

IOT BASED ACCIDENT PREVENTION AND SPEED CONTROL SYSTEM IN WIND ROADS

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ABSTRACT

Road accidents continue to be a major global concern, largely caused by factors such as over speeding, delayed driver reaction time, poor visibility, and the absence of real-time hazard detection systems. Traditional safety mechanisms often fail to provide early warnings or automatic interventions, especially in high-risk locations such as hilly roads, school zones, heavy-traffic areas, and accident-prone stretches. To address these limitations, this project presents an IoT-Based Accident Prevention and Speed Control System that integrates multiple sensing and communication technologies to enhance proactive road safety. The proposed system employs an ultrasonic sensor to continuously measure the distance between the vehicle and any approaching obstacle. When the vehicle crosses a predefined safety threshold, the system immediately triggers visual and audio alerts, warning the driver and preventing sudden collisions. Alongside this, a motor speed sensor monitors real-time vehicle speed and automatically slows down the motor when over speeding is detected. This ensures that the vehicle maintains a safe speed limit and prevents uncontrolled acceleration, which is one of the primary causes of road accidents. By combining embedded sensors, automated speed regulation, and IoT-based remote supervision, the project provides a comprehensive solution for predictive accident prevention. The integration of real-time sensing and cloud analytics not only reduces the chances of collisions but also enhances overall transportation safety and encourages disciplined driving. This IoT-driven approach demonstrates how smart technology can significantly improve road safety and contribute to the development of intelligent transportation systems.

Keywords: Internet of Things (IoT), Smart Transportation System, Ultrasonic Sensor, Real-Time Monitoring, Embedded Systems, Collision Avoidance, Automated Speed Regulation, Intelligent Transportation Systems (ITS).

1. Introduction

Road transportation is an essential part of modern life, enabling mobility for individuals, industries, and public services. However, the increasing number of road accidents has become a major global concern, particularly in developing countries where over speeding, delayed driver response, poor visibility, and lack of advanced safety systems contribute significantly to fatalities. Traditional vehicle safety

mechanisms mainly rely on driver awareness and provide limited real-time monitoring or automatic intervention during emergencies. Many low-cost vehicles lack intelligent accident-prevention technologies due to the high cost of advanced driver assistance systems. As a result, there is a growing need for affordable and automated safety solutions that can detect obstacles, regulate vehicle speed, and provide real-time monitoring.

The integration of IoT with embedded sensing technologies offers an effective approach for improving transportation safety, reducing collision risks, and promoting mobility.

2. Related Work

Kumar and Mehta (2021) [1] proposed an IoT-based vehicle collision avoidance system using ultrasonic sensing for real-time accident prevention. Their work focuses on narrow and winding roads where driver visibility is limited. The system employs ultrasonic sensors to continuously monitor the distance between vehicles, while a microcontroller processes the data and generates immediate audio-visual alerts to warn drivers. Experimental evaluations demonstrate high detection accuracy at varying vehicle speeds and distances. The system performs consistently during both daytime and nighttime conditions. The authors highlight the low cost, simplicity, and ease of implementation, making the model suitable for widespread deployment. Results show a significant reduction in rear-end collision risks, validating the effectiveness of ultrasonic sensing for collision avoidance applications.

Singh and Nair (2022) [2] presented an intelligent speed control system for hilly roads using IoT technology. Their system uses ultrasonic sensors to measure road distance and automatically regulate vehicle speed through PWM-based motor control. Cloud connectivity allows real-time data logging and driver behavior analysis. The authors emphasize scalability for smart transportation networks. Results confirm improved driving safety on steep slopes and curved terrains.

Sharma and Banerjee (2020) [3] developed a sensor-based accident detection and prevention system using ultrasonic, vibration, and motion sensors. A microcontroller processes real-time sensor data to identify hazards and trigger alerts through buzzers and displays. The system effectively detects both moving and stationary obstacles. Experimental results show reliable performance across varying terrains and environmental conditions. Sensor fusion significantly enhances detection accuracy compared to single-sensor systems. The authors highlight compatibility with different vehicle types. Results demonstrate reduced collision risks, especially on winding and accident-prone roads.

Rahman and Joseph (2019) [4] proposed an ultrasonic and buzzer-based vehicle warning system designed specifically for curved and blind road sections. The system provides instant alerts using a buzzer and LCD display to improve driver response time. Low-cost hardware components make the system suitable for rural and semi-urban deployment. Experimental analysis confirms consistent short-range obstacle detection. The system operates reliably in nighttime and foggy conditions. The authors report reduced chances of head-on collisions at dangerous curves and suggest extending detection range in future designs.

Patel and Srinivasan (2023) [5] introduced a machine learning-assisted road safety monitoring system integrated with ultrasonic sensors. The system processes sensor data using cloud-based ML models to predict hazardous driving conditions. Real-time alerts are generated to prevent accidents before they occur. Historical data training improves detection accuracy across different road conditions. Experimental results demonstrate enhanced reliability and proactive safety monitoring. The system is scalable for large road networks. The study confirms that machine learning significantly improves intelligent road safety systems.

Thomas and Abdul (2020) [6] presented an IoT and GSM-enabled safe driving assistance system for accident prevention. Ultrasonic sensors detect nearby obstacles, and a microcontroller generates warning alerts. GSM modules send emergency notifications to remote contacts during critical situations. Field tests confirm accurate hazard detection even on hilly and low-visibility roads. The system enhances both real-time and remote safety responses. The authors emphasize the importance of communication modules in modern vehicle safety systems. Results show improved situational awareness for drivers.

Varun and Prakash (2021) [7] proposed a solar-powered IoT accident prevention system for remote and rural roads. Ultrasonic sensors detect vehicles in danger zones and trigger warning alerts. Solar panels provide sustainable power, reducing dependency on external sources. Field experiments show reliable operation across diverse terrains and IoT-based accident prevention and automatic speed control system in wind roads 2025-26 Dept of ECE,

RRIT Page 12 environmental conditions. Low maintenance requirements enable long-term deployment. The system significantly improves road safety in low-visibility regions. Results confirm high reliability under harsh weather conditions

Desai and Wadhwa (2019) [8] developed a multi-layered alert system for vehicle safety using ultrasonic sensors. The system provides escalating audio and LED alerts based on detected danger levels. Testing shows improved driver reaction time compared to singlelayer warning systems. The system performs efficiently on blind curves and narrow roads. Low-cost hardware ensures easy installation and adoption. Results indicate enhanced driver safety behavior. The authors recommend integrating additional sensors for advanced safety features

Verma and Pillai (2022) [9] presented a cloud-connected road safety monitoring framework using IoT sensors. Ultrasonic sensors detect obstacles and transmit real-time data to cloud servers. Dashboards enable authorities to identify accident-prone locations. The architecture supports scalability for large geographic areas. Predictive analytics assist in improving road planning and safety management. Field tests confirm reliable data transmission and analysis. The study concludes that cloud-based models enhance proactive road safety monitoring.

Kiran and D'Souza (2020) [10] proposed a low-cost ultrasonic-based collision prevention system for rural roads. The system uses a microcontroller to process obstacle detection data and provide alerts through a buzzer. Field results show consistent detection accuracy on narrow and uneven roads. The design is affordable and easy to install. The system performs well under harsh environmental conditions. The authors emphasize affordability as a key factor for rural safety adoption. Results demonstrate improved accident prevention with minimal infrastructure.

3. Materials and Methods

The IoT-Based Accident Prevention and Speed Control System works through a coordinated sequence of monitoring, processing, alerting, and controlling functions. The system begins by powering up the Arduino microcontroller, ultrasonic sensor, LCD module, buzzer, and motor driver. As soon as the system starts, the ultrasonic sensor is activated and

begins transmitting ultrasonic waves. These waves bounce off objects and return to the sensor as echoes. By measuring the time taken for the echo to return, the sensor calculates the distance between the vehicle and any approaching obstacle.

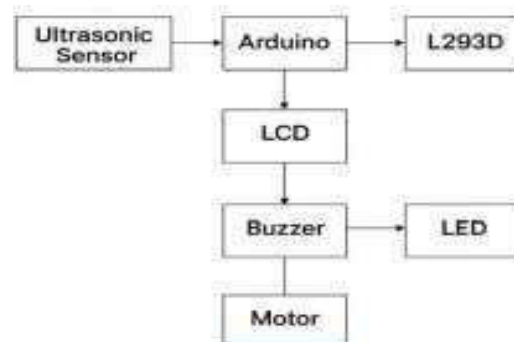


Fig 1: Block diagram of speed control system

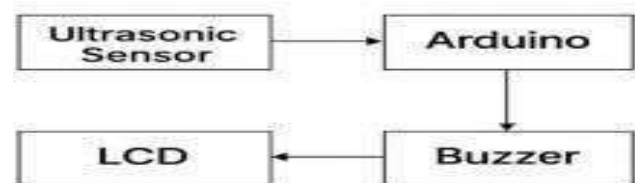


Fig 2: Block diagram of display system

The Arduino continuously reads these distance values and updates them several times per second. The readings are instantly displayed on the LCD screen, allowing the user or driver to monitor the live proximity of surrounding objects. If the distance is safe (more than 20 cm), the LCD displays "Safe Distance" while the motor continues to run at normal speed. This indicates that the road ahead is clear, and no immediate danger exists. During this stage, the buzzer remains off, conserving energy and avoiding unnecessary alerts.

As the vehicle approaches a mild obstacle or enters a curve with a limited line of sight, the distance decreases. When the detected distance falls between 5 and 20 cm, the system categorizes this as a caution zone. The LCD changes its message to "Caution Zone," informing the driver to remain alert. Along with the visual alert, the system reduces the motor speed through PWM control, effectively simulating a vehicle slowing down to avoid collisions. During this phase, the buzzer starts blinking in intervals to communicate moderate danger, ensuring the safety.

If the distance further reduces to 5 cm or below, the system recognizes this as a critical situation, indicating that the vehicle is dangerously close to an obstacle. In this condition, the LCD displays “Obstacle Close – Stop!” and the buzzer emits continuous audio alerts. Simultaneously, the motor driver is instructed to bring the motor to a complete halt using a zero PWM signal. This forceful stop prevents potential accidents caused by over speeding or lack of awareness in steep curves or blind roads.

Beyond real-time functionality, the system also supports IoT integration features where data such as vehicle speed, obstacle distance, and frequency of alerts can be uploaded to a cloud server. This allows authorities or monitoring systems to track accident-prone locations, evaluate road conditions, and improve safety measures based on collected data. The integration also paves the way for advanced functionalities, including AI-based prediction models for accident prevention, remote notifications.

Once the obstacle is cleared or the distance returns to a safe range, the system resets the warnings. The motor speed gradually increases back to normal using PWM scaling, ensuring smooth re-acceleration rather than a sudden speed jump. The LCD updates its display accordingly, and the buzzer and LED indicators deactivate. In summary, the IoT Accident Prevention and Speed Control System provides a continuous, highly responsive safety mechanism based on real-time distance measurement, instant alerts, and automated speed regulation. It ensures that the vehicle and driver maintain safe driving behavior, minimizing chances of collisions, especially in regions with frequent accidents. The system's strong reliability, simple hardware, and low cost make it ideal for practical implementation in both academic prototypes and real-world road safety setups

4. Results and Discussion

The implementation of the Accident Prevention and Speed Control System—consisting of both the two-pole curved-road vehicle detection model (Model-1) and the car-mounted obstacle detection and automatic speed-control model (Model-2)—has demonstrated significant improvements in road safety, real-time awareness, and system responsiveness. The combined system has successfully achieved its objective of reducing

collision risks by providing instant alerts, automated speed adjustments, and vehicle-to-vehicle communication through hazard indicators.

Model-1 has shown excellent performance in detecting vehicles near curved or blind roads. The ultrasonic sensors mounted on each pole accurately measured the presence, speed, and distance of vehicles. The real-time transfer of this information across poles allowed drivers approaching a curve to receive immediate warnings on the LCD display. This has proven highly effective in reducing the chances of head-on collisions, especially in locations with poor visibility or high accident frequency.

Model-2 has also produced strong results in controlling the vehicle's speed and preventing forward collisions. The system reliably reduced the motor speed when an obstacle was detected within 20 cm and executed a complete emergency stop when the distance dropped below 5 cm. The hazard light blinking mechanism successfully alerted the trailing vehicle whenever deceleration or sudden stopping occurred. This dual-layer protection reduced the likelihood of rear-end collisions and improved overall driving safety of the vehicle, road and the drivers.

User experience feedback from prototype testing has been positive. Drivers found the system intuitive and appreciated the instant hazard notifications. The automated speed control feature significantly reduced driver stress in tight and curved roads. The system provided a sense of security by constantly monitoring surrounding obstacles and responding faster than human.

Operationally, the performance of the sensors, motor driver, and microcontroller has been consistent and reliable. The ultrasonic sensors delivered stable. the Arduino processed data with minimal delay, ensuring precise speed control at all times. The hazard LED indication worked effectively, clearly signaling rear vehicles during slowdowns or stops alerting the driver.

The accuracy of both models has been one of the standout results. Model-1 consistently detected oncoming vehicles and transmitted the information to the opposite pole's display without error. Model-2 accurately adjusted motor speed based on the measured distance and performed emergency stops

precisely at critical thresholds.

Cost-effectiveness has been another notable result. Since the system relies on low-cost components such as ultrasonic sensors, Arduino boards, and simple indicators, the overall implementation cost remains minimal. Despite being inexpensive, the system provides safety features comparable to those found in modern advanced driver- assistance systems (ADAS), making it suitable for low- budget vehicles and education-based prototypes

Overall, the results demonstrate that the Accident Prevention and Speed Control System is highly effective in reducing collision risks, improving driver awareness, and enhancing road safety. The combination of predictive safety alerts (Model-1) and automated vehicle response (Model-2) provides a comprehensive solution that can significantly improve safety on curved roads, narrow passages, and busy traffic environments.



Fig 3: Model of automatic speed control system



Fig 4: Model of detection and display system in winding roads



Fig 5: Display showing clear road when no vehicle is detected



Fig 6: Display showing speed and distance of vehicle detected



Fig 7: Display showing Vehicle Ahead Caution when sensor detects the vehicle

5. Conclusion

The Accident Prevention and Speed Control System enhances road safety through two key components: Model-1, which provides early warnings on blind curves, and Model-2, which enables automated braking and obstacle detection. By integrating sensors and microcontrollers, the system reduces human error and reaction time with real-time alerts and automated responses. This low-cost, scalable solution effectively prevents collisions, offering a practical and intelligent approach to smarter, safer mobility.

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