Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 6 (2023)

Emergency Vehicle Traffic Management System Facilitating Expedited Response and Safety

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Abstract

An advanced infrastructure known as the Emergency Vehicle Traffic Management System (EVTMS) was created to guarantee quick response times and improve safety for emergency vehicles traveling through cities. By utilizing cutting-edge sensor technology, real-time data analytics, and sophisticated traffic control algorithms, emergency vehicle traffic management systems (EVTMS) maximize traffic flow and assign priority to emergency vehicles' routes, therefore reducing response times and upholding general road safety. The system uses smart objects to detect the emergency vehicle's impending siren beforehand, and it then frees up the incoming traffic lane by stopping traffic in the other lanes at the intersection.

Keywords-Object Detection, IoT, Ultrasonic Sensors, Congestion Control

1. INTRODUCTION

The goal of the project is to create a smart traffic management system that will improve traffic flow efficiency by using automated algorithms, sensors, and communication. The technology aims to lower traffic, commuter expenses, and pollution at junctions by dynamically altering traffic light timings depending on real-time vehicle presence. In the modern world, traffic is the primary cause of many problems for everyday living. In addition to the usual problems of congestion, traffic seriously impairs emergency vehicles' ability to operate normally. Emergency vehicles must be given priority over all other vehicles, but either because of unforeseen circumstances or because of selfish drivers, they are unable to arrive at their destinations on time, which can be fatal. It appears that a system must be in place that recognizes emergency vehicles before they arrive at a junction and clears the traffic in front of them beforehand.

In order to better manage and regulate the constantly expanding traffic, a variety of sophisticated traffic management technologies have been deployed in the last few years [1]. Passing EVs at periods of high traffic, however, is a problem that has to be solved. An electric vehicle (EV) is a car that can offer emergency assistance during a crisis. Typically, these cars are free from standard traffic laws so they may get to their location as quickly as possible. The three primary categories of EVs are law enforcement, firefighting, and medical. In order to assist them get to their destination as quickly as possible, these EVs are outfitted with visual and auditory warning systems [2, 3].

2. SYSTEM OVERVIEW

The aim of an emergency vehicle traffic management system is to improve safety and reaction times. It makes use of intelligent routing, real-time data processing, and sophisticated traffic monitoring to guarantee emergency vehicles can go quickly and safely. This system assists in allocating priority to emergency vehicles, cutting down on delays and enhancing the overall efficacy of emergency response by combining technology with traffic signalsand communication networks.

Levi L. Rose devised a traffic light control system [4] that is exclusively utilized by emergency vehicles. Each emergency vehicle has a sensor fitted, which transmits the signal to a receiver at each traffic light intersection. The signal code will be transmitted to the recipient when the emergency vehicle arrives at the traffic light intersection. After the receiver demodulates the code, the intersection's red traffic light turns on. As a result, the

emergency vehicle will travel a different path than other cars to get to its destination. N.M.Z.Hashim [5] built a traffic light control system that uses an Arduino Mega 2560 to construct the emergency sequence mode of the traffic signal. The emergency vehicle's presence is initially recognized, and radio waves are used in wireless transmission mode to convey the message. The emergency signal code that the controller creates when it detects RF signals is changed back to normal after the responding vehicle has left the intersection.

3. RELATIVE WORKS

For emergency responders and the public to be safe as well as to enable quicker response times, an efficient emergency vehicle traffic management system is necessary. In order to maximize routes, reduce delays, and give priority to emergency vehicles in times of crisis, this system combines cutting edge technology with strategic planning. Authorities can dynamically modify traffic signals and impose temporary traffic control measures to provide clear routes for emergency vehicles by utilizing real-time data, including traffic conditions and incident sites. Additionally, driving education programs and public awareness campaigns may emphasize to drivers the value of obeying traffic laws and yielding to emergency vehicles. All things considered, reducing hazards and saving lives during crises are made possible by an effective emergency vehicle traffic management system.

4. TECHNOLOGY USED

4.1 *Ultrasonic Sensor*

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Fig.1 HC SR04 Ultrasonic Sensor

4.2 *RFID tags*

RFID tags are a type of tracking system that uses radio frequency to search, identify, track, and communicate with items and people. Essentially, RFID tags are smart labels that can store a range of information from serial numbers, to a short description, and even pages of data.

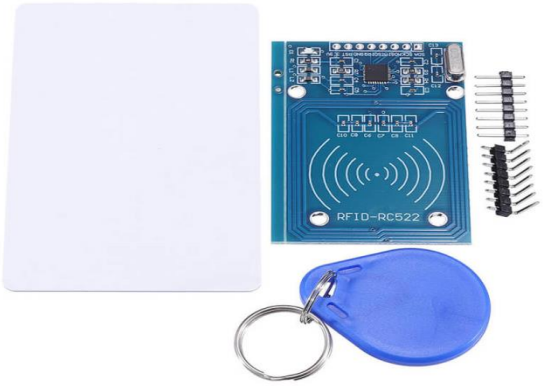

Fig.2RFID RC522 MODULE

4.3 *Arduino Mega*

Typically used to add a reset button to shields which block the one on the board. The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication.

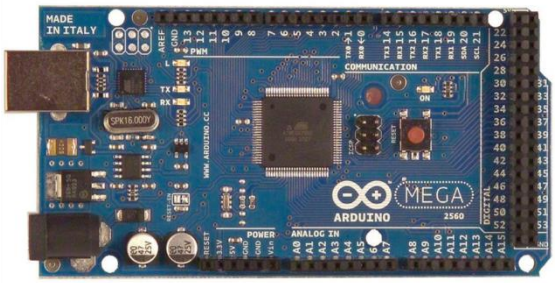

Fig.3Arduino Mega2560

4.4 *Arduino Nano*

The Arduino Nano is a microcontroller-based device with 16 digital pins that can be used for various purposes. It can be used for almost every task, from minor to massive industrial-scale projects. It can also be used for prototyping and developing new applications.

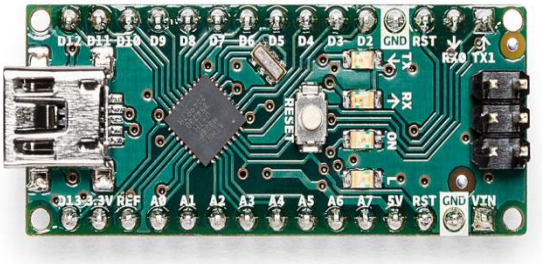

Fig.4Arduino Nano

5. BACKGROUND AND MOTIVATION

5.1 Background

Eff5ective emergency vehicle traffic management systems are essential to guaranteeing quick response times and upholding public and emergency responder safety in today's hectic metropolitan settings. The intricate urban infrastructure and growing population density provide formidable obstacles for emergency services trying to move quickly through traffic while following safety protocols. In crowded cities with frequent traffic, conventional traffic-flow aids like sirens and flashing lights are sometimes insufficient. Furthermore, other drivers may get confused or adopt risky driving practices as a result of these techniques.

In addition, these systems frequently have the ability to coordinate the actions of several emergency vehicles responding to the same incident, guaranteeing effective resource use and reducing latency. Allthings considered, improving the efficiency and security of emergency response activities in contemporary urban settings largely depends on the creation and application of strong emergency vehicle traffic management systems.

The paper [6] presents an IoT-based infrastructure for EV priority and self-organized traffic regulation at crossings. Three main parts make up the new platform and protocol called EVP-STC, which is being proposed. The junction controller first collects data on vehicle density and EV placement on each road segment approaching an intersection. It is installed at traffic lights. The junction controller then modifies the traffic signal timing in response to this real-time traffic data.

5.2 Motivation

Efficient traffic management systems for emergency vehicles are essential in contemporary urban settings to enable fast reaction times and guarantee the security of first responders and bystanders. The driving force for these kinds of technologies is the urgent need to maximize emergency services' capacity to move quickly through clogged roadways, particularly in high-stress scenarios where every second matters. Cities can greatly decrease response times, eliminate delays, and improve overall emergency service efficiency by putting modern traffic management technologieslike real-time traffic monitoring, predictive analytics, and smart routing algorithmsinto practice.

6. EXISTING SYSTEM ARCHITECTURE

The preset time schedules used by many of the present traffic signal control systems result in less than ideal traffic flow management. In order to address this issue, a cutting-edge solution is being looked for that makes use of automated algorithms and real-time sensor data from junctions to dynamically modify the length of the green and red lights for particular traffic directions**.**The current emergency vehicle traffic management system is meant to guarantee public and emergency responder safety while enabling quicker response times. Usually, a variety of technologies are used in this system, including traffic signal preemption.

Communication technologies also allow emergency vehicles and control center to coordinate in order to minimize traffic and maximize response routes. Although these developments, problems like constrained coverage regions, data transmission lag, or possible conflicts with normal traffic flow may arise, necessitating ongoing system maintenance and enhancement. For the purpose of to maximize response times and improve public safety in general during emergencies, current emergency vehicle traffic management systems which combine data-driven decision-making with real-time communication and safety measures represent a significant advancement in emergency response infrastructure.

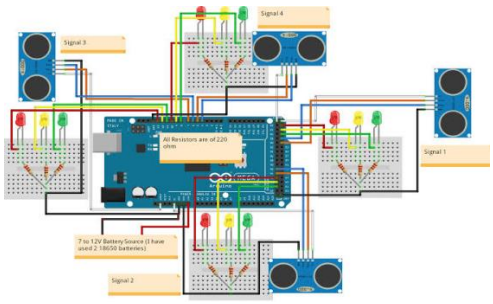

Fig.5Existing Architecture Diagram

7. PROPOSED SYSTEM ARCHITECTURE

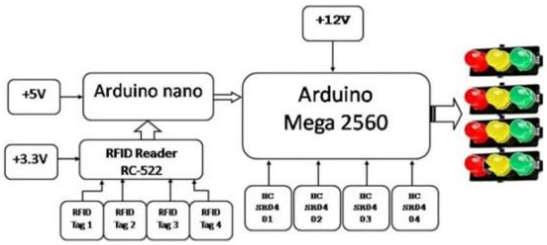

Fig.6Proposed Architecture Diagram

Create a smart traffic system that optimizes traffic signal timings based on real-time vehicle density, lowering traffic, commute expenses, and pollution at junctions. This may be achieved by utilizing sensors, communication and algorithms. Additionally, it uses an RFID reader to assist as an emergency vehicle. When an emergency vehicle approaches a signal, a smart object 100 meters away from the signal intersection uses a sound detection

sensor to detect the emergency vehicle's siren sound. Making a choice is the focus of the second phase. The Decision Support System will be deployed at the signal intersection. The smart devices that are positioned on the several routes that will meet at the intersection send signals to this system.

7.1. Priority Traffic Singal Control

At junctions, emergency vehicles are given priority clearance thanks to the integration of EVTMS with traffic light management systems. The technology automatically modifies traffic signals to give a green light in the direction of travel when an emergency vehicle approaches a crossroads, enabling the vehicle to go immediately.

7.2Dynamic Route Optimization

The most effective path for emergency vehicles is dynamically determined by the system using the current traffic situation, any closed roads, and other pertinent information. To guarantee the quickest reaction time, it takes into account variables including traffic congestion, road conditions, and the location of emergency situations.

7.3 Public Notification and Awareness

Through a variety of platforms, including social media, mobile applications, and electronic road signs, EVTMS informs the public of impending road closures, the presence of emergency vehicles, and detours that drivers may take to avoid traffic.

7.4 Vehicle to Insfrastructure (V2I) Communication

When an emergency vehicle is outfitted with Vehicle-to-Intruder(V2I)communication technology, it may instantly communicate its location, speed, and direction to the traffic control system. With the use of this data, the system may proactively modify traffic patterns to make room for the emergency vehicle that is coming.

7.5 *Emergency Vehicle Preemption*

To provide unhindered access for emergency vehicles, the system may also include the capacity to preemptively operate additional traffic management elements like railway crossings, toll booths, and drawbridges in addition to controlling traffic signals.

8. SYSTEM DATA

Sophisticated technology such as an emergency vehicle traffic management system is used to guarantee public and emergency responder safety as well as quicker response times. In order to minimize reaction times to events and crises, this system optimizes the routing and navigation of emergency vehicles through traffic by integrating many data sources and technologies.

Real-time traffic monitoring and analysis, which enables the determination of the best routes for emergency vehicles based on current traffic circumstances, is usually one of the system's key components.

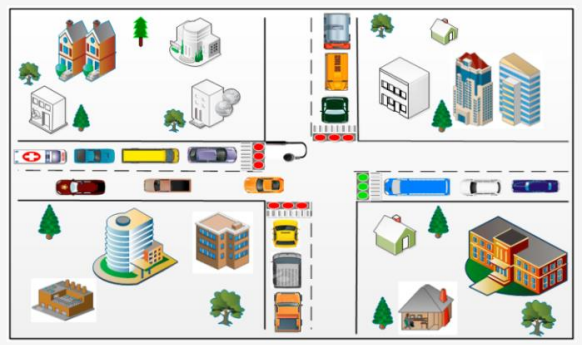

Fig.7Emergency vehicle waiting at an intersection.

9. RESULTS AND DISCUSSIONS

One essential tool for improving the effectiveness and security of emergency response operations is the Emergency Vehicle Traffic Management System (EVTMS). Faster reaction times are made possible with EVTMS, all the while protecting both people and emergency personnel. This system reduces delays and enhances

the efficacy of emergency response by optimizing route design, giving priority to emergency vehicles at traffic signals, and alerting cars to cede the right of way. In times of emergency, EVTMS is essential in preventing fatalities and limiting property damage due to its proactive approach to traffic management.

Furthermore, the traffic management system's emphasis on safety has produced impressive outcomes in reducing the dangers related to emergency response operations. The risk of crashes and accidents has been greatly decreased by implementing features like junction priority control, preemptive traffic signal modifications, and real-time communication between emergency vehicles and other road users. Moreover ,the system's capacity to adjust dynamically to shifting event patterns and traffic circumstances has proven crucial for preserving efficacy and efficiency in times of high demand or unanticipated catastrophes.

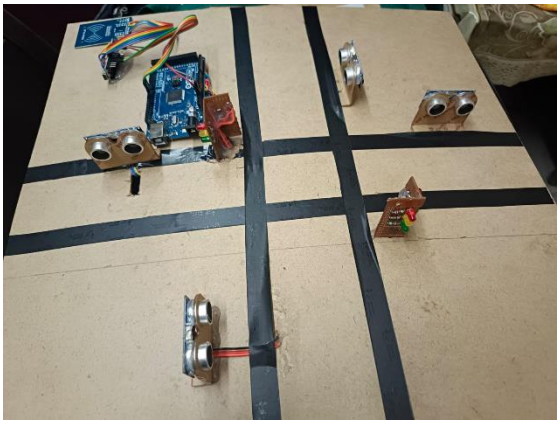

Fig.8Final Output

10. CONCLUSION

The deployment of an emergency vehicle traffic management system is a crucial step in guaranteeing quicker response times and improving public and emergency responder safety overall. By integrating modern technology such as real-time traffic monitoring, route optimization, and intelligent signaling, this system not only promotes the quick transit of emergency vehicles over congested streets but also eliminates the danger of accidents and delays. Communities can gain from better emergency response results and increased public safety through smooth coordination between emergency services and transportation authorities, eventually saving lives and protecting property.Thesystem's primary goal is to address the problem of emergency vehicles getting stuck for extended periods of time or delayed by slow-moving traffic.

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