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Accident Prevention Using IoT for Car Safety

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Abstract
Our project addresses the global road safety crisis, where over 70 percent of accidents are attributed to over-speeding. To mitigate this issue, we are developing an IoT-based car safety device that continuously monitors a vehicle's speed, compares it, and triggers an alert if the vehicle exceeds the allowed limit in an accident-prone zone. The device features an LCD display to show the area's accident level and a buzzer that activates until the vehicle leaves the accident-prone zone. This proactive approach encourages safe driving behavior by providing real-time feedback to drivers. In addition to the hardware device, the project incorporates a comprehensive web portal for data management and user access. This portal, with roles for Admin, Police, and Transport Ministry Officers, enables traffic authorities to update speed limits and define accident-prone zones within the centralized database. The database feeds real-time data to the IoT device, ensuring accurate and updated speed restrictions tailored to each location. With this device and system integration, we aim to reduce accidents by providing immediate feedback to drivers and empowering authorities to manage speed limits effectively. This project's combined use of IoT technology and data management offers a robust solution for enhancing road safety and supporting data-driven traffic management.
Keywords: *Arduino-based; GPS Tracking; Road Safety*

1. Introduction
Road safety remains a critical global issue, with over-speeding accounting for nearly 70% of traffic accidents worldwide. Despite advancements in vehicular safety systems, driver behavior continues to be a major contributing factor to accidents, necessitating proactive measures for accident prevention. Traditional approaches, such as speed limit signboards and law enforcement surveillance, have proven inadequate in ensuring compliance, especially in accident-prone zones. Recent advancements in the Internet of Things (IoT) have enabled real-time monitoring and intervention in various domains, including intelligent transportation systems. This research presents an IoT-based car safety device designed to mitigate over-speeding risks in accident-prone areas. The system integrates a GPS module, an accelerometer, an LCD display, and a buzzer to monitor a vehicle's speed, compare it against predefined limits, and provide immediate feedback to drivers. Unlike existing accident detection systems that primarily focus on post-crash response, our solution emphasizes real-time accident prevention by alerting drivers before a potential mishap occurs. Additionally, this project incorporates a web-based portal for centralized data management, allowing traffic authorities, police, and transport ministry officers to dynamically update speed limits and accident-prone zones. This real-time integration ensures that the IoT device receives accurate and location-specific data, enhancing its effectiveness in accident prevention. By combining IoT technology with data-driven traffic management, our system provides a robust solution for improving road safety and encouraging responsible driving behavior. This study aims to contribute to the growing body of research in intelligent transportation by offering a proactive, scalable, and data-driven approach to road safety. The proposed system's novelty lies in its dual-layered implementation—real-time driver feedback and dynamic traffic

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regulation—making it a comprehensive and state-of-the-art solution in accident prevention. [1-5]

1.1.Background and Motivation

Road safety remains a critical global issue, with over-speeding contributing to more than 70% of traffic accidents. Existing speed regulation mechanisms, such as traffic signs and speed cameras, often fail to provide real-time feedback to drivers, leading to increased accident risks, particularly in high-risk zones. The advent of IoT technology has opened new possibilities for intelligent transportation systems, offering proactive solutions to enhance road safety and compliance with speed limits. (Figure 1)

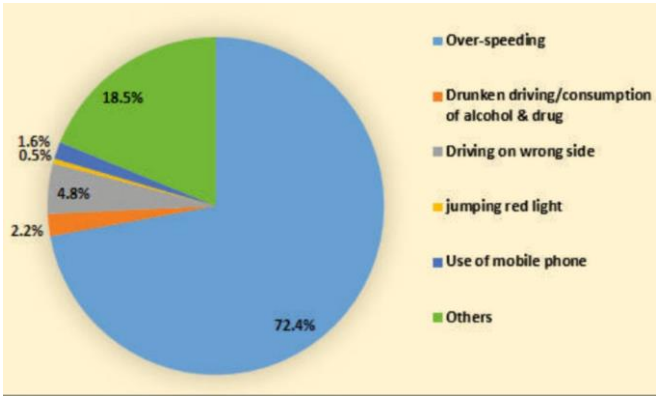

Figure 1 Reasons for Accidents

1.2.Existing Solutions and Challenges

Previous studies have proposed various IoT-based accident detection and reporting systems. However, most of these focus on post-accident detection rather than real-time accident prevention. GPS and GSM-based tracking solutions notify emergency services after a crash but do not actively deter over-speeding in accident-prone zones. The lack of centralized data management and real-time communication between authorities and vehicles further limits their effectiveness. [5-10]

1.3.Objectives of the Study

This research aims to develop an IoT-enabled car safety system that continuously monitors vehicle speed, compares it with predefined accident-prone zone limits, and provides instant feedback to the driver. The key objectives include:

- Designing an integrated hardware device with a buzzer and LCD display to alert drivers in real-time.
- Implementing a web-based portal for authorities to dynamically update speed limits and accident-prone areas.
- Enabling seamless data synchronization between traffic management databases and vehicles for enhanced road safety. [11-12]

2. Method

2.1.System Architecture

The proposed IoT-based car safety system consists of two main components:

- Hardware Device – Installed in vehicles, comprising a GPS module, an accelerometer, an LCD display (I2C interface), a buzzer, and a microcontroller (Arduino).
- Web Portal – A cloud-based database where authorities update speed limits and accident-prone zones.
- Data flows from the web portal to the vehicle's hardware in real-time, allowing dynamic enforcement of speed limits. [13-15]

2.2.Hardware Implementation

The hardware prototype integrates:

- GPS Module: Determines the vehicle's real-time location.
- Accelerometer: Detects sudden braking or collisions.
- LCD Display (I2C): Displays accident-prone zone alerts and speed limits.
- Buzzer: Alerts the driver if the vehicle exceeds the speed limit.
- Arduino Uno: Acts as the central processing unit, receiving and processing data from the sensors.
- The components are connected using jumper wires, with data transmitted via I2C and Serial Communication protocols.[16-17]

2.3.Software Development

The software implementation consists of:

- Embedded Programming: The Arduino is programmed in the Arduino IDE, which processes speed data and triggers alerts. (Figure 2)
- Web Portal Development: A web-based dashboard developed with HTML, CSS, JS, JAVA, and MySQL allows authorized personnel

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to update accident-prone zones dynamically. [18-20]

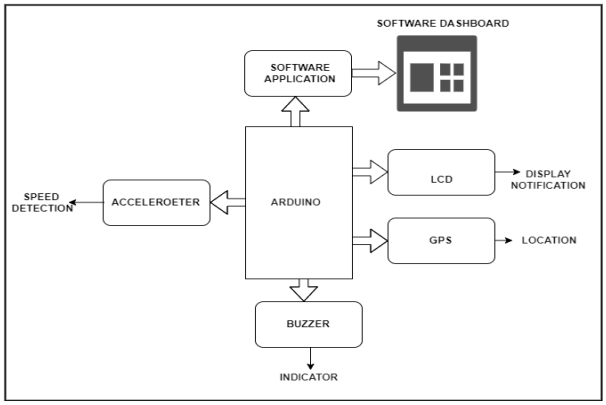

Figure 2 Block Diagram of the Circuit

2.4.Data Flow and Communication

- The GPS module sends real-time location data to the Arduino. [21]
- The Arduino fetches speed limit data for the current location from the web portal via an API.

If the vehicle exceeds the speed limit in a designated zone, the buzzer is activated and the LCD displays a warning.

3. Results and Discussion

3.1.Results

The IoT-based car safety system was developed to monitor vehicle speed, compare it with predefined speed limits, and trigger alerts in accident-prone zones. The system integrates a GPS module, accelerometer, LCD display, and buzzer to provide real-time feedback to drivers. The web portal allows authorities to update speed limits dynamically, ensuring accurate data synchronization with the IoT device. Preliminary implementation shows that the system successfully detects vehicle speed, displays accident-prone zone warnings, and activates alerts when limits are exceeded. The centralized database enables seamless updates to speed regulations. Future testing will evaluate system accuracy, response time, and overall effectiveness in reducing over-speeding and enhancing road safety.[23]

3.2.Discussion

The development of the IoT-based car safety system demonstrates the potential of integrating real-time speed monitoring with a centralized traffic management portal. By providing instant feedback to drivers through alerts and visual displays, the system encourages compliance with speed regulations, especially in accident-prone zones. The web portal's ability to dynamically update speed limits ensures that the system remains adaptable to changing traffic conditions. While the initial implementation shows promising functionality, further testing is required to assess its real-world accuracy and reliability. Factors such as GPS precision, sensor calibration, and network latency may impact system performance. Additionally, user adoption and law enforcement integration will play a crucial role in determining its effectiveness in reducing accidents. Future enhancements could include AI-driven predictive analytics to identify high-risk areas and provide proactive safety measures. [22]

Conclusion

The IoT-based car safety system effectively addresses the issue of over-speeding in accident-prone zones by integrating real-time speed monitoring with dynamic traffic management. Through the use of GPS, accelerometers, and a centralized database, the system provides instant feedback to drivers, encouraging safer driving behavior. The web portal further enhances its functionality by allowing traffic authorities to update speed limits and accident-prone zones in real time. While initial implementation confirms the system's ability to detect speed and provide alerts, further testing is required to evaluate its real-world accuracy and impact. Factors such as GPS precision, sensor calibration, and network efficiency may influence performance. Future improvements, including AI-driven analytics and expanded connectivity, could enhance its effectiveness. Overall, this system presents a scalable and proactive approach to accident prevention, contributing to improved road safety and smarter traffic management. [24]

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