Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 2082-2085 | ISSN:2251-6727

An Intelligent Traffic Signal System for Ambulance Priority Using Internet of Things

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(Received: 07 January 2024 Revised: 12 February 2024 Accepted: 06 March 2024)

KEYWORDS

Arduino,

ATMega 2560,

HC-05 Module,

LED,

LCD

ABSTRACT:

Introduction: Modern metropolitan surroundings face a great deal of traffic congestion, which is made worse by an increasing number of vehicles and a growing population.

Objectives: This proposed study seeks to alleviate this problem by introducing an innovative system that empowers ambulances to interact with traffic signals, accelerating their progress.

Methods: The Arduino ATMega 2560 microprocessor, Light Emitting Diodes (LEDs), and traffic signal relay are the key components of the system that work together to alert users to the presence of an approaching ambulance and modify the traffic signals. The proposed device turns the nearby traffic signal green and initiates a blue and green light sequence to indicate the ambulance's arrival. In the receiver component, a Bluetooth HC-05 module is employed to facilitate communication. Through a specialized program called Bluetooth Terminal HC-05, users can send signals to the traffic light system informing it of an approaching ambulance.

Results: The findings of the simulation verify that the proposed system is capable of quickly detecting the presence of an ambulance and effectively modifying traffic signals.

Conclusions: It may be easily installed on different road networks because to its affordability.

1. Introduction

Traffic congestion is a major problem in today's metropolitan environment because of the increasing number of cars on the road and the growing population. Effective emergency medical services are critical in these crowded settings. This proposed study sets out to create an intelligent traffic management system that gives emergency vehicles especially ambulances, fast clearance in order to address this difficulty. The objective of this system is to transform emergency vehicle traffic patterns by utilizing technological advancements and creative thinking [1]. Essentially, it presents a responsive and dynamic traffic signal system that enables ambulances to transmit their approach to traffic signals, enabling rapid and easy changes. Light Emitting Diodes (LEDs), Bluetooth technology, and the Arduino ATMega 2560 microprocessor form the sophisticated hardware combination at the core of this system. With this combination, ambulances can communicate with traffic lights and move through intersections safely and on time.

The proposed system is composed by a well-balanced three major components. The central control unit of the system is the Arduino ATMega 2560 microcontroller. It coordinates the whole system, allowing ambulances and traffic lights to communicate with each other without difficulty. The main mechanism is Light Emitting Diodes (LEDs), which act as visual communicators. These LEDs successfully alert nearby drivers and the traffic signal to the ambulance's presence with their blue and green light patterns. The Bluetooth HC-05 module, which enables wireless connection, is an essential link in the network. Ambulances may easily communicate to the traffic management system their location.

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2. Methods

An ambulance can use the Bluetooth HC-05 module to send a signal to the traffic system when it is getting close. The system responds to this signal by starting a visual signal series of blue and green LEDs, making sure that drivers in the locality and the traffic signal are both intensely aware of the ambulance's presence. The most significant example of the system's intelligence is when it automatically changes the nearby traffic signal to green, demonstrating its intelligence. Regardless of traffic congestion, the ambulance's quick adjustment enables it to pass through junctions quickly and without delay [2]. The architectural diagram of the proposed study is shown in Fig.1.

- Microcontroller ATmega2560 Operating Voltage 5V Input Voltage (recommended) 7-12V
- Input Voltage (limit) 6-20V
- Analog Input Pins 16
- DC Current per I/O Pin 20 mA DC Current for 3.3V Pin 50 mA
- Flash Memory 256 KB of which 8 KB used by boot loader SRAM 8 KB
- EEPROM 4 KB
- Clock Speed 16 MHz
- Digital I/O Pins 14 (of which 6 provide PWM Output)

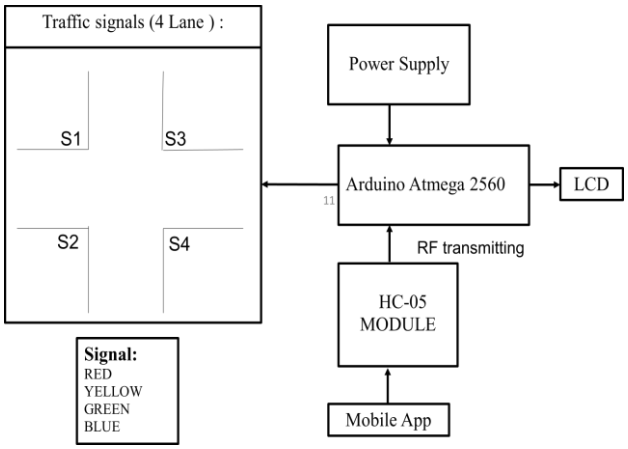

Fig. 1. Block diagram for the proposed model

This technique has several extensive advantages; the most notable are the intelligent reduced response time of ambulance. The method significantly improves emergency medical services' efficiency and may even save lives by accelerating ambulance transit. This delay reduction is crucial for both daily traffic management and emergency situations. The proposed study is distinguished by its affordability and adaptability to a broad range of road networks [3]. This study possesses the capacity to revolutionize urban traffic management by mitigating traffic congestion, enhancing signal control, and enhancing the overall effectiveness of emergency services. These outcomes would ultimately promote safer and more efficient urban settings.

3. Results

The promising results were obtained from both the simulation and testing phases of the intelligent traffic management system's installation. While using the Bluetooth HC-05 module for transmitting signal to the ambulance, this proposed system responded quickly and accurately. The adjacent drivers were aware of the up-coming ambulance along with the traffic signal using the blue and green LED lights. In particular, the opposite traffic's green signal changes in milliseconds, giving the ambulance unhindered access through the crossing.

The efficacy of the system in enhancing emergency medical services was demonstrated by the repeated validation of its ability to accelerate ambulance transit through simulations and real-world trials [4]. In addition, the practical execution demonstrated the project's cost-effectiveness and ease of installation, which matched the design goals of the proposed system. The developed structure is depicted in Fig. 2.

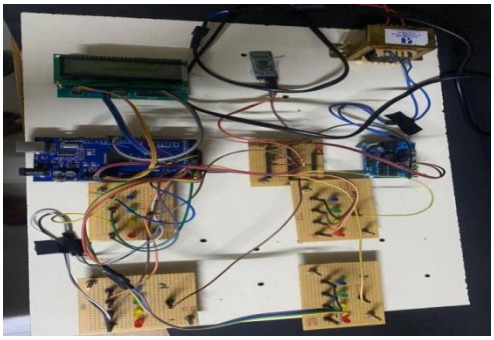

Fig. 2. Prototype for the proposed model

This study's outcomes show a significant improvement in urban traffic management, especially when it comes to giving priority to emergency vehicles.

TABLE I. RANGES OF TEMPERATURE AND VOLTAGE

Item	Symbol	Min	Max	Unit
Power Voltage	VDD -VSS	0	7.0	V
Input	Vin	VSS	VDD	

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Item	Symbol	Min	Max	Unit
Voltage				
Operating Temperature Range	TOP	0	+50	T
Storage Temperature Range	TST	-20	+60	

When combined with the autonomous traffic signal modification, the system's ability to respond quickly to ambulance signals demonstrates how it could revolutionize emergency services in crowded urban settings. By reducing response times, it not only enhances the efficiency of emergency medical services but also holds the potential to save lives in critical situations [5]. Moreover, the system's positive impact on road user safety cannot be overstated. Minimizing the time ambulances spend idling at congested intersections contributes to a safer environment for all road users. This is particularly significant in densely populated urban areas where traffic congestion is a recurring challenge. The adaptability and cost-effectiveness of the system suggest that it can be seamlessly integrated into various urban road networks without the need for extensive infrastructure changes. This scalability makes the development a viable solution for a wide range of urban environments. In the broader context of urban traffic management, this project aligns with the vision of smarter and more responsive cities [6]. It introduces an intelligent and dynamic element to traffic signal control, easing congestion, optimizing signal adjustments, and fostering a safer and more efficient urban environment. As smart city concepts evolve, this system's integration could play a pivotal role in creating technology-driven and interconnected urban landscapes. Overall, the project's results and potential ramifications underscore its significance in addressing contemporary traffic management challenges [7].

This work is very effective, as evidenced by its outcomes, where the potential to revolutionize emergency services in busy urban areas is highlighted by the quick and accurate response to ambulance signals. The instantaneous activation of blue and green LEDs, and the automatic adaptation of traffic signals that were demonstrated during testing. It has the potential to improve emergency medical services' competence by drastically reducing ambulance response times, a breakthrough that could have a big impact on public health and safety.

It helps create a safer urban environment by reducing the amount of time ambulances are stuck at busy junctions. The system's flexibility and cost-effectiveness make it a adaptable solution that can be enthusiastically implemented in diverse urban landscapes, regardless of existing infrastructure. Its capacity to grow ensures that it remains significant in tackling traffic management issues on a worldwide scale while also improving accessibility and utility. The developed detection system is shown in Fig. 3.

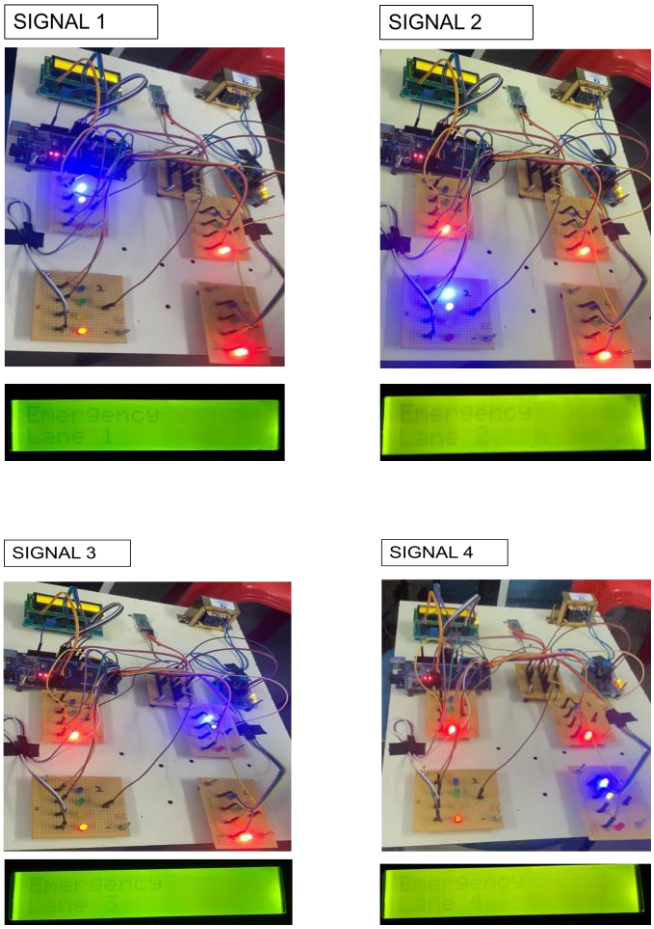

Fig. 3. Results of the proposed system

Conclusion

The establishment of an intelligent traffic management system characterizes a leap into a smarter, more efficient future in a world where urban traffic congestion presents ever-greater obstacles. This work recommends a possible solution to the long-standing problem of congested streets and delayed emergency response recognition to its integration of progressive components and creative functionality. In conclusion, this work represents a significant step towards tackling modern traffic management

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challenges. It not only promises to revolutionize emergency response times but also contributes to safer and more efficient urban roadways. Cities hoping to give their citizens a safer and more intelligent future have a potential option in this technology because of its scalability, affordability, and adaptability.

4. Conclusions

As part of the system, the ambulance will have a mobile application that will employ cameras to detect traffic congestion in traffic signals, send out a separate signal, and then communicate that information to the user via a cloud platform. If there is an heavy traffic, a Google API (Digital Map) alternative route or hospital is displayed. The traffic signal will get a signal from the ambulance when it gets close to it, and as a result, both the blue and green lights should be switched on. This blue light will alert approaching drivers and motorists to the presence of an ambulance and advise them to give the traffic light priority.

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