, it sets traffic signal time dynamically and sends the data to a cloud server through a Wi-Fi module that is stored for further data analytics. It also deals with emergency vehicles.

3. REQUIREMENT SPECIFICATION

3.1 Hardware Requirements

- Arduino MEGA
- Ultrasonic Sensors
- RFID Module
- Traffic LEDs

3.2 Software Requirements

- Arduino IDE

4. DESIGN MODEL/ SYSTEM ARCHITECTURE

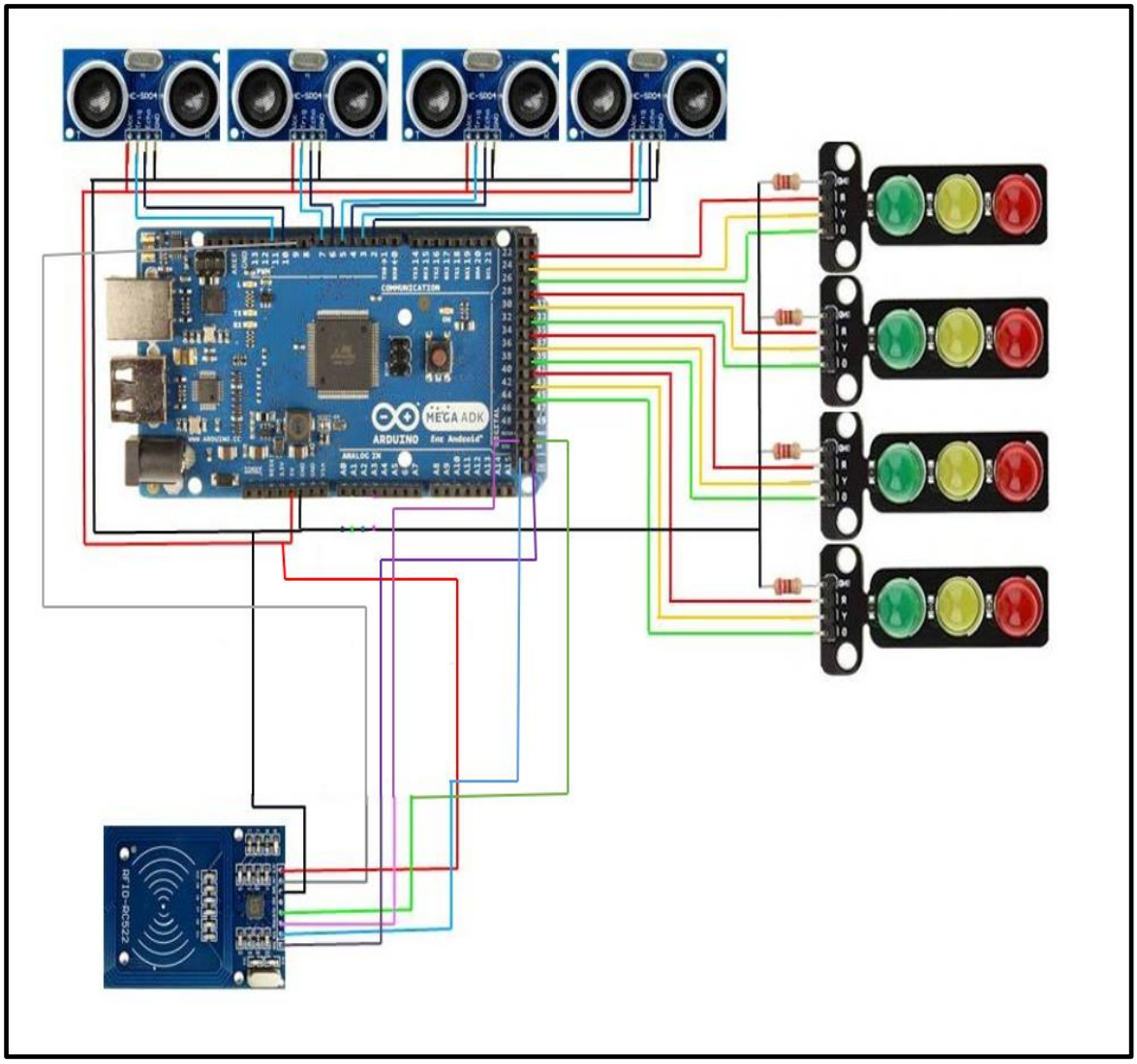

Figure 1: Circuit Diagram

As shown in the Figure 1, The system is designed and simulated using Arduino IDE and Arduino Mega as the controller. The ultrasonic sensors of four directions are connected to (11,10), (7,6), (9,8), (3,2) pins of Arduino. And 4 traffic lights are connected to (23,25,27), (29,31,33), (35,37,39) and (41,43,45) pins of Arduino. The RFID RC522 is connected to (5,53) pins of Arduino Mega. And one LED connected to pin 49 of Arduino.

5. IMPLEMENTATION

Pseudo Code:

Included libraries: TimerOne, SPI, and MFRC522.

Define arrays for signal pins and other variables.
Define constants for red and yellow light delays.
Define variables for trigger and echo pins for the ultrasonic sensors.

Initialize the MFRC522 RFID module.

Setup function:
- Initialize serial communication.
- Initialize the Timer1 for interrupt.
- Set LED and sensor pins as input/output.
- Start SPI and initialize the MFRC522 module.
- Print a message to the serial monitor.

Loop function:
- Check the distance of ultrasonic sensors and control traffic lights based on vehicle presence.
- Call the RFID function to check for authorized cards.
- Repeat for different signals.

Interrupt function (softInterr):
- Measure distances from four ultrasonic sensors.
- Calculate the distance and store it in respective variables.

Functions to control traffic lights for different signals (signal1Function, signal2Function, signal3Function, signal4Function):
- Control the traffic lights based on vehicle presence and the state of other signals.
- Call the RFID function when needed.

Functions for special signal cases (signal01Function, signal02Function, signal03Function, signal04Function):
- Implement special cases for signals, e.g., traffic light changes and RFID card checking.
- Call the RFID function as needed.

Signal function:
- Handle emergency vehicle detection and change traffic light states accordingly.

Function to turn off all LEDs except red ones (low):
- Turn off all LEDs except the red ones for all signals.

RFID function:
- Check for a new RFID card.
- Read the card's UID.
- Compare the UID with authorized cards.
- If authorized, change the state of specific pins and call the signal function.

Below figure shows the basic layout of a road traffic management system. The four-lane intersection junction is taken, traffic lights, and Ultrasonic sensors are placed on the four sides.

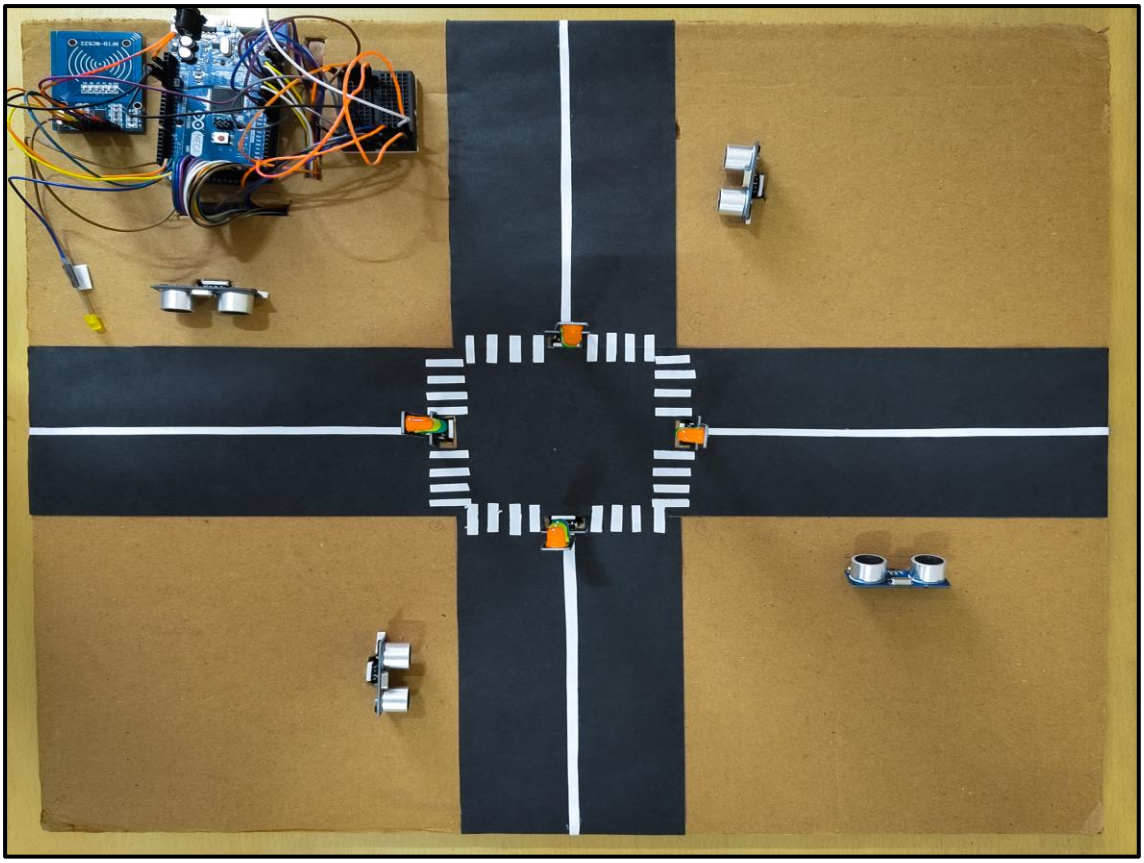

Figure 2: Four-lane intersection junction

As shown in the figure 2. The system is designed and simulated using Arduino IDE and Arduino Mega as the controller. The ultrasonic sensors of four directions are connected to (11,10), (7,6), (9,8), (3,2) pins of Arduino. And 4 traffic lights are connected to (23,25,27), (29,31,33), (35,37,39) and (41,43,45) pins of Arduino. The RFID RC522 is connected to (5,53) pins of Arduino. And one LED connected to pin 49 of Arduino.

5.1 Normal Cycle

There are RED, YELLOW, and GREEN LED's. For each of the colour, a mask pattern is present. Every time, Arduino takes traffic data as input, it decides which road should get which colour. Initially the 1st lane will have GREEN LED High and for all other lanes it will be having RED LED High. After delay of 15 seconds the YELLOW LED of 2nd lane will be High and other all lane's RED LED will be High after delay of 5 seconds GREEN LED of 2nd lane will be High for 15 seconds. After

15 seconds the same cycle continues for 3rd lane then 4th lane and again for the 1st lane and so on.

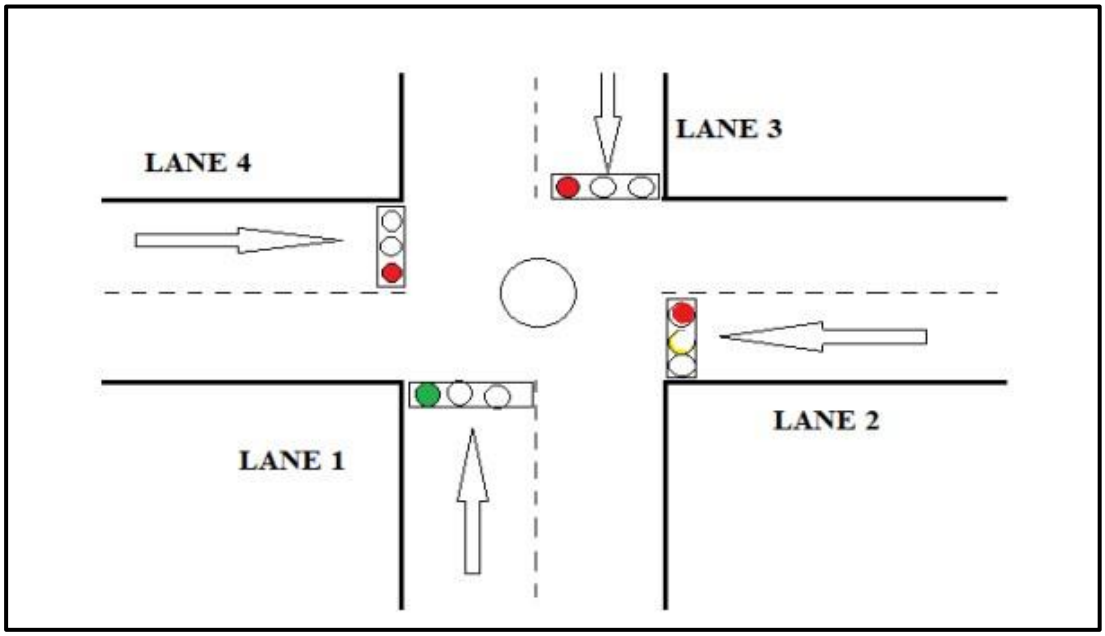

Figure 3: Normal cycle

5.2 Density based Traffic Management with Dynamic green signal timing

The ultrasonic sensors are kept at some distance from the junction which collects the data and are used to detect the density of the traffic in a particular lane. If traffic extends up to that point, that road is considered as a high traffic zone, otherwise it is considered as a low traffic zone. If any data comes from Ultrasonic sensor of any road, it means traffic is more on that road. So, green signal is given to the road having high density rather than following the normal sequence as before.

While running a normal cycle if there are more vehicles in any lane then the lane opposite to lane with more vehicles green light will be High in order to control congestion. Consider a senior if the GREEN LED for 4th lane is High and there is more traffic density on the 1st lane. According to the normal cycle the 1st lane GREEN signal will be on but

now due to high density on lane 1, the GREEN LED of 4th lane will be HIGH so that congestion on lane one will be cleared and then the normal cycle will work as before.

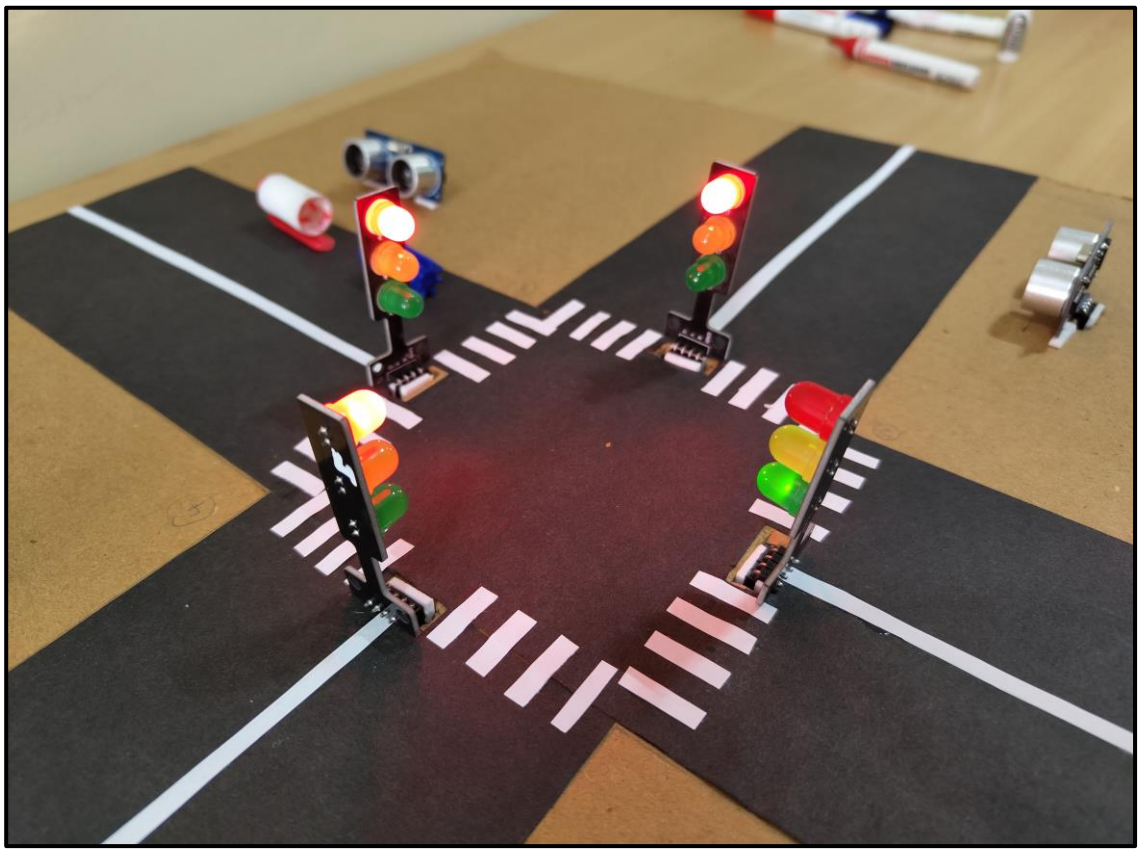

Figure 4: Density based traffic management

5.3 Emergency Vehicle Detection

The RFID tags are used to detect emergency vehicles like ambulance. When there is an Ambulance in lane, immediately the Green signal for Ambulance will be given so that Ambulance can be moved without interruption so patients can be reached to hospital as soon as possible. When there is Ambulance in lane 1 and yellow signal for lane 2 is High and after 5 sec delay the green signal for lane 2 has to be high but due to detection of ambulance on lane 1 the green signal for lane 3 will be high and for all other lane's red signal will be High. When the ambulance moves the normal cycle will continue, in this case 2 lane's green signal will be high.

6. RESULT DISCUSSION

In Normal mode, the system's entire operation depends on an on-chip microcontroller that is programmed to control traffic signals at set, predetermined intervals of time and based on the traffic density. As a result, signals are altered in various ways at various time intervals based on predefined time intervals. Similar to this, each central traffic control system is configured with unique functions and operating principles in response to the level of traffic congestion, Ultrasonic sensors based real-time traffic monitoring system can measure traffic density at roads. The smart traffic management system will give output on the basis of density of the traffic lanes so there will be particular time assigned to the lanes for the passing of vehicles so it will lower down the traffic congestion and also in the case of emergency there will be option for that to continue the traffic in normal way. And whenever it detects emergency vehicle, the traffic light of corresponding lane at intersection turns green and other all lane will become red so that emergency vehicle can move without any interruption.

The system helps in better time-based monitoring and thus has certain advantages over the existing system like minimizing number of accidents, reducing fuel cost and is remotely controllable etc. The system will be designed in such a way that it will able to control the traffic congestion. And it can also be maintained very easily.

7. CONCLUSION AND SCOPE OF FUTURE ENHANCEMENT

Smart Traffic Management System has been developed by using multiple features of hardware components in IoT. Traffic optimization is achieved using IoT platform for efficient utilizing allocating varying time to all traffic signal according to available vehicles count in road path. Smart Traffic Management System is implemented to deal efficiently with problem of congestion.

This project presents an effective solution for rapid growth of traffic flow particularly in big cities which is increasing day by day and traditional systems have some limitations as they fail to manage current traffic effectively. Keeping in view the state-of-the-art approach for traffic management systems, a smart traffic management system is proposed to control road traffic situations more efficiently and effectively. It changes the signal timing intelligently according to traffic density on the particular roadside and regulates traffic flow. This project also makes sure that emergency vehicle like ambulance will not suffer from any interruption due to traffic signal so that ambulance can reach hospital as soon as possible.

Scope of Future Enhancement:

For this system we can implement the features which help the Ambulance driver to find the nearest hospital in case of emergency. Also, we can provide information about the availability of doctors and send the alert to doctors about the patient so that they can prepare accordingly. By implementing camera module, we can detect the normal cars which are under emergency. And also detect VIP vehicles so that they can move with zero traffic.

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