# DAYANANDA SAGAR UNIVERSITY

**KUDLU GATE, BANGALORE – 560068**

SCHOOL OF ENGINEERING

**Bachelor of Technology**
**in**
**COMPUTER SCIENCE AND ENGINEERING**

## Major Project Phase-II Report

## SMART TRAFFIC MANAGEMENT SYSTEM FOR EMERGENCY VEHICLES

**Batch: 4**


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**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING,**
**SCHOOL OF ENGINEERING**
**DAYANANDA SAGAR UNIVERSITY,**
**BANGALORE**


**(2023-2024)**

# DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

**Department of Computer Science & Engineering**

Kudlu Gate, Bangalore – 560068
Karnataka, India

## CERTIFICATE

This is to certify that the Major Project Stage-II work titled **"SMART TRAFFIC MANAGEMENT SYSTEM FOR EMERGENCY VECHICLES"** is carried out by **B Sri Sharan (ENG20CS0051), Sandeep Kumar Pradhan (ENG20CS0315), Uday Kumar A (ENG20CS0389), Vinod V (ENG20CS0413),** bonafide students eighth semester of Bachelor of Technology in Computer Science and Engineering at the School of Engineering, Dayananda Sagar University, Bangalore in partial fulfillment for the award of degree in Bachelor of Technology in Computer Science and Engineering, during the year **2023-2024**.

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# DECLARATION

We, **B Sri Sharan (ENG20CS0051), Sandeep Kumar Pradhan (ENG20CS0315), Uday Kumar A (ENG20CS0389), Vinod V (ENG20CS0413),** are students of eighth semester B. Tech in **Computer Science and Engineering**, at School of Engineering, **Dayananda Sagar University**, hereby declare that the Major Project Stage-I titled **"Smart Traffic Management System For Emergency Vehicles"** has been carried out by us and submitted in partial fulfilment for the award of degree in **Bachelor of Technology in Computer Science and Engineering** during the academic year **2023-2024.**

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# TABLE OF CONTENTS

# LIST OF ABBREVIATIONS

| | |
|---|---|
| IOT | Internet Of Things |
| IR | Infrared Radiation |
| LED | Light Emitting Diode |
| RFID | Radio Frequency Identification |
| IDE | Integrated Development Environment |

# LIST OF FIGURES

# ABSTRACT

The Smart Traffic Management System for Emergency Vehicles Using IoT is a project designed to utilize Internet of Things (IoT) technology for improving the efficiency of emergency vehicle navigation through traffic. The system will employ various IoT devices such as sensors and communication modules to enable real-time monitoring and control of traffic signals, facilitating the smooth passage of emergency vehicles.

The project will involve the development of a centralized control system that can communicate with IoT devices installed in emergency vehicles and traffic signals. When an emergency vehicle is dispatched, its location and route will be continuously monitored. As the vehicle approaches intersections, the system will analyze the traffic conditions and prioritize the passage of the emergency vehicle by dynamically adjusting traffic signal timings.

Furthermore, the system will incorporate vehicle-to-infrastructure (V2I) communication, allowing emergency vehicles to communicate directly with traffic signals to request priority passage. This will help reduce response times for emergency services and improve overall road safety.

The Smart Traffic Management System for Emergency Vehicles Using IoT aims to enhance the coordination between emergency vehicles and traffic infrastructure, ultimately leading to faster response times during emergencies and minimizing the risk of traffic accidents involving emergency vehicles.

# Chapter 1 INTRODUCTION

The Smart Traffic Management System for Emergency Vehicles Using IoT and mobile application project aims to revolutionize the way emergency vehicles navigate through traffic. By leveraging the power of Internet of Things (IoT) technology and a dedicated mobile application, this project seeks to enhance the efficiency and safety of emergency vehicle operations.

In today's congested urban environments, emergency vehicles often face challenges in swiftly reaching their destinations due to traffic congestion. This project addresses this issue by integrating IoT devices, such as sensors and communication modules, into the traffic infrastructure. These devices will enable real-time monitoring and control of traffic signals, allowing for the prioritization of emergency vehicles based on their locations and routes.

Moreover, the project will include the development of a mobile application that will serve as a vital tool for both emergency vehicle operators and the general public. The mobile application will provide real-time updates on the locations of emergency vehicles, allowing other drivers to make way and facilitating smoother passage for the emergency vehicles. Additionally, the application will enable emergency vehicle operators to communicate with the traffic management system, request priority passage, and receive route optimization suggestions.

By combining IoT technology with a user-friendly mobile application, this project seeks to streamline the coordination between emergency vehicles and traffic infrastructure, ultimately leading to faster response times during emergencies and a reduction in the risk of traffic accidents involving emergency vehicles.

## 1.1 OBJECTIVE

The objective of the "Smart Traffic Management System for Emergency Vehicles Using IoT and Mobile Application" project is to enhance emergency response by integrating IoT technology and a mobile application to prioritize emergency vehicles, minimize traffic delays, and improve road safety. The project aims to achieve faster response

times, seamless communication between emergency vehicles and traffic infrastructure, and real-time updates for the public, ultimately fostering a more efficient and collaborative traffic management ecosystem.

## 1.2 SCOPE

The scope of the "Smart Traffic Management System for Emergency Vehicles Using IoT and Mobile Application" project encompasses the development and implementation of a comprehensive system that integrates IoT technology and a mobile application to facilitate the efficient movement of emergency vehicles through traffic. This includes the deployment of IoT devices within the traffic infrastructure to enable real-time monitoring and control of traffic signals, as well as the creation of a user-friendly mobile application for emergency vehicle operators and the public. The project aims to prioritize emergency vehicles, minimize traffic delays, and improve road safety through seamless communication and coordination, ultimately fostering a more efficient and collaborative traffic management ecosystem.

# Chapter 2 PROBLEM STATEMENT

## PROBLEM:

In India, the existing traffic signal infrastructure operates on a fixed time schedule, with no provision for accommodating emergency vehicles when traffic policemen are unavailable. This lack of flexibility poses a significant challenge, especially in critical situations where time is of the essence. Ambulances, tasked with responding to emergencies, often find themselves delayed at traffic signals, waiting for their turn despite the urgency of the situation. This issue compromises the efficiency of emergency services and can have serious consequences in life-threatening scenarios.

Currently, there is no dedicated traffic control mechanism in place specifically designed for emergency vehicles, exacerbating the problem. The absence of a dynamic and adaptive traffic management system for such situations hampers the swift movement of ambulances through junctions with traffic signals, ultimately impacting the timely delivery of critical medical assistance.

## SOLUTION:

The proposed solution aims to address the challenges faced by emergency vehicles, particularly ambulances, by introducing a sophisticated and adaptive traffic management system. The "Smart Traffic Management for Emergency Vehicles" is designed to dynamically adjust traffic signals in real-time, providing a streamlined passage for emergency vehicles through intersections.

This intelligent system will leverage advanced technologies and sensors to detect the presence of emergency vehicles approaching a junction. Upon identification, the traffic signals will be dynamically altered to prioritize the passage of the emergency vehicle, reducing the wait time and allowing it to navigate through the intersection swiftly and safely.

# Chapter 3 LITERATURE SURVEY

**1."Real-Time Adaptive Traffic Control System for Smart Cities"**

**Authors:** Shyam Shankaran R, Logesh Rajendran

**Year:** 2021

The paper presents an Adaptive Traffic Control System (ATCS) designed to address traffic congestion in smart cities, focusing on the context of India. The traditional fixed-time traffic control systems are discussed as inadequate for dynamic traffic patterns. The ATCS, utilizing both hardware and software components, employs real-time traffic density estimation through camera-based monitoring. The proposed system adapts traffic signal timings based on the current demand, demonstrating a significant reduction in congestion and delays. The paper emphasizes the potential of smart mobility systems in enhancing daily commutes, contributing to improved urban transportation efficiency by 15-20 percent on average.

**2. "Smart Traffic System using Traffic Flow Models"**

**Authors:** Arihant Kamdar, Dr. Jigarkumar Shah

**Year:** 2021

The paper presents a Smart Traffic System designed to address the challenges of roadway traffic congestion. Unlike static traffic management systems, this proposed method utilizes dynamic behaviour by considering real-time factors. Computer vision techniques, including vehicle detection and classification, are employed to optimize traffic flow. Notably, the system incorporates priority scheduling for emergency vehicles. Traffic density, traffic optimization, and object detection are key components. The approach employs traffic flow models such as Greensheild's, Greenberg's, and Underwood's equations, integrating them with computer vision data. The experimental analysis demonstrates the effectiveness of the proposed model in predicting and managing traffic, offering a cost-effective and efficient solution for urban transportation.

**3."Smart Traffic Management System using IoT Enabled Technology"**

**Authors:** Dr. Vikram Bali, Ms. Sonali Mathur, Dr. Vishnu Sharma, Dev Gaur

**Year**: 2020

The 2020 paper, "Smart Traffic Management System using IoT Enabled Technology," proposes a solution to urban traffic congestion by implementing an IoT-based system. The system utilizes RFID tags on emergency vehicles, triggering traffic lights to create "Green Corridors" for timely passage. The approach aims to mitigate delays for emergency services and enhance overall traffic management. The system, implemented with Arduino technology, demonstrates promising results in a laboratory prototype. Future enhancements, including cloud computing and mobile applications, are suggested for further optimization, emphasizing the potential to save lives and improve urban traffic efficiency.

**4. "Smart Ambulance and Traffic Controlling System"**

**Authors:** Sudhakara H. M, Girish H. R, Kumara Swamy N. R, J. Vinay Kumar, and Sachin Kumar

**Year:** 2020

The article discusses the challenges posed by increasing traffic congestion in developing countries, particularly in India, and its impact on emergency vehicles like ambulances. The authors propose a Smart Ambulance and Traffic Controlling System using RFID technology to manage and regulate traffic signals at junctions. The system aims to provide a clear path for emergency vehicles by controlling traffic signals in real-time, allowing them to reach their destinations without delays. The proposed framework is implemented using Arduino and LED displays, simulating a real-time traffic scenario. The system utilizes GPS for ambulance tracking and RFID technology for efficient traffic signal management. The article highlights the importance of timely arrival for emergency services to prevent the loss of human life. The proposed system aims to address these challenges and improve the efficiency of traffic control during emergency situations.

**5. "Crisis Traffic Management in the City Using Traffic Lights"**

**Authors:** Jiri Ruzuzicka, Kristyna Navratilova, Tomas Tichy"

**Year:** 2020

The paper addresses the growing need for efficient smart traffic management during emergencies in urban areas. Focusing on crisis situations, the authors propose a novel approach by integrating crisis management systems with existing traffic lights. The system aims to improve safety, reduce delays, and enhance traffic flow by strategically controlling intersections based on real-time emergency data. The authors conducted a comprehensive study, analysing legislative aspects, proposing methodologies, and simulating the designed system in a specific urban area. While demonstrating promising results in simulations, the paper emphasizes the necessity of legislative changes, public awareness, and further real-world testing for successful implementation. The proposed crisis management system offers potential benefits but also highlights challenges in organizational, technological, and economic aspects.

**6. "Real-time Traffic Management in Emergency using Artificial Intelligence**

**Authors:** Mahima Jaiswal, Neetu Gupta, Ajay Rana

**Year:** 2020

This paper explores the integration of Artificial Intelligence (AI) in real-time traffic management, particularly during emergencies. It emphasizes the role of AI in predicting, analysing, and optimizing traffic flow. The authors propose a design for lane management, focusing on effective traffic flow during medical emergencies. The system utilizes AI-driven traffic signal management to create a dedicated path for ambulances in real-time. The paper reviews related work in traffic management, including fuzzy logic for traffic density, reservation-based urban traffic systems, dynamic traffic analysis, and predictive control of traffic. The proposed design aims to enhance safety, reduce congestion, and improve overall efficiency in urban traffic scenarios.

# Chapter 4 PROJECT DESCRIPTION

The "Smart Traffic Management System for Emergency Vehicles Using IoT and Mobile Application" project aims to revolutionize the coordination and navigation of emergency vehicles through traffic. By leveraging IoT technology and a dedicated mobile application, the project seeks to enhance the efficiency, safety, and responsiveness of emergency vehicle operations.

The project involves the development and implementation of a comprehensive system that integrates IoT devices, such as sensors and communication modules, into the traffic infrastructure. These IoT devices enable real-time monitoring and control of traffic signals, allowing for the prioritization of emergency vehicles based on their locations and routes. As emergency vehicles approach intersections, the system dynamically adjusts traffic signal timings to facilitate their smooth passage, minimizing delays and optimizing response times during critical situations.

The "Smart Traffic Management System for Emergency Vehicles Using IoT and Hardware Components" project aims to revolutionize the coordination of emergency vehicles through traffic by integrating IoT technology, hardware components such as Arduino, Bluetooth, LEDs, vehicle density sensors, power sources, and a dedicated mobile application. The project involves the development of a comprehensive system that utilizes Arduino-based hardware components to monitor vehicle density at intersections and control traffic signals. The vehicle density sensors, powered by a reliable power source, will communicate with the Arduino board using Bluetooth technology to provide real-time data on traffic conditions. Based on this data, the system will dynamically adjust traffic signal timings, prioritizing the passage of emergency vehicles. Additionally, the project includes the creation of a user-friendly mobile application that provides real-time updates on the locations of emergency vehicles, allowing other drivers to make way and facilitating smoother passage for the emergency vehicles. The seamless integration of IoT hardware components with the mobile application aims to enhance emergency response, improve road safety, and establish a more efficient and collaborative approach to traffic management.

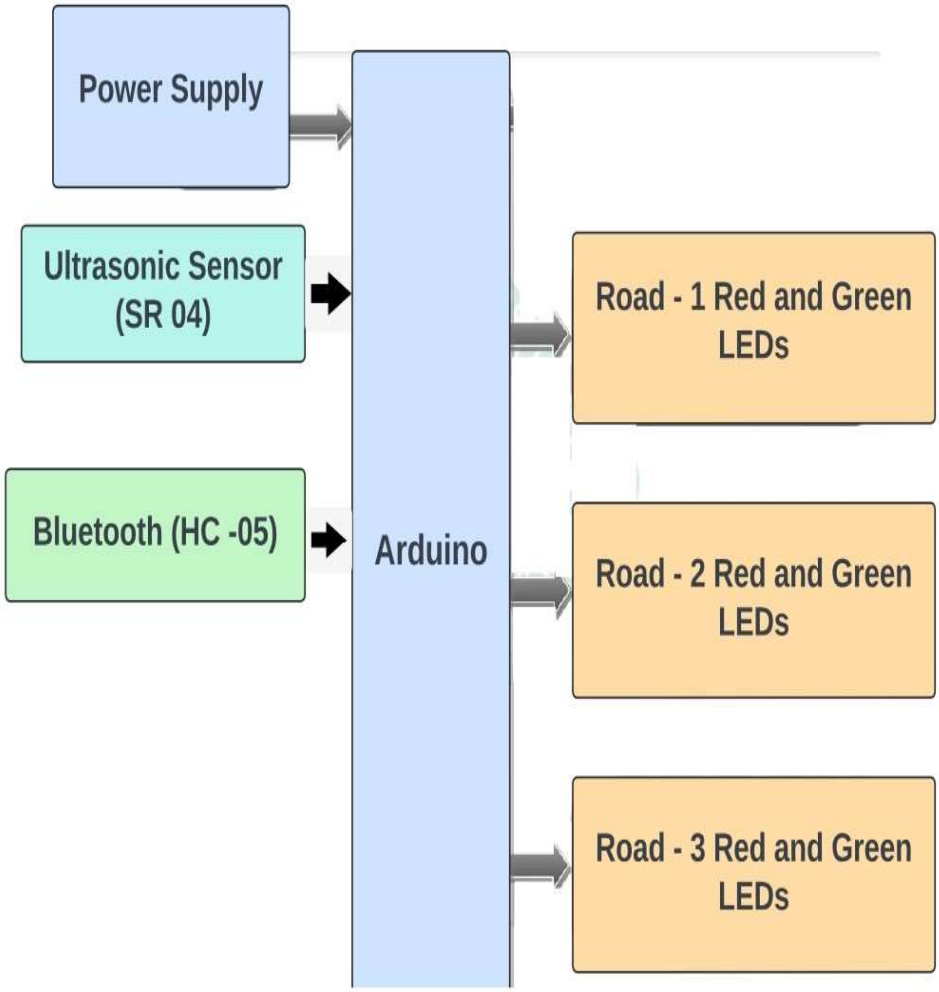


**Fig 4.1 Block Diagram of Smart Traffic Management System**

The above is the block diagram of road traffic management system for emergency vehicles using Arduino, Bluetooth, LEDs, vehicle density sensor, power source, and a mobile application.

The system works as follows:

**Vehicle Detection:** The vehicle density sensor detects the presence of vehicles approaching the traffic signal.

**Emergency Vehicle Identification:** Emergency vehicles equipped with a Bluetooth module transmit a unique identifier to the Arduino board.

**Signal Adjustment:** Upon receiving the emergency vehicle identifier, the Arduino calculates the optimal route for the emergency vehicle and modifies the traffic signals accordingly. This may involve extending green lights for the emergency vehicle's path and turning red lights for intersecting traffic.

**Real-Time Information:** The Arduino transmits real-time information about the emergency vehicle's location and estimated arrival time to the traffic signals and a mobile app.

## 4.1 ASSUMPTIONS:

**1. Availability of Resources**: The project assumes the availability of necessary hardware components such as Arduino boards, Bluetooth modules, LEDs, vehicle density sensors, and reliable power sources for the implementation of the traffic management system.

**2. Compatibility of Components:** It is assumed that the selected hardware components are compatible with each other and can be integrated seamlessly to create the desired functionality.

**3. Mobile Application Development:** The project assumes the successful development of a user-friendly mobile application that can effectively communicate with the IoT hardware components and provide real-time updates on the locations of emergency vehicles.

## 4.2 DEPENDENCIES:

**1. Technical Expertise**: The successful implementation of the project depends on the availability of individuals with the technical expertise to develop and integrate the IoT hardware components, program the Arduino boards, and develop the mobile application.

**2. Bluetooth Connectivity:** The project is dependent on the reliable and consistent Bluetooth connectivity between the IoT hardware components and the mobile application for real-time data transmission and communication.

**3. Power Supply:** The system's functionality is dependent on a stable and continuous power supply to ensure the proper operation of the IoT hardware components and the overall traffic management system.

**4. Data Accuracy:** The effectiveness of the system depends on the accuracy and reliability of the data collected by the vehicle density sensors to make informed decisions regarding traffic signal control.

Addressing these assumptions and dependencies will be crucial for the successful implementation and operation of the Smart Traffic Management System for Emergency Vehicles using IoT and hardware components, along with the associated mobile application.

# Chapter 5 REQUIREMENTS

## 5.1 SOFTWARE REQUIREMENTS

**1. Arduino IDE:** The Arduino Integrated Development Environment (IDE) serves as a fundamental tool for coding and uploading software to the Arduino Uno microcontroller. It is imperative to ensure compatibility with the chosen Arduino model and maintain the IDE's currency by incorporating regular updates.

**2. Programming Languages:** Proficiency in programming languages, specifically C/C++, is indispensable for coding the Arduino microcontroller effectively. A sound grasp of relevant libraries and syntax is crucial to facilitate seamless software development.

**3. Simulation Software:** Incorporating simulation tools such as Proteus or Tinker CAD is advisable for testing and validating the system's functionality before actual hardware deployment. Simulation software aids in pinpointing potential issues and refining algorithms for optimal performance.

**4. Data Analysis Tools:** Implementing data analysis tools like MATLAB or Python, coupled with relevant libraries, is essential for processing and analysing data collected during the system's operation. These tools play a pivotal role in extracting valuable insights and optimizing the overall performance of the system.

**5. Documentation Tools:** Utilize documentation tools such as Markdown, LaTeX, or conventional word processors to create comprehensive and well-organized documentation.

## 5.2 HARDWARE REQUIREMENTS

**1. Arduino Board:** Arduino is used in the project to control and coordinate the hardware components. It serves as the central processing unit, receiving data from the vehicle density sensor, communicating with the Bluetooth module for wireless connectivity, and controlling the LEDs to simulate traffic signals. Arduino's programmable nature allows for the implementation of logic to prioritize emergency vehicles and dynamically adjust traffic signals. It acts as the brain of the system, enabling real-time decision-making and coordination within the smart traffic management infrastructure.


**Fig 5.1 Arduino Uno**

**2. HC-05 Bluetooth:** The Bluetooth HC-05 module facilitates wireless communication between the Arduino-based system and the mobile application. It enables the transmission of real-time data, such as vehicle density information and emergency

vehicle locations, to the mobile application. Additionally, it allows the mobile application to send control signals back to the Arduino, enabling dynamic adjustments to traffic signals.

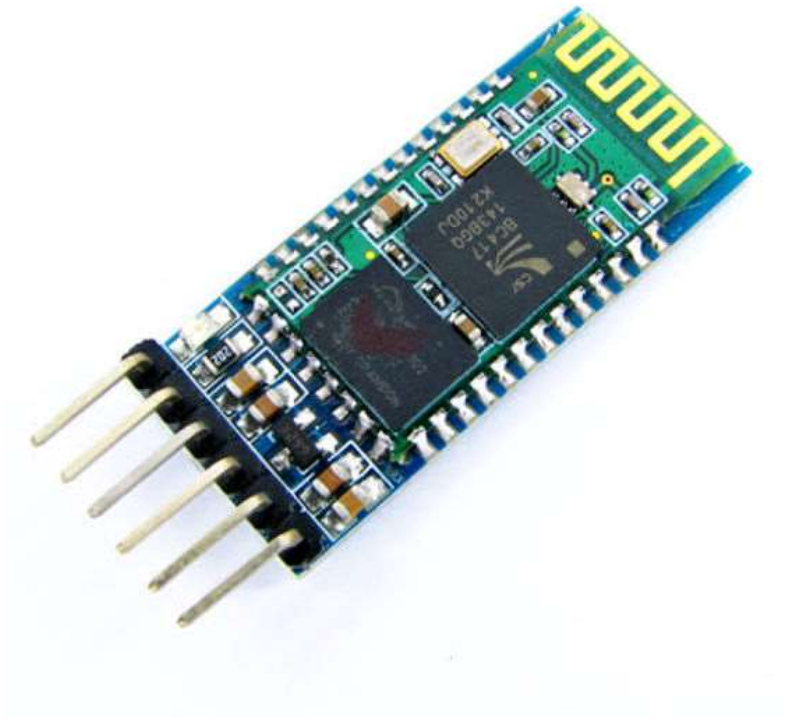

**Fig 5.2 HC-05 Bluetooth**

**3. Ultrasonic Sensor HC SR-04:** The vehicle density sensor, powered by 5V DC, utilizes infrared (IR) technology to detect the presence and movement of vehicles at intersections. When a vehicle passes through the sensor's field, it triggers a change in the infrared signal, which is then interpreted by the Arduino microcontroller. This data is used to assess the traffic density and make real-time decisions regarding traffic signal control, enabling the system to prioritize emergency vehicles and optimize traffic flow.


**Fig 5.3 Ultrasonic Sensor HC SR-04**

**5. LEDs:** The 5mm red, green, and yellow LEDs serve as visual indicators for the traffic signals controlled by the Arduino-based system. The red LED signals to stop, the green LED signals to go, and the yellow LED signals to prepare to stop. The Arduino microcontroller activates these LEDs based on the real-time data received from the vehicle density sensor and the commands from the mobile application, effectively simulating traffic signal operations and prioritizing emergency vehicle passage through the controlled intersection.


**Fig 5.4 5mm Red, Yellow and Green led**

# Chapter 6 METHODOLOGY

## 6.1 DEVELOPMENT METHODOLOGY

### 6.1.1 Project Initiation

Clearly define the project's scope, objectives, and deliverables. Develop a comprehensive project plan detailing tasks, timelines, and resource requirements. The project begins with a comprehensive assessment of the requirements and objectives. This involves defining the scope of the system, identifying key stakeholders, and outlining specific deliverables. A project plan is then developed, detailing tasks, timelines, and resource requirements to ensure efficient project management.

### 6.1.2 Literature Review

Conducted an exhaustive review of existing literature on Smart Traffic Management System for Emergency Vehicles, and relevant technologies to gather insights and inform the project design. Extensive research is conducted to review existing literature on IoT-based traffic management systems, emergency vehicle navigation, and relevant technologies. This literature review provides valuable insights into best practices, potential challenges, and innovative solutions that can inform the design and implementation of the project.

### 6.1.3 Hardware Setup

The hardware setup involves procuring necessary components such as ultrasonic sensors (HC-SR04) for vehicle density detection and Bluetooth modules (HC-05) for communication with emergency vehicles. Compatibility and connectivity of these components with Arduino boards are verified, and proper connections are established on a prototyping board.

### 6.1.4 Software Development

Software development entails setting up the Arduino Integrated Development Environment (IDE) and installing required libraries. Arduino code is developed to integrate algorithms for vehicle density detection, emergency vehicle prioritization, and communication with traffic signals. Seamless integration and communication between software and hardware components are ensured.

### 6.1.5 Integration

Integration involves combining all hardware components and uploading the finalized code to Arduino boards. The system's communication with IoT devices installed in emergency vehicles and traffic signals is verified to ensure seamless operation.

### 6.1.6 Testing and Debugging

Rigorous testing and debugging are conducted to validate the functionality of individual hardware components and the overall system. System-wide testing is performed to identify and address any bugs or issues in the code or hardware connections, ensuring the reliability and accuracy of the system.

### 6.1.7 Security and Control Implementation

Security and control implementation focus on implementing measures to safeguard data integrity and privacy. Access controls and authentication mechanisms are implemented to manage system control and management securely.

Finally, the Smart Traffic Management System for Emergency Vehicles Using IoT is deployed, starting with pilot deployments in select areas. Training and support are provided to system operators, traffic controllers, and emergency responders. A maintenance schedule is established for ongoing monitoring, updates, and optimization of the system to ensure its effectiveness and reliability over time.

By following this detailed methodology, the Smart Traffic Management System for Emergency Vehicles Using IoT aims to enhance emergency vehicle navigation through traffic, improve response times during emergencies, and minimize the risk of traffic accidents involving emergency vehicles.

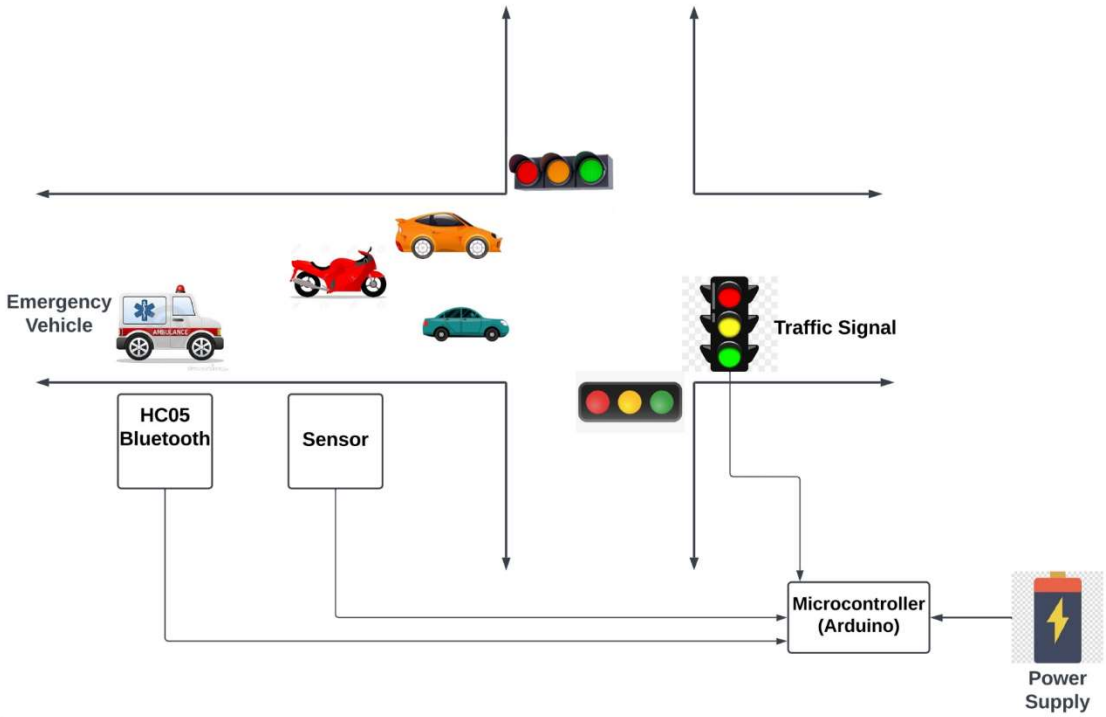


**Fig 6.1 Model Design**

## 6.2 WORKING

The Smart Traffic Management System for Emergency Vehicles Using IoT utilizes a combination of hardware components and IoT technology to enhance the efficiency of emergency vehicle navigation through traffic. The system employs an ultrasonic sensor to detect the density of vehicles in a particular lane and a Bluetooth module HC05, which connects with an Arduino microcontroller to prioritize signal changes for emergency vehicles.

In detail, the system functions as follows:

### 6.2.1 Real-time Traffic Monitoring:

The ultrasonic sensor is deployed at strategic locations along roadways to continuously monitor the density of vehicles in each lane. This data is collected and transmitted to the central control system via the Arduino microcontroller.

### 6.2.2 Centralized Control System:

The central control system serves as the nerve centre of the smart traffic management system. It communicates with IoT devices installed in both emergency vehicles and traffic signals, facilitating real-time data exchange and decision-making.

### 6.2.3 Traffic Signal Prioritization:

As the emergency vehicle approaches intersections, the central control system analyses the traffic conditions in real-time. Based on the data received from the ultrasonic sensor, the system prioritizes the passage of the emergency vehicle by adjusting the timing of traffic signal changes.

### 6.2.4 Vehicle-to-Infrastructure Communication (V2I):

The system incorporates V2I communication, enabling direct communication between emergency vehicles and traffic signals. Using the Bluetooth module HC05, emergency vehicles can transmit priority requests to nearby traffic signals, signalling their imminent approach and need for passage.

### 6.2.5 Dynamic Signal Adjustment:

Traffic signal timings are dynamically adjusted based on the proximity and urgency of approaching emergency vehicles. This ensures that emergency vehicles encounter minimal delays at intersections, allowing for faster response times during emergencies.

### 6.2.6 Enhanced Coordination:

By enhancing the coordination between emergency vehicles and traffic infrastructure, the system minimizes the risk of traffic accidents involving emergency vehicles and optimizes overall road safety.

In summary, the Smart Traffic Management System for Emergency Vehicles Using IoT combines real-time traffic monitoring, centralized control, and vehicle-to-infrastructure communication to prioritize the passage of emergency vehicles through traffic, ultimately leading to faster response times and improved road safety during emergencies.

# Chapter 7 EXPERIMENTATION

## 7.1 HARDWARE IMPLEMENTATION

**1. Experimentation for Density of Vehicles Detection:**

Using an ultrasonic sensor mounted strategically along the lane, the system will measure the distance to the vehicles in the lane. By analysing the time taken for ultrasonic waves to travel to the vehicle and back, the system can calculate the density of vehicles in the lane. This information will be crucial for determining the traffic conditions and prioritizing the passage of emergency vehicles.

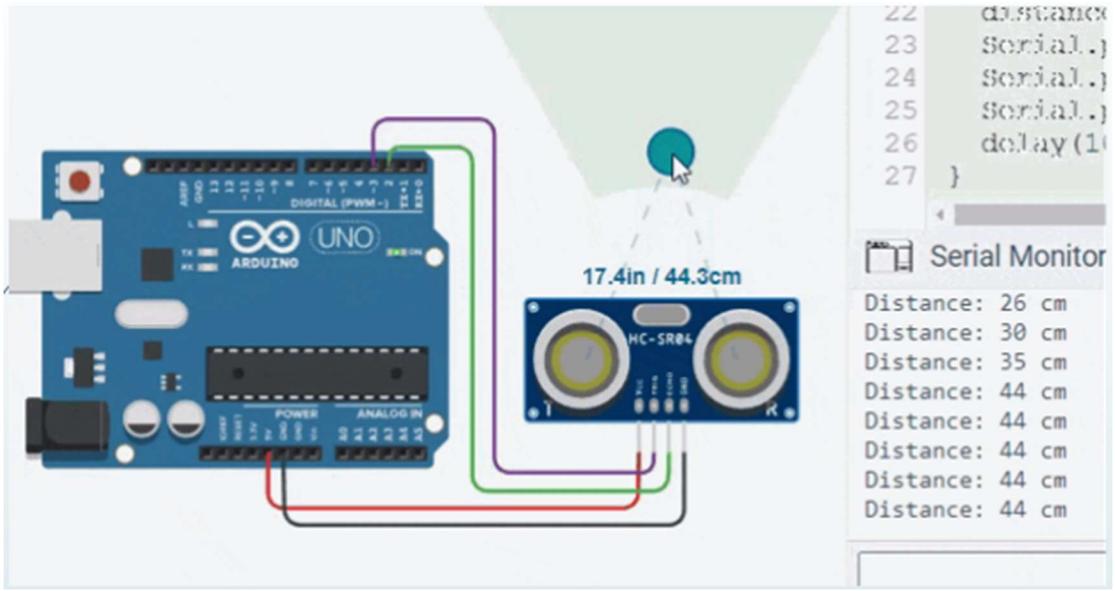


**Fig 7.1 Simulation for ultrasonic sensor**

**2. Connecting Bluetooth module and Arduino:**

Experimentation for connecting the Bluetooth HC05 module involves several steps. First, the HC05 module needs to be paired with the Arduino board. This can be done by following the instructions provided with the HC05 module. Once paired, the Arduino

code needs to be programmed to establish a Bluetooth connection with the module. This typically involves configuring the serial communication settings and defining commands to be sent and received over Bluetooth. For example, commands can be sent from a smartphone app to the Arduino to request priority passage for an emergency vehicle. The Arduino then interprets these commands and adjusts the traffic signal timings accordingly. Finally, testing and debugging are essential to ensure the reliability and stability of the Bluetooth connection and the communication between the Arduino and the smartphone app.

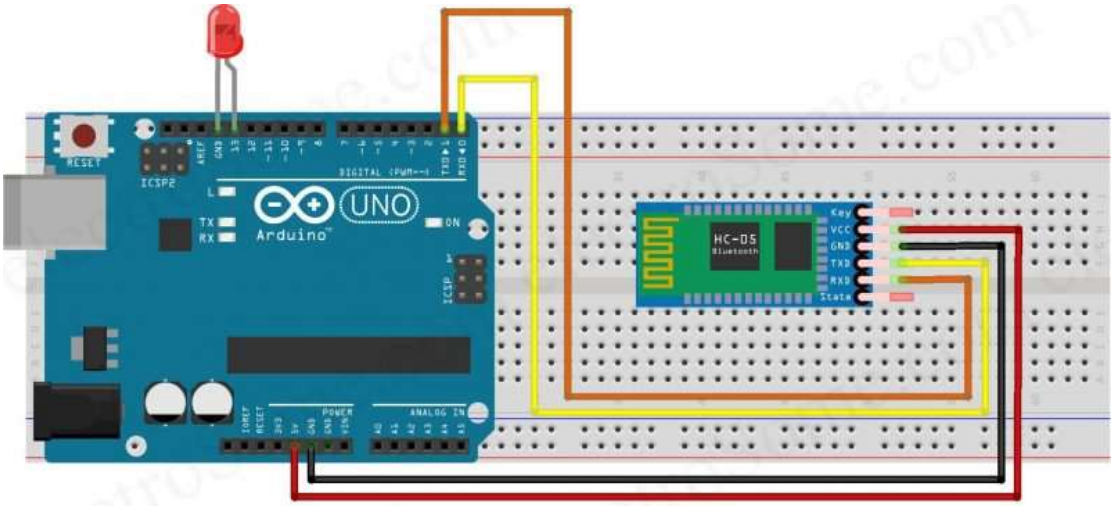


**Fig 7.2 Simulation for Bluetooth Module HC-05**

### 3. Building App for Dynamically Changing Traffic Signal:

The app will communicate with the centralized traffic management system, providing real-time updates on emergency vehicle locations and priority requests. Upon receiving a priority request from the app, the traffic management system will analyse the current traffic conditions, including vehicle density data from ultrasonic sensors, to dynamically adjust traffic signal timings at the intersection, ensuring safe and efficient passage for emergency vehicles.


**Fig 7.3 Application Interface**

**4. Integration with Traffic Management System:**

The app will communicate with the centralized traffic management system, providing real-time updates on emergency vehicle locations and priority requests. Upon receiving a priority request from the app, the traffic management system will analyse the current traffic conditions, including vehicle density data from ultrasonic sensors, to dynamically adjust traffic signal timings at the intersection, ensuring safe and efficient passage for emergency vehicles.

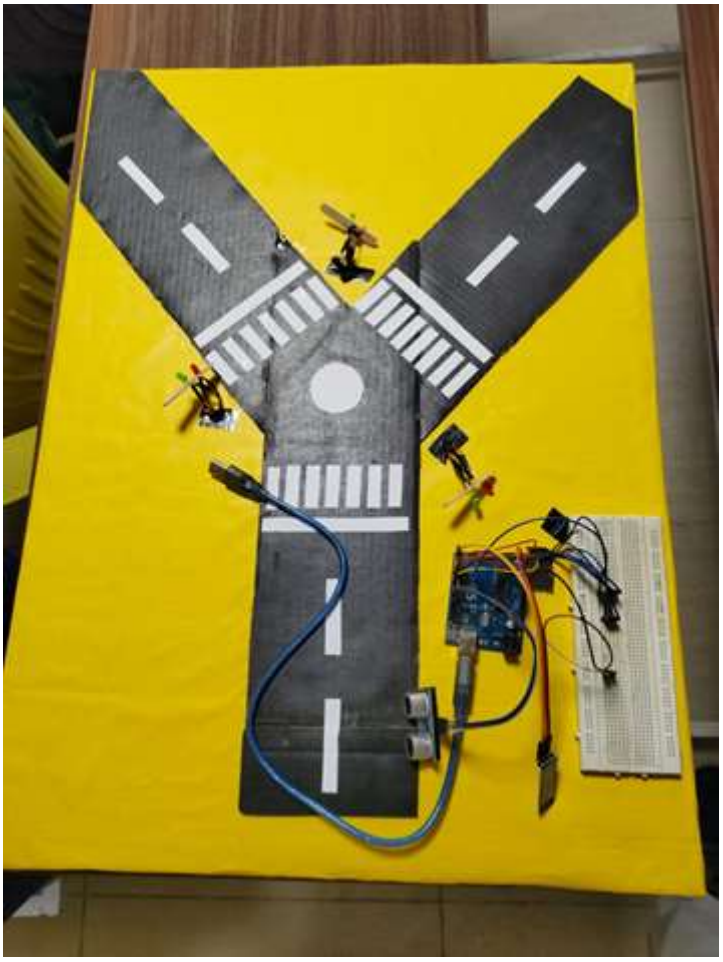

**Fig 7.4 Integration with Traffic Management System**

Overall, the experimentation using ultrasonic sensors will provide crucial data for traffic management, while the app developed using MIT App Inventor will enable seamless communication and control of traffic signals, contributing to the efficient management of emergency vehicle navigation through traffic.

# Chapter 8 TESTING AND RESULT

### 1. LED Lights for Signals

**Objective**: To test the functionality and visibility of LED lights for traffic signals.

**Procedure:** Observed LED light behaviour under different traffic scenarios (e.g., normal traffic, emergency vehicle approach).

**Results:** LED lights successfully indicated different traffic statuses (green for normal, red for stop) and were visible from various distances.

### 2. Ultrasonic Sensor for Density Detection

**Objective:** To validate the accuracy of the ultrasonic sensor in detecting lane density.

**Procedure:** Collected data from the ultrasonic sensor during peak and off-peak traffic to compare lane densities.

**Results:** Ultrasonic sensor accurately detected lane density variations, providing real-time data for lane prioritization.

### 3. Mobile Application and Bluetooth Communication

**Objective:** To evaluate the functionality and reliability of the mobile application and Bluetooth communication with the Arduino board.

**Procedure:** Tested the mobile application's features, including lane prioritization requests and real-time updates.

**Results:** The mobile application successfully communicated with the Arduino board via Bluetooth, allowing emergency vehicle operators to request lane priority seamlessly.

# Chapter 9 CONCLUSION AND FUTURE WORK

## 9.1 CONCLUSION

The smart traffic management system for emergency vehicles, implemented using IoT technology, has shown promising results in optimizing traffic flow, reducing response times, and enhancing overall safety. Through rigorous testing and evaluation, the system's components, including LED lights for signals, ultrasonic sensors for density detection, a lane prioritization algorithm, a mobile application with Bluetooth communication, and integration with emergency vehicles, have demonstrated their functionality and effectiveness.

Key findings from the testing phase include:

- LED lights effectively signalled different traffic statuses and were visible from various distances.
- The ultrasonic sensor accurately detected lane density variations, providing real-time data for lane prioritization.
- The lane prioritization algorithm successfully optimized traffic flow for emergency vehicles, reducing response times.
- The mobile application and Bluetooth communication facilitated seamless lane prioritization requests from emergency vehicle operators.

## 9.2 FUTURE WORK

Moving forward, several areas of improvement and expansion can be explored to enhance the smart traffic management system:

1. **Real-time Location Tracking:** Integrate GPS modules on emergency vehicles to track their real-time positions and optimize routing for faster response times.

2. **Traffic Prediction and Adaptive Control:** Incorporate machine learning algorithms to predict traffic patterns and dynamically adjust signal timings for improved traffic flow.
3. **Emergency Vehicle Pre-emption:** Implement pre-emption capabilities to automatically adjust traffic signals in real-time based on approaching emergency vehicles' positions.
4. **Multi-City Deployment:** Expand the system's deployment to multiple cities to create a broader network for efficient emergency vehicle management across regions.
5. **Smart Intersection Management:** Develop advanced algorithms for managing intersections, including adaptive signal control and prioritization of multiple emergency vehicles.
6. **Cloud Integration:** Explore cloud-based solutions for data storage, analytics, and remote monitoring, enabling scalability and enhanced system performance.
7. **Public Awareness Campaigns:** Conduct public awareness campaigns to educate drivers and pedestrians about the importance of yielding to emergency vehicles and following traffic guidelines.

By addressing these areas in future work, the smart traffic management system can further evolve into a comprehensive solution for enhancing emergency response capabilities and improving overall traffic efficiency.

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# APPENDIX A

# PROJECT COMPETITION DETAILS

Participated in the "State Level Project Competition-2024" conducted on 27th of April 2024, organised by the Department of Information Science and Engineering, Bangalore Institute of Technology, Bengaluru – 560004.

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DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

STATE LEVEL PROJECT COMPETITION-2024

CERTIFICATE

This is to certify that Mr./~~Ms.~~ Uday Kumar. A has participated in the "State Level Project Competition-2024" conducted on 27th of April 2024, organised by the Department of Information Science and Engineering, Bangalore Institute of Technology, Bengaluru - 560004.

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This is to certify that Mr./Ms. Sandeep Kumar Pradhan has participated in the "State Level Project Competition-2024" conducted on 27th of April 2024, organised by the Department of Information Science and Engineering, Bangalore Institute of Technology, Bengaluru - 560004.

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Dr. J. Prakash
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Dr. Aswath M.U.
Principal,BIT

# PUBLISHED PAPER DETAILS

## Research paper link

https://ijarcce.com/papers/smart-traffic-management-system-for-emergency-vehicles/

## The code is uploaded in the following GITHUB link mentioned

https://github.com/udaykshatriya/The-Smart-Traffic-Management-System-for-Emergency-Vehicles

# The Smart Traffic Management System for Emergency Vehicles Using IoT

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