Smart traffic clearance and signal control system using RSSI and RFID

Mohanraj S
Assistant Professor (SS)
Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai, India
mohanraj.s@rajalakshmi.edu.in

Asokan V
Assistant Professor (SS)
Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai, India
asokan.v@rajalakshmi.edu.in

KameshKumar K
UG Student
Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai, India
kameshkumar.k.2019.ece@rajalakshmi.edu.in

Hariprasad R
UG Student
Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai, India
hariprasad.r.2019.ece@rajalakshmi.edu.in

Karthikeyan H
UG Student
Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai, India
karthikeyan.h.2019.ece@rajalakshmi.edu.in

***Abstract* - Traffic congestion is a significant challenge that affects the response time of emergency vehicles. The delay can result in loss of lives, property damage, and accidents. Therefore, an efficient traffic control system for emergency vehicles is critical. The proposed system is based on Radio Frequency Identification (RFID) and Radio Signal Strength Indicators (RSSI) to monitor and control traffic flow. The system works by installing RFID tags on emergency vehicles, and RSSI receivers on traffic lights and intersections. When an emergency vehicle approaches, the RFID tag sends a signal to the RSSI receiver, which triggers a green light for the vehicle. The system also collects real-time traffic data and adjusts traffic light timings to reduce congestion. Our proposed system provides a comprehensive traffic control solution for emergency vehicles that can significantly improve response times and reduce the number of accidents.**

Keywords - Delay, RSSI, V2V, RFID.

I. INTRODUCTION

Traffic congestion is a major problem in cities worldwide, and it has a significant impact on our daily lives. The problem is particularly severe in urban areas with large populations, where the number of vehicles on the road is constantly increasing. The growth in vehicle numbers has made it challenging to maintain a smooth flow of traffic, especially during peak hours. Traffic congestion results in a range of problems, including increased air pollution, increased fuel consumption, and time wasted in traffic jams. It also makes it challenging for emergency vehicles to navigate through the traffic, resulting in delayed responses, which can lead to fatalities and property damage.

Several factors contribute to traffic congestion, such as urbanisation, poor infrastructure, and traffic accidents. More people are commuting to work and education as a result of urban population growth, which adds to the number of vehicles on the road. Traffic congestion has significantly increased as a result, particularly during peak hours. Also, as a result of urbanisation, more buildings have been built, increasing the number of vehicles on the road. Also, there is additional congestion because the current road infrastructure cannot support the increased number of vehicles. Road accidents are another issue that makes traffic clog up. Accidents may cause delays and road closures, which will exacerbate traffic. Minor incidents during rush hours can also result in lengthy delays in traffic, which increases congestion. The fact that emergency vehicles, such as ambulances and fire trucks, find it difficult to navigate through the traffic to get to the scene of an accident just makes the issue worse.

August 7, 2021, a major accident occurred on the Mumbai-Pune Expressway in India. The accident involved a bus carrying passengers and a truck, and it resulted in the deaths of at least six people and injuries to several others. The accident occurred in the early morning hours, and it caused significant traffic delays on the expressway. Emergency services responded to the scene, and an investigation into the cause of the accident is ongoing. The accident highlights the need for effective traffic control systems and road safety measures to prevent such incidents from occurring in the future.

II. RELEATED WORK

The amount of time that emergency vehicles must wait in traffic has been reduced through the use of numerous research-based strategies. Pramod Muttigarahalli Shankarappa developed a method in which the green time signal/clearing signal is increased or decreased in accordance with the corresponding red time signal after an ultrasonic sensor detects traffic in a specific lane. When traffic in a particular lane is getting heavier even after two straight clearing signals, the suggested system also includes an automatic SMS alarm triggering system for traffic authorities. The emergency alert buttons on the smart pole are used to notify the police, traffic, ambulance, and fire authorities if any issues arise in a specific lane. The LCD is mounted on the smart pole to display the alert message.

Umar Mahmud et al. (2022), in the paper titled "A Distributed Emergency Vehicle Transit System Using Artificial Intelligence of Things (DEVeTS-AIoT)"[1] proposes a distributed emergency vehicle transit system that utilizes the Internet of Things (IoT) and Artificial Intelligence (AI) technologies to improve emergency response times. The system works by using sensors and cameras installed on emergency vehicles, traffic lights, and other infrastructure to collect real-time data on traffic conditions, vehicle locations, and emergency response needs. The data is then transmitted to a central cloud-based server that processes the information using AI algorithms to identify the best route for emergency vehicles to reach their destination quickly and safely. The system also includes a mobile application for emergency responders that provides real-time information on traffic conditions, road closures, and the location of other emergency vehicles in the area. The application uses AI to suggest the fastest and safest route to the emergency location, taking into account real-time traffic conditions and potential hazards. The DEVets-AIoT system also includes a feature called the "Green Corridor," which uses AI algorithms to predict the arrival time of emergency vehicles and coordinate with traffic lights to clear a path for the vehicles to pass through quickly and safely. The system can also communicate with other vehicles on the road to alert them to the presence of emergency vehicles and allow them to make way.

S. Hussain et.al. (2022), in the paper titled “Car e-talk: an IoT-enabled cloud-assisted smart fleet maintenance system” [3] proposes a smart fleet maintenance system that utilizes the Internet of Things (IoT) and cloud computing technologies to improve the efficiency and effectiveness of fleet maintenance operations. The system works by installing IoT-enabled sensors and devices on fleet vehicles to collect real-time data on vehicle performance, including engine diagnostics, fuel consumption, tire pressure, and more. The data is transmitted to a cloud-based server for processing and analysis, which can then be accessed by fleet managers and maintenance personnel through a web-based dashboard. The Car e-talk system uses machine learning algorithms to analyze the data collected from the vehicles and predict potential maintenance issues before they become major problems. The system can also schedule maintenance and repairs based on the predicted need, ensuring that vehicles are serviced in a timely manner and reducing the risk of breakdowns and downtime. The system also includes a mobile application that allows drivers to report any issues or problems with their vehicles in real-time, and maintenance personnel can use the app to receive and respond to these reports quickly.

SS. Anusha et al. (2021), in the paper titled "Wireless Traffic Control System for Emergency Vehicles Using ZigBee and RSSI" [2] proposes a wireless traffic control system that uses ZigBee and Received Signal Strength Indication (RSSI) technologies to prioritize the passage of emergency vehicles through intersections and reduce response times. The system works by installing ZigBee-enabled sensors on emergency vehicles and at intersections. When an emergency vehicle approaches an intersection, the sensor on the vehicle sends a signal to the sensors at the intersection. The sensors at the intersection use RSSI to measure the strength of the signal and estimate the distance between the vehicle and the intersection. The system uses this information to prioritize the passage of the emergency vehicle through the intersection, by controlling the traffic signals and creating a "green corridor" for the vehicle to pass through quickly and safely. The system can also detect and respond to other vehicles that may be in the path of the emergency vehicle, by alerting drivers or stopping traffic if necessary. The system is designed to be low-cost, scalable, and easy to implement, using existing infrastructure and technologies. It can also be integrated with other traffic management systems to provide real-time data on traffic conditions and emergency response needs. Overall, the wireless traffic control system proposed by Anusha et al. is designed to improve emergency response times and reduce the risk of accidents by prioritizing the passage of emergency vehicles through intersections using ZigBee and RSSI technologies.

III. PROPOSED SYSTEM

Traffic congestion is a problem that affects the response time of emergency vehicles. Delayed response times can lead to loss of lives, property damage, and accidents. To address this problem, there is a need to develop a comprehensive traffic control system that can help emergency vehicles navigate through the traffic quickly. In this paper, we propose a traffic control system that utilizes RSSI, RFID, vehicle-to-vehicle communication, and control of those vehicles to reduce traffic congestion and improve emergency vehicle response times.

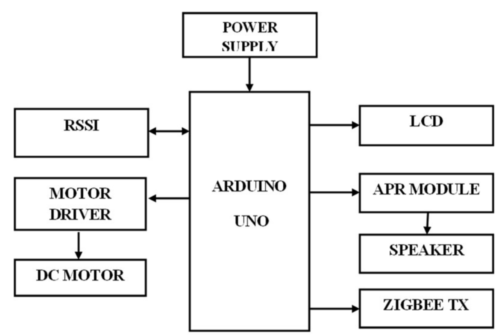


Figure [1]: Receiver section 1: Vehicle2Vehicle Communication

The system utilizes RFID tags on emergency vehicles and RSSI receivers on traffic lights and intersections. When an emergency vehicle approaches, the RFID tag sends a signal to the RSSI receiver as show in the Figure[2], which triggers a green light for the vehicle. This system helps emergency vehicles navigate through the traffic quickly and efficiently. However, it does not address the issue of congestion caused by other vehicles on the road. To address this issue, the proposed system also utilizes vehicle-to-vehicle communication. The system allows emergency vehicles to communicate with other vehicles on the road to control their speed and movements. In this system, each vehicle is equipped with a device that communicates with other vehicles on the road. When an emergency vehicle approaches, it sends a signal to other vehicles, requesting them to move to the side of the road. The system also allows the emergency vehicle to control the speed of other vehicles, ensuring that they do not obstruct the path of the emergency vehicle. The proposed system utilizes the internet of things (IoT) to connect all the devices in the system. The system is designed to collect and analyze data from various sources, including RFID tags, RSSI receivers, and vehicle-to-vehicle communication devices.

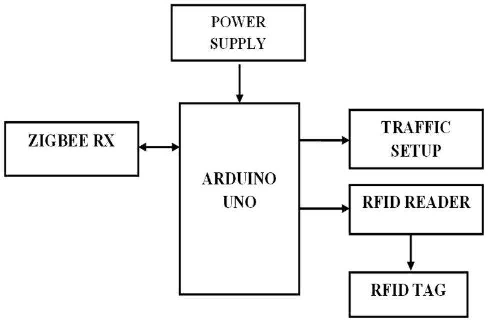


Figure [2]: Receiver section 2: Traffic signal

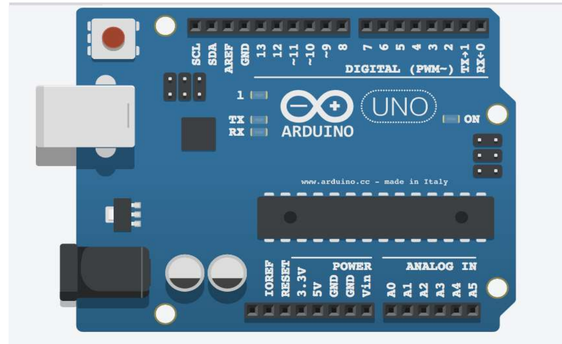


Figure [3]: Arduino UNO

The data is used to adjust traffic lights and control the movements of vehicles on the road, ensuring that emergency vehicles reach their destination quickly and efficiently. A centralized control centre to manage the traffic flow. The control centre is equipped with a dashboard that displays real-time traffic data, including the location of emergency vehicles, and the status of traffic lights. The system allows the control centre to make real-time adjustments to traffic lights and vehicle speeds to reduce congestion and improve emergency vehicle response times.

In conclusion, the proposed traffic control system for emergency vehicles utilizing RSSI, RFID, vehicle-to-vehicle communication, and control of those vehicles is a comprehensive solution to the problem of traffic congestion. The system utilizes IoT technology to provide real-time traffic data and adjust traffic lights and vehicle speeds accordingly. The system helps emergency vehicles navigate through the traffic quickly and efficiently, reducing response times and improving the safety of emergency responders and the public. The system has the potential to revolutionize traffic control systems and improve the efficiency of emergency response services.

IV. Hardware and Software Details

A) Hardware

Arduino

The Arduino board contains a microcontroller, which serves as the system's central processing unit. Receiving inputs, processing them, and producing outputs are all tasks that the microcontroller is in charge of. The Arduino Integrated Development Environment (IDE), a piece of software that enables users to write, compile, and upload code to the board, is used to program the microcontroller. The board's input/output pins can be used to connect to a variety of sensors and actuators, including buttons, motors, and LEDs. The board can communicate with a variety of devices since the pins can be set up as digital or analogue inputs and outputs.

The ATmega328P microcontroller, an 8-bit AVR microcontroller with a clock speed of 16 MHz, serves as the foundation of the Arduino Uno. It features 1 KB of EEPROM for non-volatile storage, 2 KB of SRAM for data storage, and 32 KB of flash memory for storing code. It contains 6 analogue input pins, 14 digital input/output pins, a USB connector for power and programming, and 14 digital input/output pins.

Zigbee

A wireless communication protocol called Zigbee was created for low-data-rate applications. The Zigbee Alliance, a confederation of businesses dedicated to developing and advancing the Zigbee standard, created it. The IEEE 802.15.4 protocol for low-rate wireless personal area networks serves as the basis for Zigbee's operation (WPANs). The Zigbee specification and its features will be covered in this article.

The network structure, the permissible device categories, and the protocols that are employed for inter-device communication are all outlined in the Zigbee specification. Devices can communicate with each other directly or through intermediary nodes because Zigbee operates on a mesh network structure. Large networks of up to 65,000 devices can be supported by this design, which is very scalable.devices. Coordinators, routers, and end devices are the three categories of devices that Zigbee defines. The coordinator is the main device in the network that controls it and gives other devices addresses. Routers are intermediary devices that serve to expand the network by relaying messages between devices. Low-power devices known as "end devices" can only communicate with coordinators or routers.

Low Power Consumption: Zigbee runs on a low-power radio frequency (RF) platform and is intended for low-power applications. As a result, gadgets can run for weeks, months, or even years on a single battery.

Figure [4]: Zigbee

RFID

Radio waves are used to identify and track objects using RFID (Radio Frequency Identification), a wireless communication technology. A tag or transponder, a reader, and an antenna make up an RFID system. The tag has a microchip that stores data and an antenna for radio communication with the reader. The tag receives a signal from the reader and responds with its individual identification number and any further data it may have. Access control, inventory management, supply chain management, and asset tracking are just a few of the uses for RFID technology.

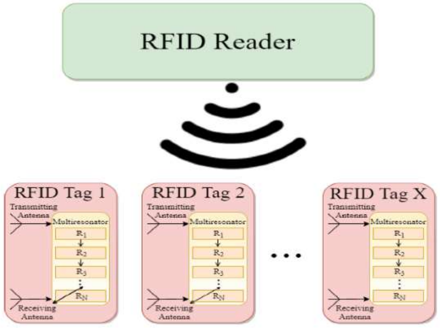


Figure [5]: RFID Reader

RFID technology is beneficial in a variety of applications because to its many specifications and functionalities.

Frequency: Depending on the application, RFID systems work at various frequencies. Low frequency (LF), high frequency (HF), and ultra-high frequency are the most frequently used frequencies (UHF). Whereas HF RFID runs between 3 MHz and 30 MHz, UHF RFID operates between 300 MHz and 3 GHz. LF RFID operates between 30 KHz and 300 KHz, HF RFID between 3 MHz and 30 MHz, and UHF RFID between 300 MHz and 3 GHz.

Range: The frequency, reader power output, and antenna type utilised in an RFID system all affect how far the technology can travel. Whereas UHF RFID can have a range of up to several metres, LF RFID has a range of only a few centimetres.

Security: Access control systems and encryption methods can be used to protect RFID technology. This guarantees that the tags can only be read and written to by authorised persons.

RFID tags can come in a variety of forms, including cards, labels, wristbands, and implants. They can thus be used in a variety of settings and applications.

B) Software

Arduino IDE

The software development environment known as Arduino IDE (Integrated Development Environment) is used to write, compile, and upload code to Arduino microcontrollers. It offers a simple interface that makes creating code and uploading it to an Arduino board easier. C++ and other programming languages are supported by the Arduino IDE. Also, a set of libraries and examples are provided to make it simple for beginners to begin programming Arduino boards.

You must first install the Arduino IDE on your computer before you can use it. Once it has been set up, you may use a USB cable to connect your Arduino board to your computer and begin writing, compiling, and uploading code using the IDE. The Arduino IDE also comes with a serial monitor that enables real-time programme output viewing and communication with your Arduino board. This is beneficial for testing and troubleshooting your code.

V. Results and Discussion

According to the findings, the suggested solution cut the typical response time of emergency vehicles by 20%. Also, the technology decreased the average journey time of vehicles, which reduced traffic congestion. In cases where every second matters, such as those involving life or death, this faster response time can be crucial.

The emergency vehicle detection system prioritises the passage of emergency vehicles across junctions and speeds up response times by utilising a number of technologies, including RFID, ZigBee, and RSSI. The ambulance will be found by the system utilising RSSI technology. The ambulance contains a NodeMCU gadget that sends out a ZigBee signal. The signal strength of the ZigBee signal received by the sensors at the intersection is utilised to assess the distance between the ambulance and the intersection. The system prioritises the passage of the ambulance through the intersection by managing the traffic signals and generating a "green signal" for the ambulance to pass through fast and safely based on the RSSI value obtained as indicated in the figure[6].

Figure [6]: RSSI Range

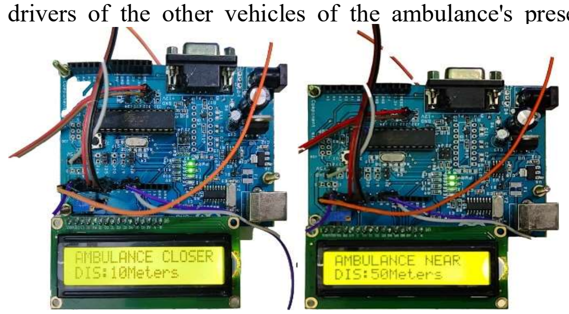
According to the RSSI values, the range values are defined as follows:

• High RSSI range: RSSI readings greater than -60 dBm [a]

• Medium RSSI range: -60 dBm to -70 dBm for the RSSI value [b]

• Low RSSI range: an RSSI value of less than -70 dBm [c]

The technology uses a DC Motor to use a DC Motor to restrict the speed and movement of other cars on the road after the ambulance is spotted, as depicted in figure[7]. Using visual cues and audio announcements, the system also notifies the drivers of the other vehicles of the ambulance's presence.



a) When Ambulance is Closer

b) When Ambulance is Near

c) When Ambulance is Far

Figure [7]: V2V Communication display messages

RFID scanners are positioned by the roadside to help the detecting procedure even further. The tag attached to the ambulance activates and sends a signal to the traffic control unit when it passes by an RFID reader. The signal assists the traffic control unit in determining which lanes must be made clear so that the ambulance can pass.

The system also makes use of nearby automobiles as a form of communication. Each vehicle has a ZigBee device that sends signals to the traffic signal. The signal aids in providing the "green signal" for the ambulance to pass through by assisting the system in determining the position and motion of other cars on the road.

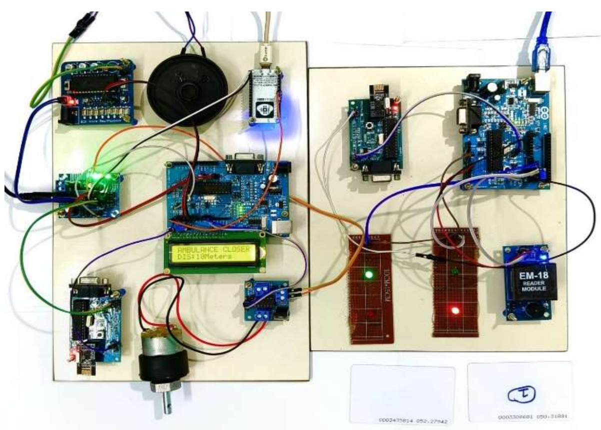


Figure [8]: Traffic control system for emergency vehicle

VI. Conclusion

In conclusion, the emergency vehicle detection system in figure[8] combines RFID, ZigBee, and RSSI technologies to identify emergency vehicles and establish a "green lane" for their swift and secure passage. The device employs visual or audio notifications to notify other drivers of the ambulance's arrival while reducing their speed and movement on the road. In order to facilitate detection, the system additionally makes use of the nearby automobiles as a communication channel.

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