Smart Traffic Control System for Preventing Signal Jumping and Handling Emergency Vehicles Using IOT

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Abstract - The Smart Traffic Control System for Preventing Signal Jumping and Handling Emergency Vehicles Using Iot is an experimental approach toward urban traffic control and road safety. The system provides for the automated use of road barricades integrated with traffic lights to ensure red signal disobedience by vehicles, accidents, and actual compliance with traffic rules. Whenever a signal turns red, the automated system raises a barricade to block vehicle motion, relying on the green phase for the barricade to be removed for safe passage and vehicular movement. Ultrasonic sensors detect the presence of vehicles and avoid situations where the barricade would trigger without proper reasons. Emergency vehicles are given two-way Bluetooth communication straight to the dispatcher, which can manually trigger the barricade. Central software monitoring and control allow for real-time adjustments and data analysis for optimal traffic flows. The proposed system aims to control signal jumping, manual dependence, and safety concerns of the present traffic management systems. Automating and integrating safety features with smart traffic management, this project proposes a holistic solution to improving road safety and strengthening measures against traffic violations.

Key Words: Signal jumping prevention, automated barricades, Bluetooth communication, emergency vehicle detection, smart traffic control.

1. INTRODUCTION

Increasing vehicle density, traffic violations, and inefficient manual systems make traffic management in urban areas difficult. One key major issue that hampers traffic flow and puts safety at risks for both pedestrians and others is signal jumping. Traditionally, traffic control is more manual in terms of traffic management and operation of signals in case of providing passage for the emergency vehicles.

With the onset of the Internet of Things (IoT) and new automation technologies in view, an opportunity exists to redefine traffic management systems. This project thus focuses on designing a smart traffic control system based on an IoT network of components involving sensors, actuators, and communication modules that would avoid signal jumping, manage emergency vehicles and enhance road safety. The enforcement of traffic rules will be rather efficiently achieved using automated barricades, real-time vehicle detection, and Bluetooth emergency communication, which would allow for dynamic adaptations to changing traffic conditions.

A prototype is developed to simulate and test the idea of the project. It uses Arduino-based control, ultrasonic sensors to detect obstacles, and servo motors to control the movement of barricades. The system also uses a Bluetooth module to handle the emergency vehicles (i.e. provide way) and manual override switch in case of any technical failure. This novel approach enhances compliance with traffic signals while reducing reliance on humans, thus laying the foundation for a smarter, safer city transportation system.

2. RELATED WORK

In this section we will be talking about researches done in the past regarding the issues.

Malipatil, A.R. and others presented a smart traffic control barricade system using Iot technology. The prototype is based on Arduino, servo motor is used for the control of the barricade ,LCD Display is used to display the information and RFID technology is used to handle the ambulance when the traffic signal is red. Each ambulance is allotted with a RFID tag which is scanned by the RFID scanner and the data is sent to the control system by using GSM technology for verification. Based on the response the signal is changed [1].

Devika, S.G. and her team proposed a system which enhances the current traffic management systems .The system aims to implement dynamic traffic signals to avoid congestions and efficient traffic flow by counting the number of vehicles at the previous junction and vehicles arriving at the intersection .It also prioritizes the emergency vehicles, it uses YOLO v8 algorithm along with siren recognition using a classifier model [2].

Kumaar, M.A. and his collaborators designed a density based traffic light control system interfaced with a barrier gate and GSM technology. The density of the traffic is estimated using the IR sensor and a stop line is drawn whenever a vehicle crosses the line when the signal is red the driver is notified and message is sent to the control room. The entire operations are carried out by PIC microcontroller [3].

Prasad, S.S. and his team proposed a simple system which aims for the safety of the pedestrians. Barricades are used to stop the movement of vehicles during red signal allowing pedestrians to cross the road safely .It uses vibration sensor to detect if any vehicles came in contact with the barricade which automatically activates the camera to capture the number plate of the vehicle .The controller used is Raspberry PI-3 B+ [4].

Madisa, M.K. and Joseph, M.K. give a unique and valuable provision for urban traffic congestion and the smooth passage of emergency vehicles by the combined use of Android applications and cloud computing. A real-time dynamic traffic management system is designed using IoT devices, Arduino IDE, GSM modules, and mobile technology. Cloud servers are used for data processing and communication in the system to

provide the requisite change in traffic signal settings to allow free passage for emergency vehicles and reduce congestion [5].

3. PROPOSED SYSTEM

The proposed Smart Traffic Control System is designed to bring order to road activity and prevent violation of signals by the aid of automated barricade technology embedded with IoT. Prototype-based, this system has the power to strictly enforce traffic signals by physically controlling vehicle movement at intersections. Alongside this is an innovation in the identification of traffic lights with the helping hand of servo motor controlled barricades. The barricades rise when the traffic signal turns red and retract when it turns green, thus most effectively preventing vehicles from jumping traffic lights.

It includes an Arduino Uno R3 microcontroller as the system control processor, taking the input from various sensors and controlling the traffic light, barricade, and system alarm. An ultrasonic sensor prevents accidental deployment of the barricade by detecting the proximity of a vehicle to the barricade. A Bluetooth module HC-05 or HC-06 allows for connection with emergency vehicles which can send override commands to the microcontroller for automatically retracting barricades, send alerts and turning traffic lights green. A manual override is also available for handling any system failure. A buzzer to warn drivers of the changing traffic light operations sounds when the yellow light is present.

The LED traffic lights (Red, Yellow, and Green) function in a timed sequence along with the position of the barricade in order to facilitate proper traffic flow. The implementation of Software Serial in the Arduino code does not get in the way of the communication between the Bluetooth module and the main serial channels, thus steering the module aptly .This IoT based traffic management solution is a strong, automated way to reduce jumping signals, securing roads and control the emergency vehicles and ensure traffic discipline while at it.

4. ARCHITECTURE

The architecture of the proposed system is designed for efficient integration of hardware components and smooth communication between modules. The prototype developed includes only a single road instead of intersection to test the functionality. The connections are made using breadboard to make the testing simple .An android application named “Arduino Bluetooth Controller” is used for communication to send messages from driver (Emergency vehicle) to the Central control unit.

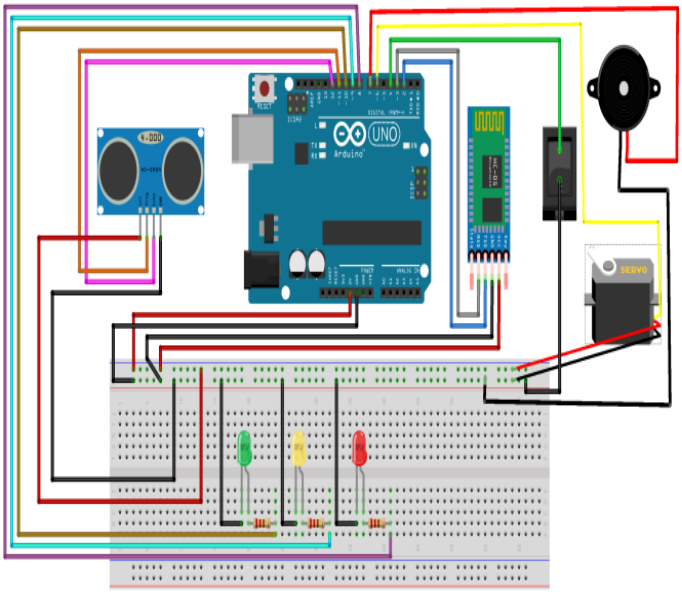

Fig -1: Hardware Setup

Fig 1 shows the connections of the system. Ultrasonic sensor is connected to check the proximity of the vehicles, Bluetooth module is used for the communication between emergency vehicles and control unit. It uses servo motor for the movement of the barricades.

In the design the major components used are:

1. Arduino Uno R3
2. Ultrasonic Sensor (HC-SR04)
3. Bluetooth Module (HC-05)
4. Servo Motor (SG-90)
5. Bread Board
6. Switch and Buzzer

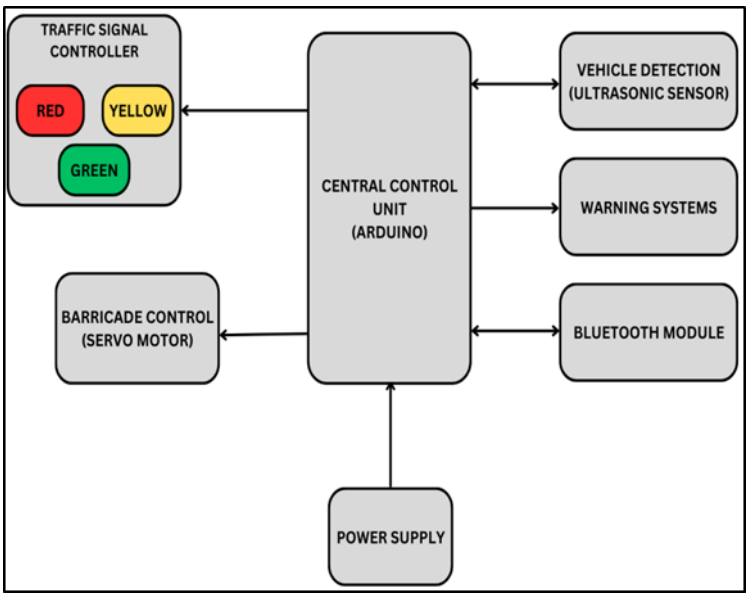

Fig -2: System Design

5. WORKING

The prototype developed combines automated road barriers with conventional traffic lights, increasing road safety and compliance with traffic lights. Once power to the circuit is

applied, the Arduino Uno R3 initializes all the connected components and sets the level of the servo motor to lift the barricade while turning the red traffic light on to mark the beginning. The Bluetooth module is also initialized, allowing the system to respond to emergency overrides as necessary.

Under normal conditions, the traffic lights normally run in sequential order. The red LED will be the first, stopping cars while the servo will lift the barricade to stop any vehicles from going ahead. After that, the yellow LED goes into action, combined with the buzzer, warning of the signal change shortly. Once the green LED is illuminated, the servo motor lowers the barricade, allowing vehicles to come forth and the cycle repeats itself.

The ultrasonic sensor (HC-SR04) plays an important role in obstacle detection in robes of barricades. Instantly, if a vehicle or any other object is detected to be closer than 10 cm from the barricade, the system will never permit hopping in, avoiding possible damages or injuries. Normal functioning resumes after the obstruction has been cleared. Furthermore, it supports emergency operation through the Bluetooth module (HC-05/HC-06). Once a Bluetooth-enabled emergency vehicle sends a Bluetooth message of "Emergency," the system will immediately turn ON the green light, bring down the barricade, and immediately put on a buzzer, alerting the nearby vehicles that an emergency exists. Post emergency, the system will return to its normal traffic control cycle, which works usually.

A manual override switch is also provided; the switch is pressed to activate the green signal to lower the barricade for vehicles to pass. This combination of automatic control, real-time obstacle detection, emergency handling, and manual override capabilities provides the prototype with a complete solution for avoiding traffic signal violations and making the roads safer.

6. RESULT

The prototype of the smart traffic control system was successfully developed for the testing phase and proven effective in preventing signal jumps and enhancing traffic management. The outcome of this is that the automated barricade system combined with the ordinary traffic light system provides a reliable physical mechanism for compliance enforcement with red lights, thus greatly minimizing possible violations.

In tests, the lights changed from red, through yellow, to green; the signal-generated barricade went up when the light turned red and down when the light turned green. It guaranteed that no car would go through on red signal and thus prevented signal jumping. With the yellow light and accompanying buzzer sound, it provided an additional alert to the drivers regarding forthcoming signal changes and improved their response time.

The system's ultrasonic sensor was able to stop the barricade from moving when an obstruction was detected within a distance of 10 cm. This feature also protected the barricade from harming itself in case of accidental impact by criminals and ensured safety by keeping all the vehicles outside the barricade space and away from getting trapped or hurt. The system returns to normal operation automatically only when the object is removed.

Testing confirmed the existence of emergency response function utilizing the Bluetooth module that was tested by sending another mobile signal—a signal saying "EMERGENCY." The program on reception changed immediately to green light, barricade goes down and a buzzer goes on to clear the way for emergency vehicles. Once the emergency is over, the system resumed its general traffic operation.

The switch will manually override the system that allowed the operator to lower the barricade and turn the signal green in the case of malfunction in the system or special conditions affecting the flow of traffic. The system will obey its automatic execution cycle once the manual override is released.

7. CONCLUSION

The prototype provides a very good demonstration of how to tackle traffic signal violation, handling emergency vehicles and improving road safety. IoT-enabled devices include ultrasonic sensors, Bluetooth modules as well as barricades controlled by servo. The system serves the purpose of ensuring strict adherence to traffic signals. The functioning of traffic lights and barricades in synchrony prevents unauthorized vehicle movement and provides a fail-safe against accidents.

The simple autonomous capability to track the obstacles near the barricade and respond to emergency vehicle signals shows how practical the system may apply into an actual field. The manual intervention is an extra measure of assurance on the reliable nature of the project outdoing its works uninterrupted by any unexpected failures or critical situations. The project has also addressed the concept of automation with safety protocols, balancing approaches to handling traffic violations with emergencies. If developed further, this foundational project could inspire further advances toward smart traffic control systems and ultimately smarter and safer cities.

8. FUTURE SCOPE

The smart traffic control system carries great promise in improving urban traffic management and road safety. It can be integrated in the future with IoT and smart city structures for centralized watching, monitoring, and real-time optimization of traffic. Artificial intelligence and machine learning can be added to dynamically switch signals in anticipation of predicted traffic patterns; this could reduce congestion. Vehicle-to-Everything (V2X) communication can allow more direct communication with vehicles which will prioritize emergency services. Inclusion of cameras with license plate recognition can ensure immediate recognition of violations and thus automatic reporting. The system will be eco-friendly powered by renewable energy sources like solar panels. The same system can be modified to fit larger intervals and different traffic conditions. Such a mobile and cloud-based control application will allow traffic authorities to monitor and manage the system remotely. Finally, putting public transportation into the equation can prioritize buses or other mass transit vehicles and hence optimize the flow of traffic while diverting some traffic towards public transport.

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