

Prevention of Train Accident Using Arduino UNO

Sahana T (3BR19EE074), Sahana U (3BR19EE075), Santosh Kumar P A (3BR19EE080), Rachana K (3BR19EE105)

Department of Electrical and Electronics Engineering
Ballari Institute of Technology and Management, Ballari, Karnataka, India

ABSTRACT

Railway transportation is one of the most widely used modes of transportation for both passengers and goods. Although railway systems are generally considered safe, accidents caused by obstacles on railway tracks, fire or smoke inside trains, flooding, track defects, and operational failures may result in collisions, derailments, injuries, loss of life, and property damage. This paper presents an Arduino Uno-based train accident prevention system intended to identify hazardous conditions and provide an early warning to the train operator. The proposed system uses an Arduino Uno as the main processing unit along with sensors for detecting obstacles and other abnormal conditions. An ultrasonic sensor detects objects present in the path of the train, while LEDs and buzzers provide visual and audible warnings. Sensor information is processed by the Arduino in real time so that appropriate warning or preventive action can be initiated. The developed approach provides a simple, economical, and low-power solution for improving railway safety. The experimental implementation demonstrates that the proposed system can detect obstacles and activate warning indications, thereby providing an opportunity for the operator to stop the train before a potential collision.

Keywords— Arduino Uno, Train Accident Prevention, Ultrasonic Sensor, Obstacle Detection, Railway Safety, Buzzer, LED, Collision Avoidance.

INTRODUCTION

Railways play an important role in passenger transportation and the movement of goods. Despite continuous developments in railway technology and safety systems, accidents such as collisions and derailments continue to occur due to obstacles on tracks, mechanical failures, human errors, malfunctioning signals, unprotected crossings, and environmental conditions. Obstacles present in the right-of-way of a train can create particularly dangerous situations because a moving train requires a considerable distance to stop. Therefore, early identification of hazardous objects is important for reducing the probability and severity of railway accidents.

The proposed system introduces an Arduino-based safety mechanism for detecting potentially dangerous conditions. An ultrasonic sensor is employed primarily for detecting obstacles in front of the train. The sensor measures the distance between the train and an object and communicates this information to the Arduino Uno controller. Based on the programmed threshold conditions, the controller activates LEDs and buzzers to warn the train operator. The project also considers the detection of smoke or fire and flooding as important aspects of railway safety. The overall objective is to develop a simple and cost-effective embedded system capable of improving the reliability of railway accident prevention.

LITERATURE SURVEY

Several researchers have proposed sensor- and microcontroller-based techniques for improving railway safety. P. Navaraja [1] presented a railway track crack-detection approach using ultrasonic and PIR sensors for identifying defects and abnormalities in railway tracks. D. Sinha and F. Feroz [2] investigated obstacle detection on railway tracks using vibration sensors with Bayesian signal filtering. Their approach demonstrates the importance of reliable sensing and signal-processing techniques for detecting potentially hazardous conditions. Krishna, Shashi Yadav, and Nidhi [3] developed an automatic railway gate control system using a microcontroller to reduce human intervention and improve safety at railway crossings. These studies indicate that sensors combined with embedded controllers can provide an effective platform for railway monitoring and accident prevention.

J. Xuer [4] investigated a visual-monitoring-based railway grade-crossing surveillance system for improving safety at railway crossings. Other studies considered in the project report have explored ultrasonic sensors, GPS, GSM, RFID, and Arduino-based systems for obstacle detection, railway track monitoring, automatic gate operation, collision avoidance, and train speed control. These approaches demonstrate that real-time sensing and automatic warning mechanisms can reduce dependence on manual monitoring. However, implementing an economical system capable of rapidly identifying an obstacle and immediately alerting the train operator remains important. Therefore, the present work employs Arduino Uno and ultrasonic sensing to develop a comparatively simple accident-prevention prototype.

PROBLEM STATEMENT

Train accidents may occur because of human error, obstacles on railway tracks, track abnormalities, faulty signaling, mechanical problems, or environmental conditions. Failure to detect such hazardous conditions sufficiently early can result in collisions, derailments, injuries, and property damage. Hence, there is a requirement for a reliable and economical system capable of continuously detecting obstacles and providing an immediate warning to the train operator. The proposed work addresses this problem by developing an Arduino Uno-based train accident prevention system using sensors and alarm devices.

OBJECTIVES

1. To design and implement an Arduino Uno-based train accident prevention system capable of detecting obstacles or hazardous conditions on the railway track.
2. To provide immediate visual and audible warnings through LEDs and buzzers so that appropriate action can be taken to prevent collision and improve passenger safety.

PROPOSED SYSTEM

The proposed system is centered on an Arduino Uno based on the ATmega328P microcontroller. An HC-SR04 ultrasonic sensor is connected to the controller and continuously monitors the region in front of the train prototype. The ultrasonic sensor transmits high-frequency sound waves toward an object and determines its distance by measuring the time required for the reflected echo to return. The Arduino processes the measured distance and compares it with the predefined safe-distance condition. When an obstacle enters the specified detection range, the controller identifies the situation as potentially hazardous.

The output section consists primarily of LEDs, buzzers, and an LCD display. When an obstacle is detected, the Arduino activates the appropriate LED and buzzer to provide visual and audible warnings to the train operator. The LCD can be used to display system or detection information. The system is powered through a suitable power-supply unit/battery. The prototype therefore integrates sensing, processing, display, and warning functions into a single embedded safety system.

BLOCK DIAGRAM

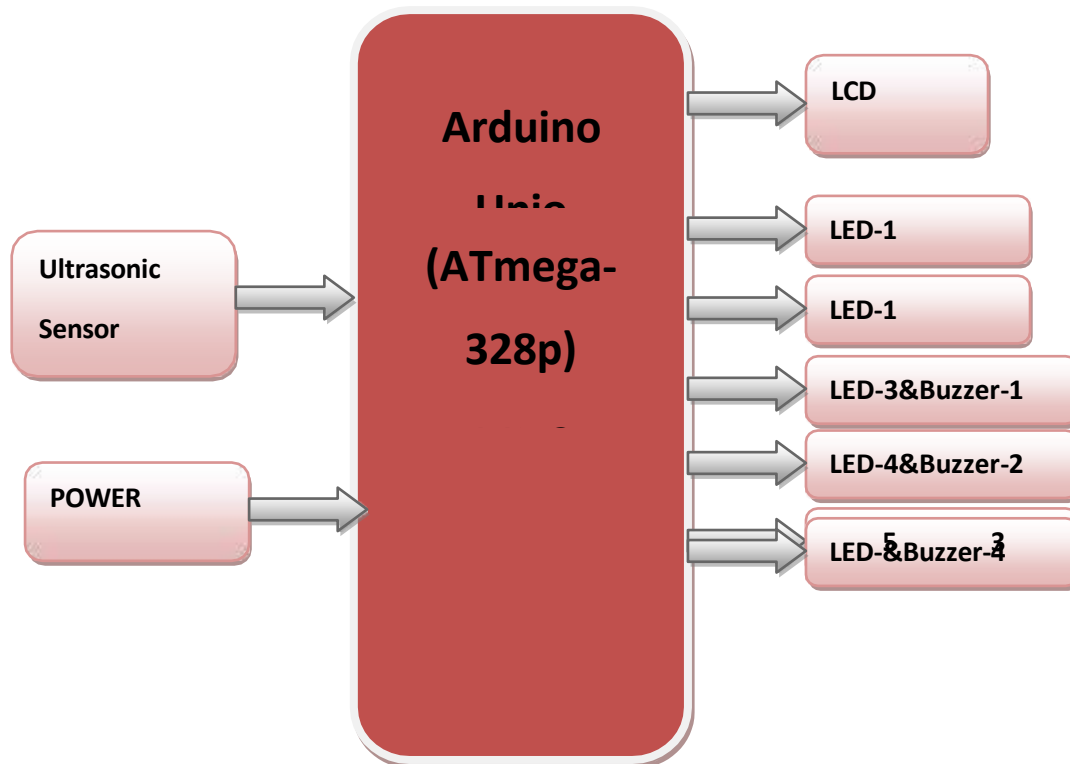


Fig. 1. Block diagram of the proposed train accident prevention system

Fig. 1 shows the block diagram of the proposed train accident prevention system, in which the HC-SR04 ultrasonic sensor and power supply are connected to the Arduino Uno controller. The Arduino processes the sensor signals and controls the LCD, LEDs, and buzzers to provide continuous obstacle monitoring and immediate warning to the train operator.

CIRCUIT DIAGRAM

Fig. 2 shows the circuit diagram of the proposed train accident prevention system, where the Arduino Uno is interfaced with the ultrasonic sensor, LCD, LEDs, and buzzers. The circuit detects obstacles on the railway track and activates visual and audible warning signals to alert the train operator

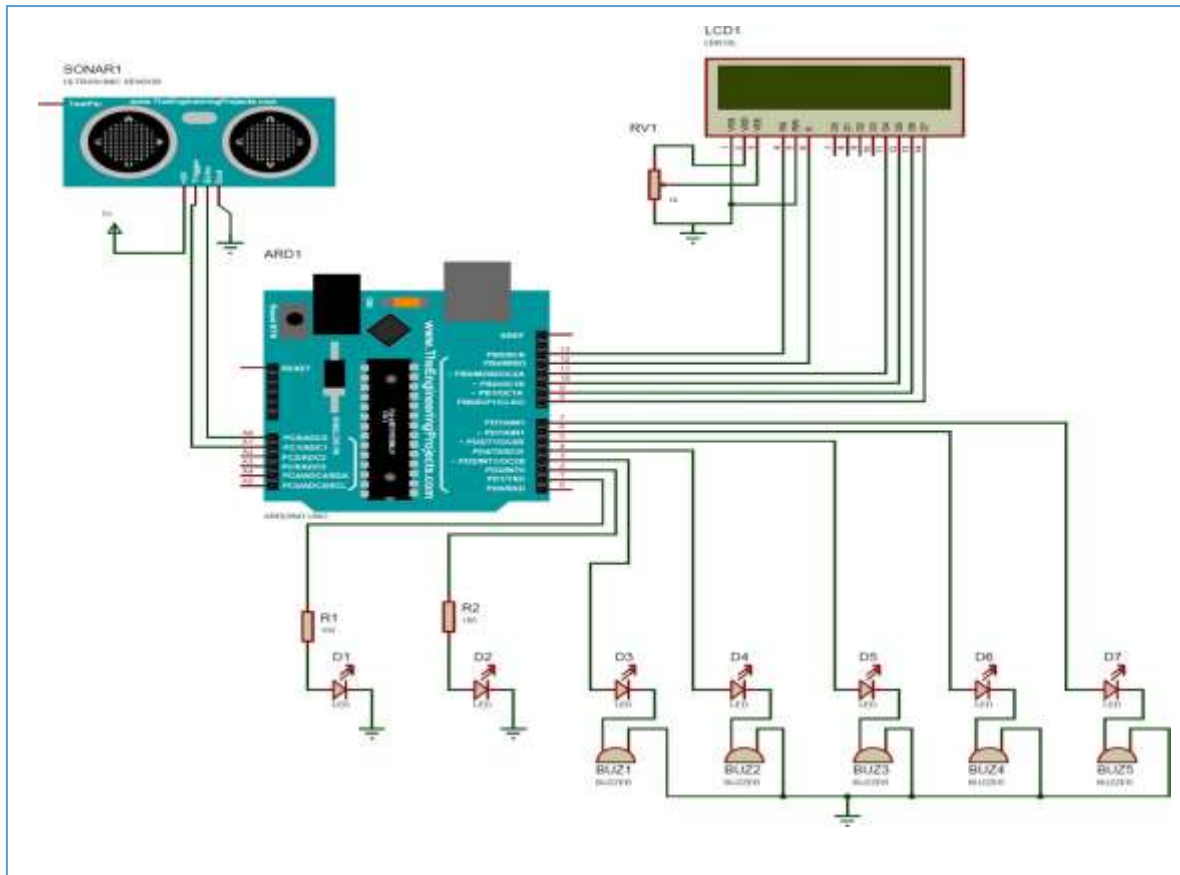


Fig. 2. Circuit diagram of the proposed train accident prevention system

METHODOLOGY

The methodology begins by interfacing the ultrasonic sensor with the Arduino Uno using the appropriate trigger and echo connections. LEDs and buzzers are connected to the controller through the required output connections, and the entire circuit is supplied from the power source. The Arduino is programmed using the Arduino IDE to continuously acquire distance information from the ultrasonic sensor. The transmitted ultrasonic wave is reflected by an obstacle, and the controller determines the distance based on the echo-return time.

During operation, the Arduino continuously compares the measured distance with the programmed threshold. If no obstacle is detected within the unsafe region, the system remains in normal operation. When an object enters the detection range, the Arduino activates the warning LED and buzzer. The warning continues until the obstacle is removed or suitable action is taken by the operator. The completed prototype is tested by placing objects within the sensing range and observing the response of the LEDs and buzzers. This methodology demonstrates the basic principle of real-time obstacle detection and warning for railway accident prevention.

RESULTS AND DISCUSSION

The developed system demonstrates the operation of an Arduino-based railway accident prevention prototype. During testing, the ultrasonic sensor functions as a proximity detector. Whenever an obstacle appears in front of the sensor, the system generates an indication through the LED and continuously operates the buzzer to alert the train operator. The warning allows the operator to respond to the obstacle and stop the train before reaching the hazardous location.

The project also considers smoke/fire and flooding detection as additional safety functions. The report indicates that a smoke sensor can provide an alarm when smoke is detected inside the train, while a rain/water sensor can identify unsafe water levels on the railway track. Combining these sensing functions can provide a broader railway safety mechanism. The experimental observations indicate that sensor-based monitoring with an Arduino controller can provide timely warning signals and potentially reduce accidents when appropriately implemented in a real railway environment.

CONCLUSION

An Arduino Uno-based train accident prevention system has been presented for improving railway safety through real-time detection and warning. The developed prototype primarily employs an ultrasonic sensor to detect obstacles present in the path of the train. When an obstacle is detected, the Arduino Uno processes the sensor information and activates LEDs and buzzers to warn the operator. The project also considers the detection of smoke and flooding as additional safety measures.

The implementation demonstrates that a low-cost embedded controller and suitable sensors can be used to develop a basic railway safety system. The Proteus simulation and prototype concept indicate the potential of sensor-based monitoring to improve the reliability of railway safety systems. With further development, integration of automatic braking, long-range communication, and additional sensors could make the proposed approach more effective for practical railway accident prevention.

REFERENCES

- [1] P. Navaraja, "Crack Detection System for Railway Track Using Ultrasonic and PIR Sensor," vol. 5, 2014.
- [2] D. Sinha and F. Feroz, "Obstacle Detection on Railway Tracks Using Vibration Sensors and Signal Filtering Using Bayesian Analysis," *IEEE Sensors Journal*, vol. 16, no. 3, Feb. 2016.
- [3] Krishna, Shashi Yadav, and Nidhi, "Automatic Railway Gate Control Using Microcontroller," *Oriental Journal of Computer Science & Technology*, vol. 6, no. 4, Dec. 2013.
- [4] J. Xuer, "Visual Monitoring Based Railway Grade Crossing Surveillance System," in *Proc. Congress on Image and Signal Processing*, 2008.
- [5] Pololu, sensor and electronic component technical resource.
- [6] Carnegie Mellon Robotics Academy, ultrasonic sensor technical resource.
- [7] PiBorg, "HC-SR04 Ultrasonic Sensor," technical resource.
- [8] Electrosome, "Interfacing Rain Sensor with Arduino," technical resource.
- [9] SainSmart, "MQ-5 Smoke/Gas Detector Sensor," technical resource.