Emergency Vehicle Traffic Control using RFID

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Abstract

An enhanced traffic control system with a preference for emergency vehicles is proposed and put into practice by this research project. It leverages both cutting-edge Dynamic Traffic Sequence Algorithm (DTSA) technology and RFID (Radio Frequency Identification). The system aims to lessen traffic by permitting emergency vehicles on the road like ambulances or fire trucks to reach their destinations without unnecessary stops. The novel DTSA is realized using an Atmega 328 microcontroller, which controls the whole traffic management system, including the RFID and the LCD screen.

Keywords: Atmega 328 microcontroller, UHF(Ultra high frequency) RFID

1. Introduction

With the significant increase in population, particularly in developing countries like India, there has been an increasing number of automobiles overall on the roads. This surge has resulted in frequent road accidents and traffic congestion. One of the critical issues during traffic congestion is the delay emergency vehicles such as ambulances or fire engines face, which makes saving human lives challenging. To address this issue, this paper proposes an RFID-driven technology. To facilitate escape from traffic jams, the system controls and monitors traffic signals at intersections when an emergency vehicle approaches. This research aims to simulate real-time traffic scenarios by modeling the proposed framework using Arduino and LED (Light emitting diode) displays. Simulation results demonstrate improved performance in detecting and managing emergency vehicles. [2] With an emphasis on emergency vehicles, this research effort suggests and develops an enhanced traffic control system. Using a cutting-edge Dynamic Traffic Sequence Algorithm (DTSA) and RFID technology, the system aims to lessen gridlock at the signals by permitting emergency vehicles to reach their destinations without unnecessary stops by changing the Traffic signals and displaying an emergency text on the LCD (Liquid Crystal Display) display. The DTSA is released using an Atmega 328 microcontroller (Arduino UNO), which controls the complete traffic control system as well as the RFID and the LCD.[1]

2. Literature Survey

The primary objective of this system is to lessen traffic congestion by enabling emergency vehicles, such as ambulances, to arrive at a certain area without needing to stop at traffic signals until they get there. The framework integrates RFID technology with LabView programming. [4] In emerging nations like India, the populace is increasing, resulting in the number of automobiles on the road growing exponentially. This surge results in road accidents and traffic congestion. It becomes difficult to save lives when An emergency vehicle, like a fire engine or ambulance, is caught in heavy traffic. An RFID-based proposed system aims to address this issue.

This technology facilitates a simple escape from traffic jams by controlling and regulating traffic signals at intersections when an emergency vehicle approaches. Real-time traffic scenarios are simulated by the suggested framework with the use of Arduino and LED displays. Results from simulations show enhanced performance in detecting and managing emergency vehicles. [5][11] The fuss is caused between emergency vehicles like ambulances, Police Vehicles, etc., and public road users. This system provides a solution to overcome this vulnerability. The quantity of automobiles on the road has increased rapidly in response to the notable population rise, particularly in emerging countries such as India. Congestion in the roads and frequent road mishaps are the results of this surge. The primary problem is traffic jams that make it harder to save lives. Jams cause delays for fire engines and ambulances during congestion.[8]This research suggests an RFID-based solution to deal with this problem. To facilitate escape from traffic jams, the system controls and monitors traffic signals at intersections when an emergency vehicle approaches. This study uses Arduino and LED displays to mimic the suggested framework to simulate real-time traffic scenarios. [6][9]

3. Proposed Work

The flowchart (Figure 1) presents a systematic framework designed to prioritize emergency vehicles at traffic signal junctions using RFID technology. The sequence initiates with the detection of an RFID tag unique to emergency vehicles. Upon recognition of the RFID tag, the system evaluates the current signal state. If the signal is green, the process terminates as no intervention is required. Conversely, if the signal is red, the system activates a visual cue, displaying the message "Emergency vehicle approaching," thereby alerting other drivers to the impending signal change.

After a brief one-second delay, presumed to ensure driver awareness, the framework commands the traffic signal to alter its state, granting the emergency vehicle passage by switching the light in its lane to green while simultaneously converting all other signals to red. This state is maintained to provide the emergency vehicle with an unobstructed route.

As the vehicle progresses through the intersection, the framework's attention shifts to the subsequent lane, where a second RFID reader is stationed. This reader verifies the passage of the specific emergency vehicle by detecting the same RFID tag number.

A successful tag match initiates the signal reset procedure, reinstating the regular traffic signal operation. Suppose there is a mismatch or no tag is detected, indicating the potential presence of another emergency vehicle or a system error. In that case, the signal does not reset, and the system reverts to assessing the signal color for the subsequent vehicle.

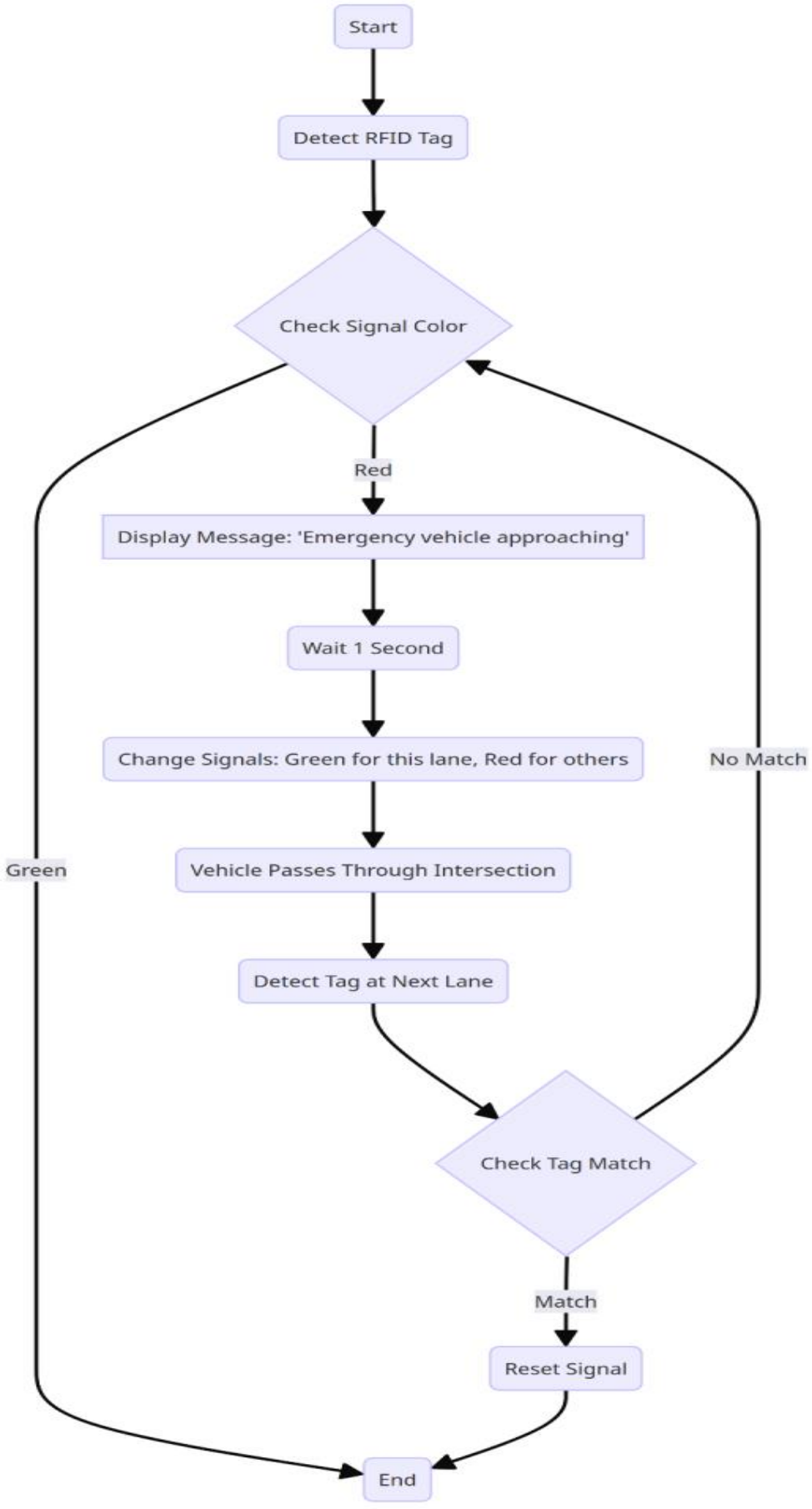

Figure 1. Flowchart

The process concludes following the reset of the traffic signal, indicating the completion of the emergency vehicle's passage through the intersection and the resumption of the standard traffic control protocol.

Supposedly there is an incoming emergency vehicle, an RFID card will be along the vehicle, and an RFID scanner beside the road, the card will be scanned then initially the system will check if the card is authorized by verifying the unique ID of the card. RFID (Radio Frequency Identification) cards are a type of smart card that utilizes radio waves to transmit data from an embedded chip to a reader. It consists mainly of 3 components namely microchip, antenna, and reader. The microchip is embedded within the card. It stores and processes data. It contains an antenna to enable wireless communication. The antenna is usually a small coil of wires that surrounds the microchip. It receives and transmits radio frequency signals to and from the reader. The reader is a device that generates radio waves and receives signals back from the RFID tag. It is sometimes referred to as an interrogator or scanner. Readers can be either handheld or fixed. RFID cards are an integral part of modern identification and access control systems, providing a convenient and efficient way to manage and secure various aspects of our lives. An RFID (Radio Frequency Identification) reader, also known as an interrogator or scanner, is a device that communicates with RFID tags to read and process data stored on them. The components consist of an antenna, RFID module, and power supply. The antenna emits radio waves to communicate with the RFID tags and receives data back from them. The RFID module consists of circuitry that processes the data received from the antenna and communicates with the host system. RFID readers can be powered by various means, such as a direct power source, Power over Ethernet (PoE), or batteries for mobile readers. It contains 12 characters. If the RFID card is authentic and if the signal is red then the signal is turned to green. To make sure that the signal works as usual after the emergency vehicle crosses the road crossing, another set of RFID readers will be there on the other side of the route. After the RFID tag is read the light of signal works as usual. On the other, if the RFID card is unauthorized there will be no effect on the signal. It will work normally.

4. Experiment

Use of UHF RFID module

In the proposed traffic management framework, the deployment of Ultra High Frequency Radio Frequency Identification (UHF RFID) technology is integral. The selection of UHF RFID is predicated on its superior range capabilities, which facilitate the detection of emergency vehicles' RFID tags from distances up to 15 meters. This extended range is critical for preemptive signal changes at intersections. Moreover, UHF RFID's rapid tag recognition is essential for accommodating the high-velocity transit of emergency responders.

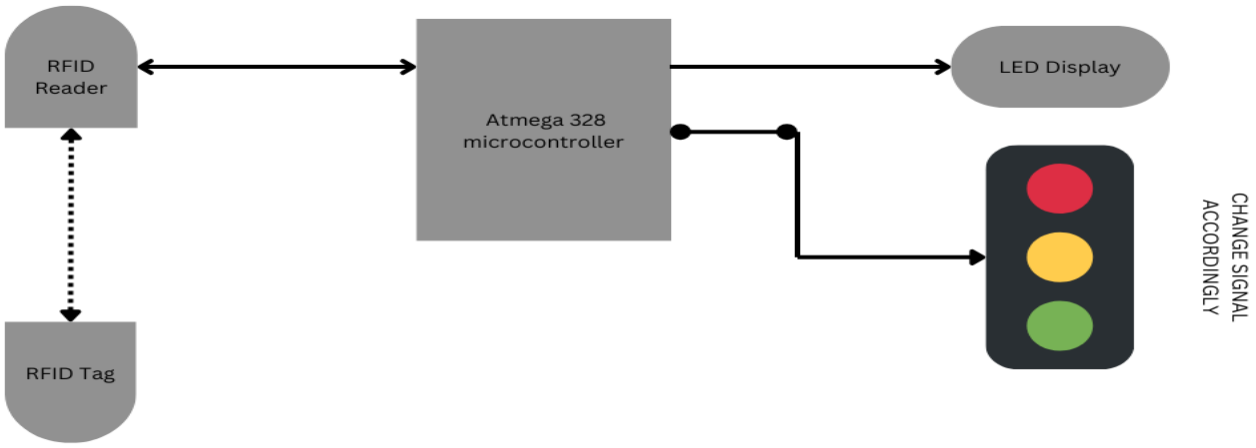

Figure 2: Block Diagram

The capability of UHF systems to process numerous tags concurrently is particularly advantageous at multi-lane intersections where simultaneous emergency responses might occur. Importantly, UHF RFID does not necessitate a visual connection with the tag, providing flexible tag placement on the vehicles and ensuring consistent performance regardless of environmental variables.

The economical aspect of UHF RFID tags, compared to their active counterparts, renders this solution fiscally viable for large-scale applications across multiple vehicles and traffic control points. This cost efficiency does not compromise the seamless integration with existing traffic management infrastructures.

As we can observe in Figure 2 we scan the RFID tag towards the RFID reader, and then the signal from the RFID reader is sent to the Atmega 328 microcontroller. The microcontroller processes the signal and changes it according to a program. The microcontroller then sends a signal to the LED display, which illuminates accordingly. The LED display could show a green light if the RFID tag is authorized, or a red light if it is not.

Figure 2 displays the system designed for enhanced traffic management. The architecture includes a combination of an RFID module, an Arduino Uno microcontroller, a power supply, an LED display, and traffic lights, all integrated to efficiently manage traffic flow.

The core of the RFID module lies in its ability to transmit and receive signals. The transmitter emits a unique RFID signal, which the receiver captures. Upon reception, the signal is sent to the Arduino Uno. This microcontroller board, based on the ATmega328, is tasked with processing the incoming RFID data to discern the presence and category of the vehicles at the intersection.

Utilizing the RFID data, the Arduino Uno executes algorithms designed to determine the traffic conditions in real time. When an emergency vehicle is detected, the microcontroller triggers a change in the traffic light sequence. This automated prioritization ensures that emergency vehicles can quickly go across the intersection which will save many lives.

Fig. 3 details the experimental arrangement employed to validate the proposed system. The setup mimics a real-world intersection where various miniature vehicles, inclusive of an emergency unit, are utilized to simulate traffic scenarios. Each toy vehicle is outfitted with an RFID tag to represent the transmitters,

while RFID readers are positioned strategically near the mock junction, approximately one meter from the crossing points.

As a vehicle approaches and reaches the designated RFID reader's zone, the transmitted RFID signals are picked up and relayed to the Arduino controller. These signals are carried through conductive connections, traditionally implemented using copper wiring. The Arduino Uno, after receiving this information, assesses vehicle density and adjusts the traffic lights accordingly. This dynamic alteration of traffic signals is displayed through a compact LED display that stands in for the full-scale traffic lights, thereby completing the simulation of the traffic management system.

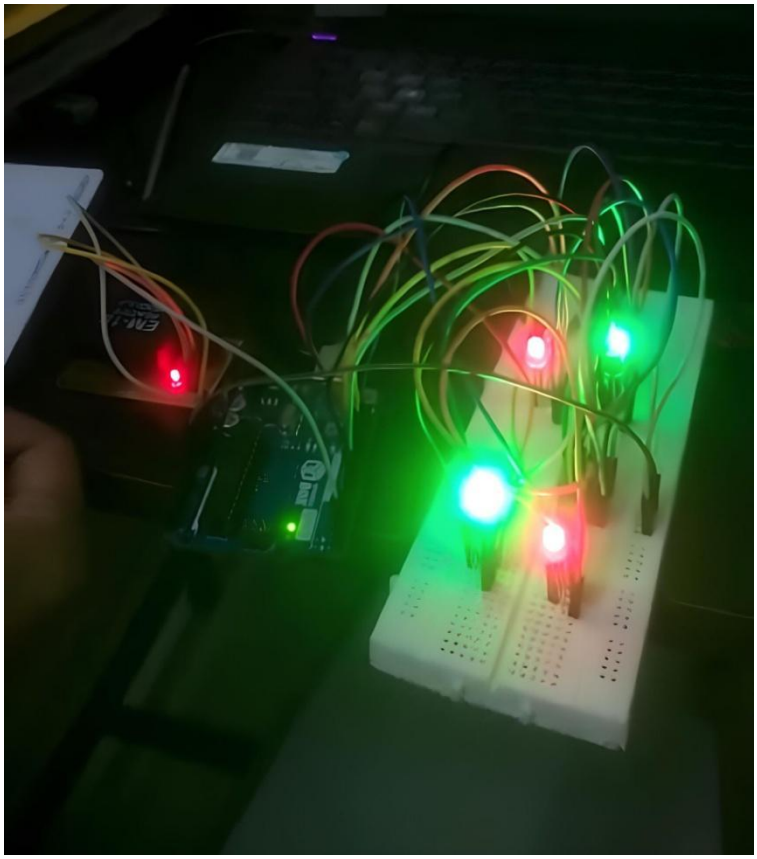

Figure 3.Implementation

5. Conclusion

A microcontroller is used in the proposed RFID-based traffic control system to read RFID signals and alter traffic signals dynamically. This technology is a major step toward sophisticated traffic management in urban settings, as it promises to enhance both traffic flow and emergency vehicle response times. The technology's potential for practical use is strengthened by its successful deployment in a controlled experimental environment.

6. Future enhancements

1. Integration with Smart City Infrastructure: Integrating the system with existing smart city infrastructure could further enhance its effectiveness in managing emergency vehicles.[6]
2. Advanced Collision Avoidance System: Implementing an advanced collision avoidance system utilizing real-time data from surrounding vehicles and infrastructure can help to prevent accidents more effectively.[7]

3. Machine Learning Algorithms: By enabling the system to anticipate traffic patterns better, machine learning algorithms can help emergency vehicles to route more effectively.[8][10]
4. Multi-Modal Warning System: Enhancing the warning system to include multi-modal alerts such as SMS notifications to nearby vehicles or pedestrians to further improve awareness.[9]
5. Adaptive Traffic Signal Control: Implementing adaptive traffic signal control algorithms can dynamically adjust traffic signals to optimize emergency vehicle routes.[6]
6. Utilizing cloud-based data storage and processing enhances the scalability of systems and the ability to analyze data in real time.[7]
7. Integration with Emergency Response Dispatch Systems: Integrating the system with emergency response dispatch systems can provide more accurate and timely information to emergency vehicle operators.[8]

7. References

1. Shebila, S. S., & Sankar, R. (2018). Traffic Control System for Emergency Vehicles using Radio Frequency Identification. *International Journal of Linguistics and Computational Applications (IJLCA),* 5(2), 16. ISSN 2394-6385 (Print), ISSN 2394-6393 (Online).
2. Naik, T., Roopalakshmi, R., Ravi, N. D., Jain, P., Sowmya, B. H., & Manichandra, " RFID-Based Smart Traffic Control Framework for Emergency Vehicles", 2018 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 1261-1265). IEEE. DOI: 10.1109/ICICCT.2018.8473001
3. Sai, P. H. V. T., Anand, N., Viswajeeth, A., Raj, M. S. N., Raj, R. A., & Srikar, P. (Year of Publication). An Effective Traffic Guidance and Support for Emergency Vehicles Using RFID Technology. In *Intelligent Manufacturing and Energy Sustainability* (pp. Page Range). Springer Nature Singapore. Naik, T., Roopalakshmi, R., Ravi, N. D., Jain, P., Sowmya, B. H., & Manichandra. (2018). RFID-Based Smart Traffic Control Framework for Emergency Vehicles. In 2018 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 1261-1265). IEEE. DOI: 10.1109/ICICCT.2018.8473001
4. Yeong-Lin Lai, Yung-Hua Chou, Li-Chih Chang. "An intelligent IoT emergency vehicle warning system using RFID and Wi-Fi technologies for emergency medical services." Telemedicine and e-Health 24, no. 3 (2018): 209-218. DOI: 10.3233/THC-171405
5. Hu, J., Liu, Y., Chen, Y., & Luan, K. (2017). RFID-based intelligent vehicle monitoring and management system. EURASIP Journal on Wireless Communications and Networking, 2017(1), 1-13.
6. Rizwan, M., & Anwar, S. M. (2018). A smart traffic management system using RFID and Internet of Things. In 2018 4th International Conference on Control, Automation and Robotics (ICCAR) (pp. 242-246). IEEE.
7. El-Kordy, M. M. A., El-Bassiouny, A. H., & Bayoumi, M. (2018). Review on Traffic Management Based on RFID and Wireless Sensor Networks. In 2018 IEEE International Conference on Systems, Man, and Cybernetics (SMC) (pp. 2086-2091). IEEE.
8. Kolte, Sanket, Anup Ingle, Ketki Kshirsagar, P. G. Gawande, Kalpana A. Kumbhar, and Rupa S. Kawchale. "Traffic Flow Optimization Using CNN and GCN for Adaptive Signal Control." In *2023 3rd Asian Conference on Innovation in Technology (ASIANCON)*, pp. 1-4. IEEE, 2023.
9. Kshirsagar, Ketki P., Rajeshree Rokade, and Dhanapal Kamble. "IoT-based gesture recognition for smart controlling." Int J Recent Technol Eng (IJRTE) 8.4 (2019).

10. Kumbhar, Kalpana, and Ketki P. Kshirasagar. "Comparative study of CCD & CMOS sensors for image processing." *International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering* 3 (2015): 194-196.
11. Gujarkar, Prajwal, Sarthak Lonkar, Tanmay Jain, Shubham Nigal, Pramod Patil, Pallavi Deshpande, Ketki Kshirsagar, Shraddha Habbu, Gauri Ghule, and Archana Ratnaparkhi. "IoT based Smart Attendance System." In *2023 International Conference on Emerging Smart Computing and Informatics (ESCI)*, pp. 1-6. IEEE, 2023.