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IOT Based Smart Traffic Management System

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Abstract: One of the significant challenges faced by major cities today is traffic management. The possible reason for this can be the increasing number of vehicles, lack of proper infrastructures, improper roads, growing population etc. Increased accidents and pollution levels have been observed as the most common problems in major cities. All this gives rise to the need of IOT based Traffic control system which continuously detects, monitors, and adjusts traffic signal timings according to traffic load. This paper describes methods for controlling and monitoring traffic.
Keywords: Smart Traffic management, Traffic Congestion, Internet of Things, Ultrasonic Sensors, Traffic sensors, Traffic Density, Intelligent Signals.

I. INTRODUCTION

Today, Traffic Congestion in modern cities is a serious issue. Traffic congestion occurs due to the number of vehicles exceeding the road capacity. Traffic Jams, accidents and increased pollution levels have been observed as the most common problems in major cities. Well-Organized traffic management may result in a convenient flow of traffic and may reduce congestions. The existing method of traffic system is outdated in which signals are allotted with specific predetermined timings. Each lanes are allotted Signals with fixed time and the signals switches automatically depending on these fixed timer values. This traditional method is not sufficient enough to meet the requirements of a growing traffic related problems. All this gives rise to the need of IOT based Traffic control system which continuously detects, monitors, and traffic signal timings according to traffic load.[1] [2] On the Other Hand, It has been observed that Emergency vehicles are stuck at lanes due to heavy traffic due to scheduled traffic signal, Which in turn results in delay for the emergency vehicles to move . Emergency vehicles needs to be prioritized before any other vehicles. Delayed arrival of emergency vehicles to destination may cause a problem. So, the lane through which emergency vehicles will be approaching can be made free by halting the traffic light for vehicles in other lanes. This may minimize the delays and help during emergency situations.[3] The implementation of Internet of Things is a far better alternative Solution in solving the congestion issues that many urban areas are facing today. With the popularity of the internet, cities can be more developed to resolve traffic related problems. With the help of Internet of things, the updated system may help resolve many challenges related to traffic daily by predicting the minimum route the vehicles can take, reducing the waiting time, less congestion, reducing travel cost, eliminating the need of Traffic Police., etc. So in order to get rid of all these problems, there becomes a need to implement newer schemes by using sensor based automation technology in the field of existing traffic signaling systems. [4]

II. LITERATURE REVIEW

The literature review consists of six different proposals for smart traffic management systems, each providing particular procedures to address congestion, optimize visitors flow, and enhance overall performance.

Shashank S has used Camera Module as his primary element and has calculated the traffic congestion based on time. He uses camera data and algorithms to dynamically set the traffic signal timings. Using this method traffic optimization can be achieved.

Priyanka Sharma uses PLC & weight-based sensors as her primary element. The Vehicles of the lane whose weight data will be higher as compared to other lanes, will be made pass through. This method aims to reduce traffic by half. Other than traffic data it can also help detecting overloaded vehicles which will protect road infrastructure and increase safety.

Mr.Ninad Lanke uses RFID as his primary element. An RFID tag will be attached to every vehicle. As a result, each time a car passes a light, the signal will automatically count the number of vehicles that pass by it, helping to identify when there is a traffic jam. Now, based on the frequency of the vehicles passing by the signal once every second, the timer can be dynamically changed.

R Srinivasan uses Image Processing to calculate traffic congestion of different lanes. It is a real time monitoring system and gives quick solutions, but it is a resource intensive methodology and thus is not cost-efficient.

Mr. Abubakar Muhammad who uses a Client-Server Communication based model to calculate the traffic of each lane and compare it. The algorithm used by the system SPF. It makes a calculated decision about whether or not to let the vehicle pass based on various data such as position, speed, etc. This method helps to reduce the waiting time of the vehicles.

Harsha J proposes a sensor-based system utilizing ultrasound sensors and image processing on Raspberry Pi to dynamically allocate signal timings based on vehicle density, reducing waiting times and optimizing traffic management

These distinct ideas demonstrate the nature of smart traffic management systems by providing insights into different approaches and technologies to deal with issues related to urban mobility. All of these methods—from camera-based image processing to RFID tracking and PLC diversion systems—each approach presents innovative solutions to optimize traffic flow and enhance overall transportation efficiency. Thus, highlighting the potential benefits of integrating IoT devices, real-time data collection, and intelligent algorithms reduce commute times, and enhance overall road safety.

Table 1. Literature Survey

Sr. No	Name of author	Primary Element Used	Output/ Visualization	Advantages	Limitations
1.	Shashank S [5]	Camera (Time based method)	The system optimally controls the duration of green or red signal by comparing current signal time with expected calculated signal time with the help of algorithm and then switches the signal accordingly.	1) Traffic optimization is achieved. 2) Efficient utilization of timing to all traffic signal. 3) Real Time Monitoring of vehicles and traffic.	1) Shadow overlapping cannot be handled. 2) Cameras during night time surveillance may need proper street lighting. 3) Cameras may fail to capture images during heavy rain and fog
2.	PLC, Weight sensors (Weight based method)	PLC, Weight sensors (Weight based method)	The Vehicles of the lane whose weight data will be higher as compared to other lanes, will be made pass through. The weight data is checked whether it crosses the threshold value or not. If it is, then the signals will be switched accordingly .	1) Traffic monitoring by recording in motion traffic data including the pedestrians. 2) Other than traffic data it can also help detecting overloaded vehicles which will protect road infrastructure and increase safety.	1) Maintenance cost of sensors becomes high since it needs to be deployed in rugged external conditions. 2) Weighing method may lead to limited accuracy due to vehicles in motion. 3) This method can be suitable for vehicles in steady and slow speed, but in case of vehicles moving with fast speed it may fail.
3.	Ninand Lanke [7]	RFID (RFID Controller, RFID Tag)	An RFID tag will be attached to every vehicle .As a result, whenever a car passes a signal, the signal will automatically keep track of how many cars are passing by it and assist in the detection of traffic congestion.The timer can now be dynamically adjusted based on the frequency of the vehicles passing by the signal each second.	1) Dynamic management of the signal helps to cut down on time wasted. 2) By giving priority to a road with heavy vehicular traffic, this also aids in preventing traffic congestion. 3) This method assists in the early detection of traffic jams.	1) RFID systems are often more expensive than barcode systems. 2) Sometimes not as accurate or reliable as barcode scanners.

4.	R Srinivasan [8]	Image Processing	A common architect of traffic control will be incorporated by using image acquisition, preprocessing and densi ty calculation and efficient detection of moving objects.	1) It is a real time monitoring system and gives quick solutions. 2) It is the only method that can give us the visuals of the current traffic system	1) A long debugging time is required to acquire the same position before and after loading . 2) Acquired images may be blurred making it difficult to identify. 3) It is a resource intensive methodology and thus is not cost efficient.
5.	Abubakar Muhammad [9]	Client-server (Communication Based)	The algorithm used by the system SPF. It makes a calculated decision about whether or not to let the vehicle pass based on various data such as position, speed, etc.	1) Waiting time of the vehicles is reduced 2) Due to the less waiting time the fuel consumption of the vehicles is reduced 3) Due to the less	1) Every vehicle should be equipped with DBTL 2) Every vehicle needs to send its details to the intersection control system leading to
				waiting time the CO2 emission is also reduced	breach in privacy of that vehicle.
6.	Harsha J [10]	Data Analysis	This system uses ultrasonic sensor and image processing and it using raspberry pi to calculate the vehicle density and allots time based on the same	1) It measures the vehicle density and allots the signal countdown accordingly leading to less waiting time per vehicle 2) Provides accurate data for detection most of the time.	1) Less use of newer technology 2) Some sensor are sensitive to change in temperature leading to false detection of vehicle. 3) Can only be used for small areas.

III. COMPONENTS USED

A. *Hardware Components*

1) *Wifi Mega (Arduino Atmega 2560 +Esp8266)*

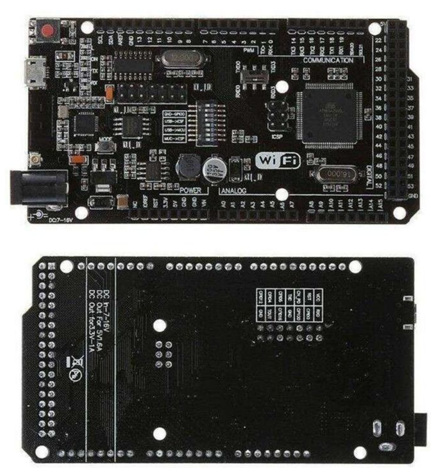

Figure 1 : Wifi Mega (Arduino Mega 2560 + ESP8266)

The Mega + WiFi R3 (Atmega2560 + NodeMCU ESP8266) development board serves as a central control hub, offering a comprehensive solution for electronics projects. With its powerful combination of the Atmega2560 microcontroller and NodeMCU ESP8266 module, it provides seamless integration of processing power and wireless connectivity. With 256KB of flash memory, 8KB of SRAM, and 4KB of EEPROM, it provides ample storage for program code, variables, and non-volatile data storage.Featuring 54 digital input/output pins, each capable of providing or receiving a digital signal, the Atmega2560 allows for extensive interfacing with external devices and peripherals. Additionally, it offers 16 analog inputs with a 10-bit resolution, enabling the board to read analog sensors and input devices accurately. The NodeMCU ESP8266 module seamlessly integrates Wi-Fi connectivity into the development board, enabling wireless communication with other devices and internet connectivity. The module includes a TCP/IP stack, allowing the board to establish TCP and UDP connections, making it suitable for IoT applications, web servers, and remote monitoring systems. The development board operates within a voltage range of 5V to 12V DC, making it compatible with a variety of power sources such as USB power adapters, battery packs, and external power supplies.
The development board features eight switches, These switches can be used for various purposes, such as mode selection, configuration settings, or user interaction in interactive projects.

2) Ultrasonic Sensor HC-SR04

Figure 2 : Ultrasonic Sensor

The HC-SR04 sensor utilizes ultrasonic waves to measure distance by emitting short bursts of ultrasonic sound and calculating the time it takes for the sound waves to bounce back from an object. This sensor typically has a measurement range of 2cm to 400cm, allowing for accurate distance measurements over a wide range of distances. It operates on a low voltage, typically around 5V DC, making it compatible with a wide range of microcontrollers and electronic devices.

3) LED Traffic Lights Signal


Figure 3 : Traffic Signal

This is a mini-traffic light display module, high brightness, very suitable for the production of a traffic light system model. Can be connected to the motherboard’s PWM pin to control the brightness of the light

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B. Software Components

1) Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software application used to write, compile, and upload code to Arduino microcontroller boards. The IDE compiles Arduino sketches into machine-readable code and uploads it to the connected Arduino board via a USB cable or other communication interfaces. It includes a library manager that allows users to easily install and manage libraries (collections of pre-written code) to extend the functionality of their projects. It includes a built-in serial monitor tool that enables users to communicate with the Arduino board and debug their sketches by monitoring serial data transmission between the board and the computer.

2) Blynk IOT Platform

Blynk is an Internet of Things (IoT) platform that enables users to build and control connected devices and projects using a smartphone app. Blynk offers a drag-and-drop interface for designing custom user interfaces (UI) for IoT projects. Users can easily add buttons, sliders, gauges, and other widgets to create interactive control panels for their connected devices. It supports a wide range of hardware platforms, including Arduino, Raspberry Pi, ESP8266, ESP32, and many others.It also provides cloud connectivity that allows users to remotely monitor and control their IoT devices from anywhere with an internet connection. Blynk offers a library of customizable widgets and triggers that can be used to interact with connected devices.

IV. BLOCK DIAGRAM

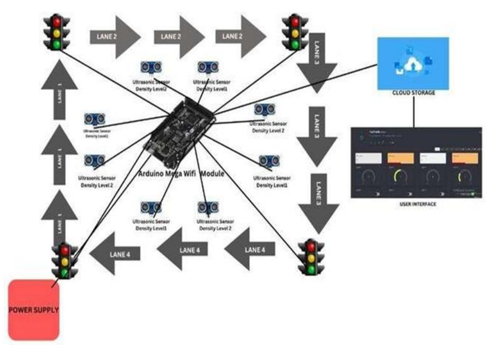

Figure 4 : Block Diagram

V. METHODOLOGY

A. System Architecture

1) WiFi Mega Boards: Our System is equipped with a WiFi Mega board, which serves as the main control unit for all the lanes. This board is responsible for interfacing with the ultrasonic sensors, controlling the traffic LED lights, and communicating with the Blynk cloud platform.
2) Ultrasonic Sensors: Eight ultrasonic sensors are deployed across the lanes, with two sensors per lane. These sensors measure the distance to vehicles in their respective lanes and provide input to the WiFi Mega boards for traffic density monitoring.
3) Traffic LED Lights: Four LED traffic lights are installed for each lane to indicate different traffic signal states (e.g., green, yellow, red). The WiFi Mega boards control the timing and sequencing of these lights based on traffic density and priority settings.

B. Software Platform

1) Arduino IDE: We have used Arduino IDE to develop and upload firmware to the WiFi Mega boards. It includes code for traffic density monitoring, traffic light control, and communication with the Blynk cloud platform.
2) Blynk Cloud Platform: We have used Blynk cloud-based platform that facilitates communication between the WiFi Mega boards and a mobile app interface. It allows for real-time monitoring of traffic conditions and provides control over emergency vehicle prioritization.

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C. Data Flow

1) Data Collection: Ultrasonic sensors continuously measure the distance to vehicles in their respective lanes and . The sensor data is collected by the WiFi Mega boards.
2) Data Processing: The Arduino firmware running on the WiFi Mega boards processes the sensor data to calculate traffic density for each lane. This involves analyzing the distance readings from the ultrasonic sensors and determining the number of vehicles present.
3) Decision Making: Based on the calculated traffic density, the WiFi Mega boards make decisions regarding traffic signal timings. The system prioritizes lanes with higher traffic density for green signals, aiming to optimize traffic flow.
4) Communication: The WiFi Mega boards communicate with the Blynk cloud platform via Wi-Fi to transmit traffic data and receive commands. This allows for remote monitoring of traffic conditions and control over emergency vehicle prioritization.

D. Interactions

When an emergency switch is activated on the Blynk app, the corresponding WiFi Mega board receives the command and adjusts the traffic signal timings to prioritize the lane for emergency vehicle passage.

The Blynk app provides a user interface for monitoring traffic conditions in real-time and controlling emergency vehicle prioritization settings.

VI. FLOWCHART

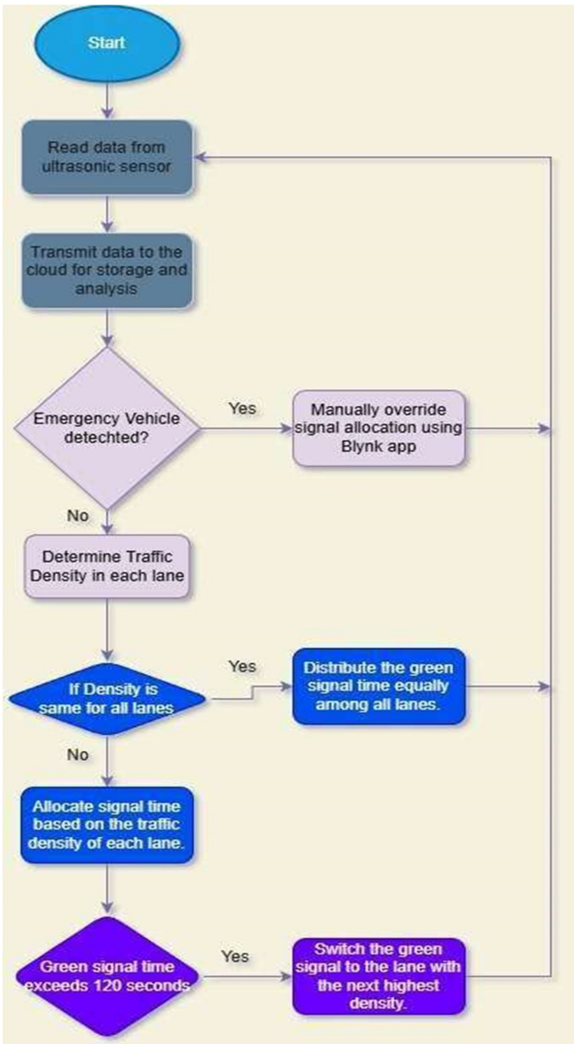

Figure 5 : Flowchart

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VII. CIRCUIT DIAGRAM

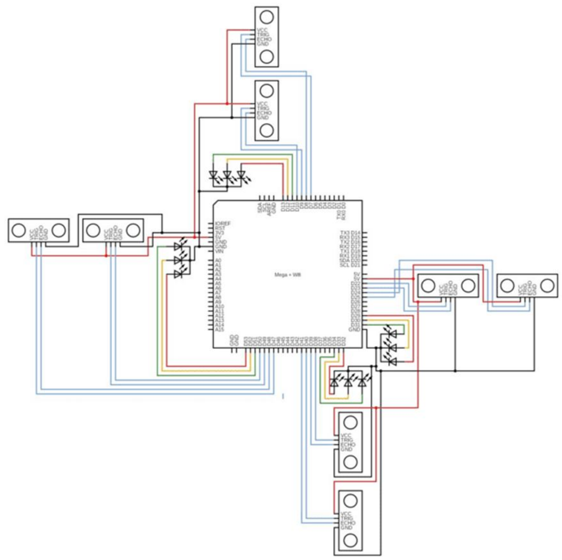

Figure 6 : Circuit Diagram

VIII. RESULTS AND DISCUSSION

At its core, the system integrates ultrasonic sensors in each lane to detect vehicle presence and calculate the lane density in real-time. These ultrasonic sensors were attached to Arduino Mega WiFi R3 Atmega2560 NodeMCU ESP8266 via jumper wires. Traffic signals are also mounted at each crossway.

A. Stage 1 (Vehicle Detection/ Data collection)

In the first stage the Ultrasonic sensor emits high-frequency sound waves. It uses a transducer to send and receive ultrasonic pulses to detect an object's proximity and the time taken for the waves to bounce back after hitting an object. This allows the precise detection of vehicles and their distances. So, in the initial level of our traffic monitoring system, we have implemented a basic setup using ultrasonic sensors to monitor vehicle presence and movement at a four-way intersection. Each lane of the crossway is equipped with multiple ultrasonic sensors which detects vehicles approaching or departing from all directions.

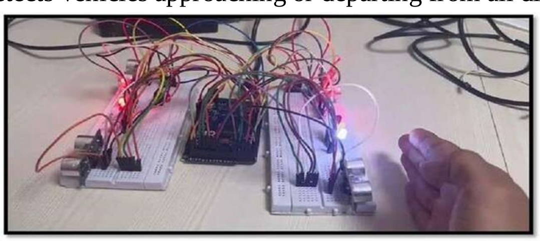

Figure 7 : Vehicle Detection

B. Stage 2 (Dynamic Signaling)

At the second stage of our system's development, we've introduced a dynamic traffic control mechanism based on the density of vehicles in each lane.

1) (Data Processing and Analysis)

We have proposed a four way density based approach in this stage. The Ultrasonic sensors positioned in each lane of the junction provides the real time data of the traffic and the Arduino Mega acts as the central processing unit. This data was further put into our code and the algorithm did robust comparative analysis to compare the density of each lane with each lane and detected the lane with highest density or traffic. Thus successful implementation of data processing algorithms was done to analyze the collected senor data.

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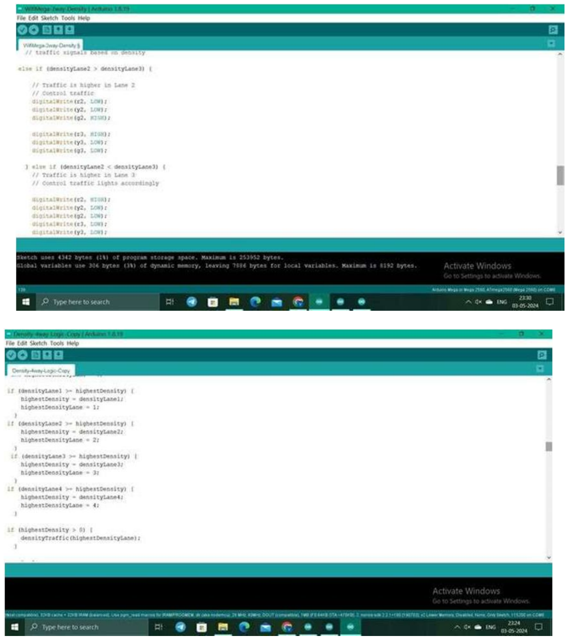


Figure 8: Data Processing

2) (Signal Time Optimization)

Depending on the results of the data processing dynamic adjustment of traffic signals and timings was done. Thus, the lane having more density was given green signal for more time. This helped us achieve the following:-

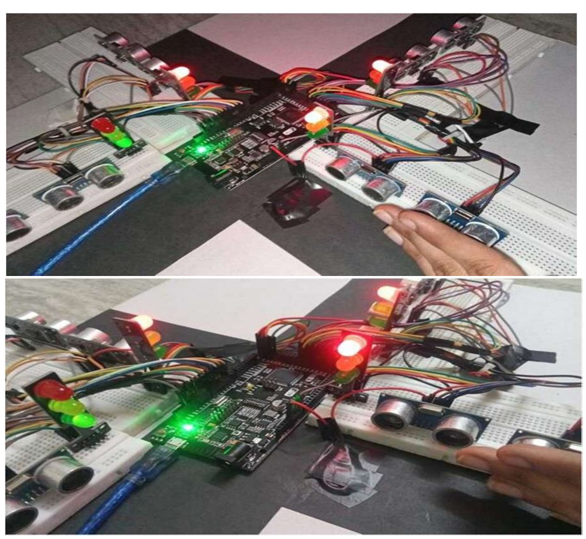
a) Improve Traffic Flow

b) Reduce Congestions (iii)Minimize delays at intersections (iv)Real time traffic analysis

3) (Software Integration/ User Interface)

This stage ensures that the user gets a smooth and seamless user interface to monitor and control the system. At this stage all the data is uploaded to an IoT based cloud platform with the help of ESP8266 module which facilitates wireless communication. Further, integration with third-party services or APIs was performed for user functionality and experience. Thus providing a user-friendly dashboard/interface for traffic operators and administrators to monitor system performance, view real-time traffic data, and access control functionalities.

a) Case 1 :- Lane x has density 1 and others have 0



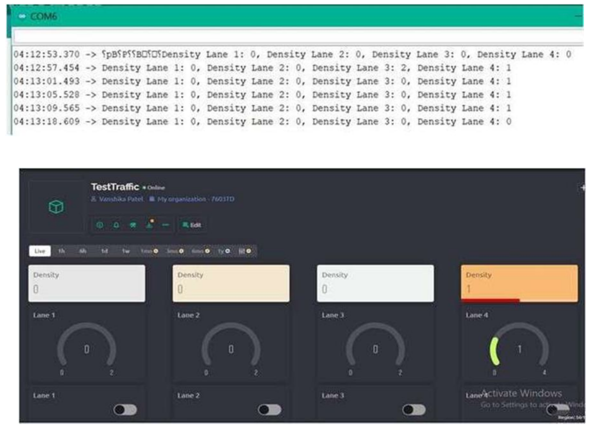


Figure 9 : Density Detection Case 1

b) Case 2:- Lane x has density 2 and others have 0

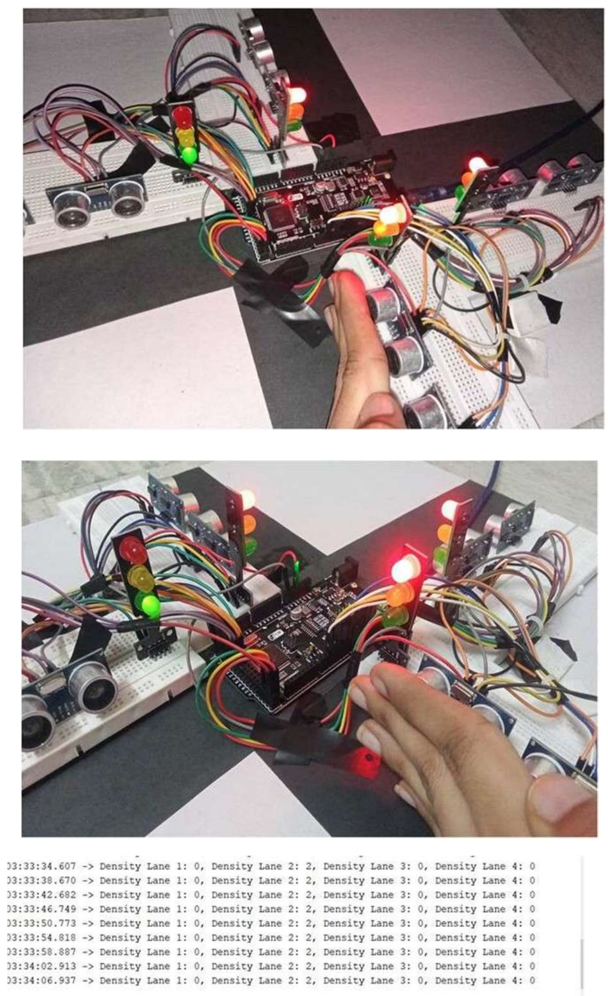


Figure 10 : Density Detection Case 2

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c) Case 3 :- Lane x has density 1 & Lane y has density 2 and rest has density 0

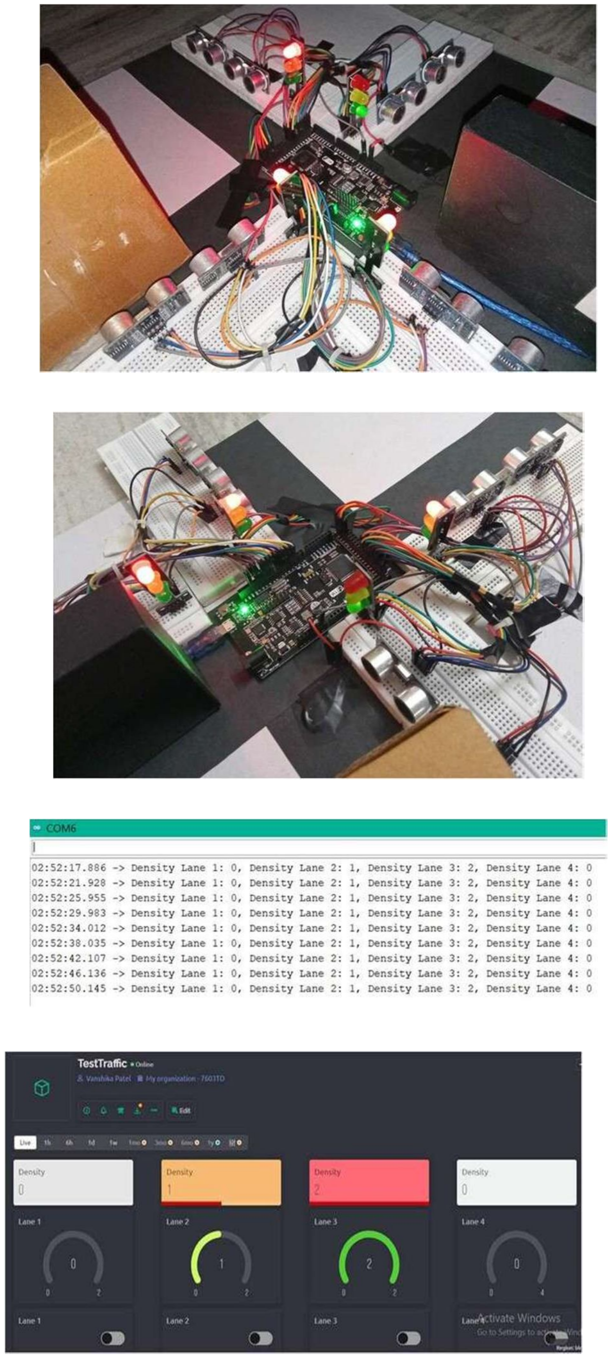

Figure 11 : Density Detection Case 2

C. Stage 3 (Emergency Vehicle Prioritization)

In this stage, integration of algorithms was done to prioritize the passage of emergency vehicles through traffic signals. By doing this, emergency vehicles get a clear pathway or prioritize green signals irrespective of the density of other lanes. The traffic operators and administrators can be given a functionality in their UI to switch the mode to Emergency mode to give green signal to the lane in which emergency vehicles are approaching. Thus, swift and efficient response to emergency situations was provided, ensuring the safety of both responders and the public.

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Figure 12 : Emergency Vehicle

D. Stage 4 (Visualization and Predictive analysis)

At this stage of development, we integrated predictive analytics algorithms to anticipate traffic patterns and optimize signal timings proactively. We also incorporated visualization tools and techniques such as charts and graphs to provide precise information about traffic congestions , traffic hours, traffic lanes etc.

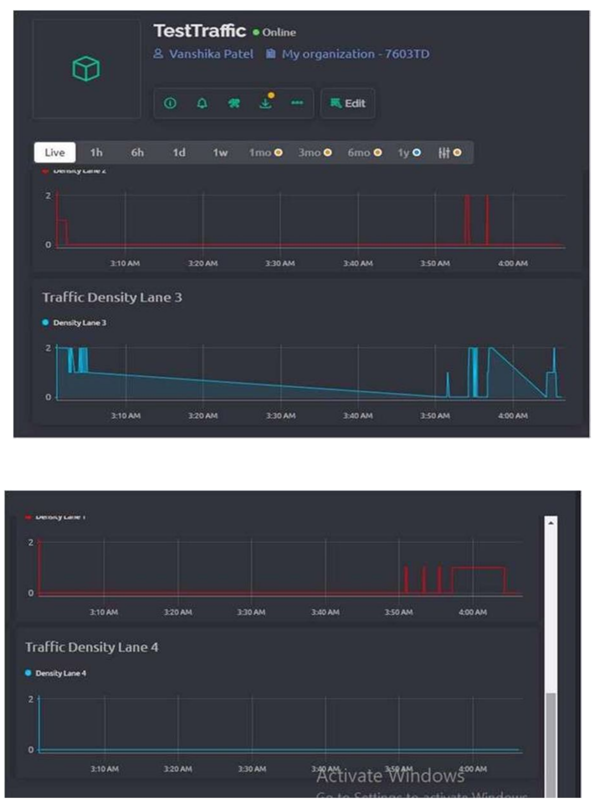

Figure 13 : Graphical Representation

IX. CONCLUSION

The IoT-based traffic control system represents a transformative solution to urban traffic congestion and road safety challenges. Through cutting-edge sensor technologies and real-time data analytics, the system offers a scalable approach to modern traffic management. By continuously monitoring traffic density and dynamically adjusting signal timings, it effectively alleviates congestion and enhances transportation efficiency. The system's manual control features, including prioritizing emergency vehicles, ensure swift response to changing traffic conditions, bolstering public safety. Looking forward, the project presents opportunities for further advancement and expansion. By integrating emerging technologies and fostering collaboration with stakeholders, it can drive widespread deployment and adoption. In essence, the IoT-based traffic control system heralds a new era in urban mobility, characterized by data-driven insights and user-centric solutions. It holds the promise of safer, more efficient, and sustainable transportation networks, ultimately enriching the quality of life for residents and visitors in cities worldwide.

X. ACKNOWLEDGEMENT

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REFERENCES

[1] Bhuvan S T, Manjunath H.R , Abhiman H.R, Ranjan Kumar, Sachin G Rao, “Smart Traffic Management System: A Literature Review” International Journal of InnovativeResearch in Electrical, Electronics, Instrumentation and Control Engineering ,Impact Factor 7.047Vol. 10, Issue 2,February 2022
[2] Sundar, R., Hebbar, S. and Golla, V, “Implementing intelligent traffic control system for congestion control,ambulance clearance, and stolen vehicle detection”, IEEE Sensors Journal, Vol. 15, No. 2, pp. 1109-1113, 2015
[3] Chowdhury, A.; “Priority based and secured traffic management system for emergency vehicle using IoT” Engineering MIS (ICEMIS), International Conference on, IEEE.,(2016).
[4] Milanes, V., Villagra, J., Godoy, J., Simo, J., Pérez, J. andOnieva, E.;”An intelligent v2i-based traffic management system” IEEE Transactions on Intelligent Transportation Systems, Vol. 13, No. 1, (2012).
[5] Shashank S, Kiran P, Nischay D, Vinay Kumar M, B R.Vatsala, Dr. C. V.Raj;”IOT Based Traffic Management System” International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT)
[6] P.Sharma, A. Goen “Smart traffic controls system using weighted data” International conference on advanced computation and telecommunication 2018
[7] N. Lanke and S. Koul, “Smart Traffic Management System”, International Journal ofComputer Applications (0975 – 8887) Volume 75– No.7,August 2013.
[8] I. Gulati and R. Srinivasan,”Image Processing In Intelligent Traffic Management” International Journal ofRecent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-2S4, July 2019.
[9] A. M.Miyim, M.M.Alhaji;”Smart Traffic Management System”; 2019 15th International Conference on Electronics, Computer and Computation (ICECCO)
[10] H. J.Nafea, N. Nair;”Density Based Smart Traffic System with Real Time Data Analysis Using IoT”; 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT)