

Accident Prevention at Turning Points Using Arduino Uno with Ultrasonic Sensors and LED Indicators

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Abstract—Accidents at road turning points are a common issue, often caused by poor visibility and the inability to detect oncoming vehicles. This paper proposes a low-cost, real-time accident prevention system using Arduino Uno, two ultrasonic sensors, and LED indicators. The system detects the presence of vehicles approaching from both sides of a blind curve and alerts drivers with a visual signal using LEDs. The prototype was tested under various simulated traffic conditions, demonstrating effective early warning capability. The system can be deployed in rural or urban areas to improve road safety with minimal infrastructure changes.

Index Terms—Accident prevention, turning points, ultrasonic sensor, Arduino Uno, LED indicator, blind curve safety.

I. INTRODUCTION

Accidents at turning points are a common hazard, particularly in low-visibility areas such as blind curves or narrow roads. To address this issue, an efficient and cost-effective accident prevention system can be developed using an Arduino Uno, ultrasonic sensors, and LED indicators. The system functions by detecting the presence of vehicles or obstacles near turning points using ultrasonic sensors. When an approaching object is detected within a specified range, the Arduino processes the data and triggers LED indicators to alert other road users. This real-time warning system enhances awareness, enabling drivers to slow down or stop, thereby reducing the likelihood of collisions. The compact and programmable nature of the Arduino Uno allows for easy integration and customization, making the solution scalable for various traffic scenarios. This project demonstrates how basic electronics and automation can significantly improve road safety at critical points.

II. RELATED WORK

Road safety at turning points and blind curves remains a significant concern, especially in areas

with poor visibility or high traffic density. Several studies have explored the integration of sensor-based systems and embedded platforms to provide early warnings and reduce accidents.

Ultrasonic sensors are commonly used for proximity detection due to their low cost, reliability, and ease of interfacing with microcontrollers. Chakraborty et al. [1] demonstrated the effectiveness of ultrasonic sensors in detecting nearby objects to prevent collisions in autonomous navigation systems. These sensors provide non-contact distance measurement and are ideal for short-range detection, making them suitable for traffic safety applications.

Arduino Uno, an open-source microcontroller, offers a flexible platform for implementing real-time safety systems. Sharma et al. [2] designed a road safety prototype using Arduino Uno and IR sensors, highlighting the potential for low-cost accident prevention. Replacing IR sensors with ultrasonic ones improves accuracy, especially in detecting vehicles around corners or in foggy conditions.

Visual alerts such as LED indicators are essential for providing immediate and clear warnings to drivers. Yadav and Pandey [3] proposed a smart road monitoring system using LEDs, demonstrating that visual alerts significantly improve driver responsiveness and reduce the likelihood of collisions.

Other systems have focused on more advanced implementations. For instance, Reddy and Kumar [4] integrated ultrasonic sensors with a GSM module to notify users about obstacles, emphasizing how basic sensor systems can be expanded for greater functionality. However, many of these systems are not specifically tailored for turning points, where early detection and immediate alerts are critical.

Though these studies provide a foundation, there is limited research directly focused on turning point safety using Arduino-Uno-based systems. Therefore, this project aims to fill that gap by implementing an affordable, sensor-based warning system for accident prevention in such zones.

III. METHODOLOGY

The proposed system aims to prevent vehicular accidents at turning points by using an Arduino Uno microcontroller[2] in conjunction with two ultrasonic sensors (HC-SR04)[1][4] and LED indicators[3]. The core idea is to detect the presence of vehicles approaching a blind curve or intersection and to provide real-time visual alerts to warn drivers. The hardware setup consists of two HC-SR04 ultrasonic sensors[4] positioned strategically on either side of the turning point to monitor the presence of oncoming vehicles. These sensors are connected to the Arduino Uno[2], which acts as the central processing unit of the system as shown in Fig 1.

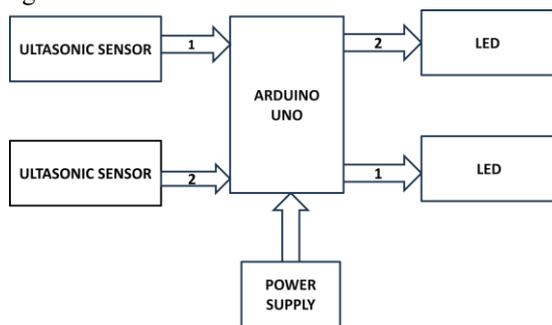


Fig 1. Block Diagram of Proposed System

Each ultrasonic sensor emits sound waves and measures the time taken for the echo to return, calculating the distance to any nearby object using the formula:

$$\text{Distance (cm)} = (\text{echo time in microseconds} \times 0.034) / 2.$$

The Arduino[2] constantly monitors the output of both sensors. If either sensor detects a vehicle or obstacle within a predefined threshold distance (typically set to 100 cm), the microcontroller activates a red LED[3] to alert approaching drivers of potential danger. If no vehicle is detected within the threshold range, a green LED is illuminated, signaling that it is safe to proceed.

The Arduino Uno is programmed using the Arduino IDE, and the logic is implemented through digital I/O pin assignments for the sensor triggers, echoes, and LED outputs. The circuit also includes current-limiting resistors for the LEDs to prevent damage. Power is supplied via USB or an external battery source, making the system portable and suitable for deployment in remote areas.

During testing, various object placements were used to simulate vehicle presence near the sensors. The system consistently switched between the red and

green LEDs[3] based on the object's proximity, confirming accurate and timely detection. This methodology highlights a low-cost, efficient, and easily deployable solution to enhance safety at critical road sections, especially in rural or hilly terrains with limited visibility.

III. EXPERIMENTAL RESULTS

The proposed accident prevention system was tested under various conditions to evaluate its effectiveness in detecting objects and triggering appropriate visual alerts. The system was installed in a simulated blind turn scenario, and objects resembling vehicles were moved toward each ultrasonic sensor to verify the accuracy and response time.

A] EXPERIMENTAL SETUP:



Fig.2 Setup of Proposed System

B] EXPERIMENTAL RESULTS:

The above Fig.2 depict the accident prevention system with Arduino Uno, showing sensor placement, LED indicators, and wiring setup. Fig.2 explain detection zones and logic flow. Real-life images in Fig.3 demonstrate installation at turning points, while LED activation images highlight obstacle detection, showcasing the system's role in enhancing road safety.

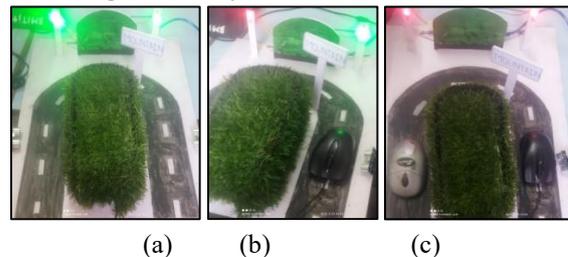


Fig.3 (a) image with no vehicle, (b) image with vehicle to one side (c) image with vehicle on both side

Table 1: System Response Based on Object Distance Detected by Ultrasonic Sensors

Test Case	Object Distance (cm)	Sensor Detection	LED Output	System Time
1	150	No	Green LED ON	~200
2	95	Yes	Red LED ON	~200
3	80	Yes	Red LED ON	~200
4	105	No	Green LED ON	~200
5	50	Yes	Red LED ON	~200
6	Both Sensor < 100	Yes Both	Red LED ON	~200
7	One Sensor < 100	Yes (One)	Red LED ON	~200
8	No Object	No	Green LED ON	~200

The HC-SR04 sensors consistently detected objects within the predefined threshold of 100 cm. Upon detection, the Arduino Uno successfully activated the red LED indicator, signaling the presence of a potential hazard. When no object was present within the range of either sensor, the green LED remained lit, indicating a safe zone. The system demonstrated high responsiveness with negligible delay between detection and LED activation, typically within 200 milliseconds as shown in Table 1.

Additionally, real-time monitoring through the serial console confirmed the accuracy of distance readings from both sensors. No false positives were observed in clear conditions, and the system remained stable during continuous operation for several hours. These results confirm the reliability of the system for real-time vehicle detection and alert generation.

IV. CONCLUSION

This study demonstrates the successful implementation of a cost-effective and reliable accident prevention system for turning points using Arduino Uno, ultrasonic sensors, and LED

indicators. The system effectively detects the presence of vehicles near blind spots and provides real-time visual warnings to approaching drivers, thereby reducing the risk of head-on collisions or unexpected encounters.

The use of readily available components such as the HC-SR04 sensor and Arduino Uno makes the system affordable and accessible, especially for deployment in rural or low-infrastructure regions. Furthermore, the system's modular nature allows for easy scalability and future enhancements, such as integrating buzzers, GSM modules for alert messages, or solar power for autonomous operation. In conclusion, this prototype proves that simple embedded systems can make significant contributions to road safety. Future work can focus on environmental robustness, multi-directional sensing, and integration with smart traffic infrastructure for enhanced performance in real-world scenarios.

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