AUTOMATIC TRAFFIC LIGHT SIGNAL BASED ON DENSITY

STUDENTS

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GUIDE

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ABSTRACT :

Traffic congestion is a growing concern in urban areas, leading to increased travel time, fuel consumption, and pollution. Traditional traffic light systems operate on fixed time intervals, which often result in inefficiencies, especially during varying traffic conditions. This paper proposes an intelligent traffic management system that dynamically adjusts signal timings based on real-time traffic density. The system utilizes ultrasonic sensors to measure vehicle density at intersections and an Arduino-based microcontroller system (Mega 2560 and Nano) to process the data and control traffic signals accordingly. Additionally, an RFID RC522 module with RFID tags is incorporated to prioritize emergency and authorized vehicles, ensuring smoother passage. The proposed solution aims to improve traffic flow efficiency, reduce waiting times, and enhance overall road safety.

INTRODUCTION :

Traffic congestion is a major challenge in urban areas, often caused by inefficient fixed-time traffic signals (Mittal & Bhandari, 2013). To address this, an intelligent traffic light system is proposed, which dynamically adjusts signal durations based on real-time vehicle density using ultrasonic sensors (Kumar & Gupta, 2017).

Additionally, emergency vehicles often face delays due to rigid traffic control mechanisms (Wong & Bell, 2012). To overcome this, an RFID-based priority system is integrated, allowing ambulances and authorized vehicles to override standard signals (Matin & Halim, 2018).

The system is implemented using Arduino Mega 2560 and Nano, RFID RC522 modules and tags, and a 12V DC power supply, ensuring a cost-effective and efficient traffic management solution. The following sections cover the system design, implementation, results, and conclusions.

RELATED WORK:

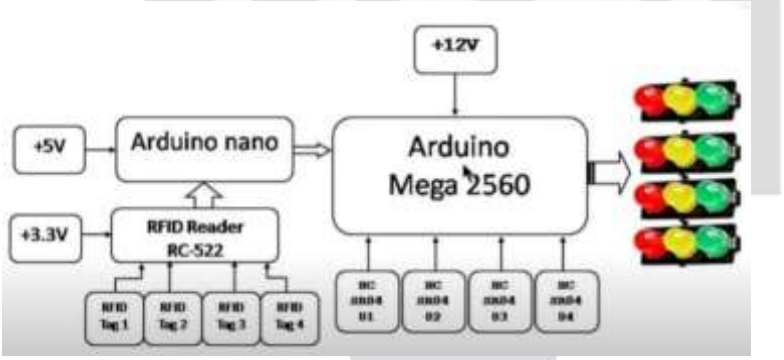
Several studies have explored smart traffic management systems to improve traffic flow efficiency. Mittal & Bhandari (2013) proposed a density-based traffic signal system that adjusts signal durations dynamically based on realtime vehicle count. Kumar & Gupta (2017) implemented an Arduino-based adaptive traffic light system using sensors for traffic density detection.

For emergency vehicle prioritization, Matin & Halim (2018) introduced an RFID-based traffic control system that allows ambulances and priority vehicles to override standard signals. Wong & Bell (2012) emphasized the need for real-time traffic control mechanisms to enhance road efficiency and safety.

Building on these studies, this paper integrates ultrasonic sensors for density detection with RFID-based emergency vehicle prioritization, using Arduino Mega 2560 and Nano to create a cost-effective and scalable smart traffic control system.

PROPOSED APPROACH :

The proposed system is designed to optimize traffic flow by dynamically adjusting traffic light durations based on real-time vehicle density while also providing priority access to emergency vehicles. This is achieved through a combination of ultrasonic sensors, RFID technology, and Arduino-based microcontrollers.



Traffic Density Detection:

- Ultrasonic sensors are placed at each lane to measure vehicle density by detecting the distance of vehicles from the sensor.
- The sensor data is processed by the Arduino Mega 2560, which determines the optimal signal duration for each lane based on traffic conditions.

Traffic Signal Control:

- Based on the sensor readings, the Arduino Mega 2560 adjusts the green light duration dynamically to reduce congestion.
- If a lane has a higher vehicle density, it gets a longer green signal, while less crowded lanes receive shorter durations.

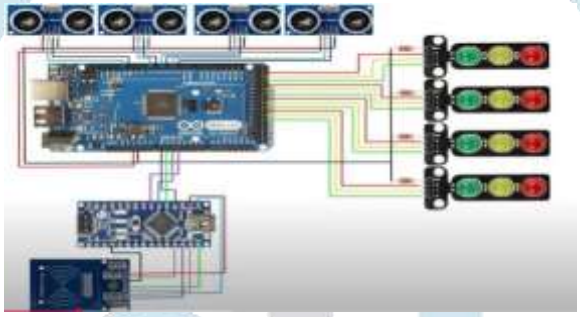
Emergency Vehicle Prioritization:

- An RFID RC522 module is installed at the intersection to detect RFIDtagged emergency vehicles (e.g., ambulances, fire trucks).

- When an authorized RFID tag is detected, the system immediately switches the traffic light to green for that lane, ensuring a clear path for emergency vehicles.
- Normal traffic signal operation resumes once the emergency vehicle has passed.

System Power and Circuit Protection:

- A 12V DC power supply is used to power the system components.
- 220-ohm resistors are integrated to protect LEDs and ensure circuit stability.

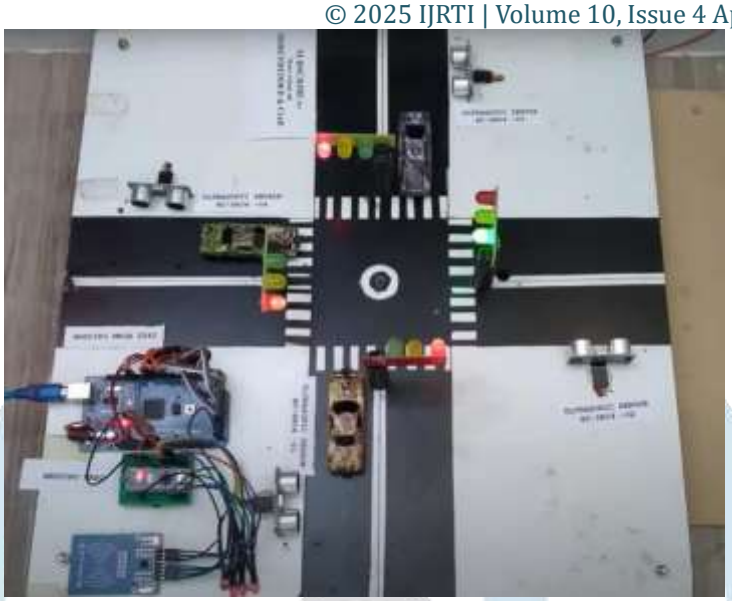


Design of Electric circuit

RESULT:

The proposed Automatic Traffic Light Signal Based on Density system was successfully implemented and tested under various traffic conditions. The results demonstrated that the ultrasonic sensors accurately detected vehicle density, allowing the system to dynamically adjust traffic signal durations. Lanes with higher congestion received longer green signals, effectively reducing traffic buildup, while lanes with lower vehicle density had shorter durations, optimizing overall efficiency. Additionally, the RFIDbased emergency vehicle prioritization system performed efficiently, instantly switching the traffic signal to green upon detecting an authorized emergency vehicle, ensuring quick and uninterrupted passage. Once the emergency vehicle cleared the intersection, the system seamlessly resumed normal traffic operations.

Furthermore, the Arduino Mega 2560 and Nano processed real-time sensor data efficiently without noticeable delays, ensuring smooth system performance. The 12V DC power supply provided stable operation, while 220-ohm resistors protected the circuit from voltage fluctuations. Compared to conventional fixed-time traffic signals, the system significantly reduced average waiting times and improved traffic flow. These results confirm that the proposed system is efficient, cost-effective, and scalable, making it a practical solution for modern urban traffic management.



CONCLUSION:

The proposed Automatic Traffic Light Signal Based on Density system successfully addresses urban traffic congestion by dynamically adjusting signal durations based on real-time vehicle density. The integration of ultrasonic sensors ensures efficient traffic flow, while the RFID-based priority mechanism allows emergency vehicles to pass without delay. The system, powered by Arduino Mega 2560 and Nano, demonstrated real-time processing efficiency, reduced congestion, and improved traffic management compared to conventional fixed-time signals.

Key findings indicate that optimized traffic signal control significantly reduces waiting times and improves emergency response efficiency. The implementation of low-cost components makes this system scalable and feasible for real-world applications. Future enhancements could include IoT integration and AI-based traffic prediction for further optimization.

This study concludes that smart, sensor-based traffic control systems can effectively improve urban traffic management, reduce congestion, and enhance road safety

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