Report on

Title Anti-Train Collision Warning System

Project report submitted to
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Project Report: Anti-Train Collision Warning System

Abstract

Train transportation is one of the most commonly used ways of travelling in India and around the globe, despite all the advancements in technology, train accidents are still happening because of human errors, signal failures, or miscommunications. The project proposes to design a low-cost, microcontroller-based anti-collision system using Arduino Uno boards, NRF24L01 RF transceivers, an LCD display, and a buzzer. Our system will allow two or more trains to communicate wirelessly and raise the alarm when their communication range is triggered. Early warning will allow the driver to apply the brake or trigger other automated systems in time and also reduce the likelihood of a collision. The report will focus on the designing, developing, and testing of the prototype that will have the capability of real-time warning alerts using the wireless RF communication system.

Keywords: Arduino Uno, NRF24L01, Anti-Collision System, Train Safety, Wireless Communication, LCD, Buzzer

Introduction

Rail networks are large the number of trains moved daily is in the thousands. The importance of safety cannot be overemphasized; one small mistake can lead to a horrific disaster. The signals and communication protocols are based on centralization and manual operation, which are expensive and slow. We propose a new cost-effective solution in which each train contains an Arduino board, connected to a sensor. The Arduino sends a heartbeat signal to notify the other boards that it is alive. If the other board does not receive this signal, it raises an

alert—using an LED/lcd and a buzzer. This cost-effective, low-power, and easily scalable design can be used as a backup solution.

Objectives

The aim of the project is to implement a low-cost Achieve bidirectional train-to-train wireless communication through the NRF24L01 modules.

This system is designed to buzz and display you through LCD every time a train comes in range.

To verify the system is decentralized and not dependent on any external infrastructure.

Methodology

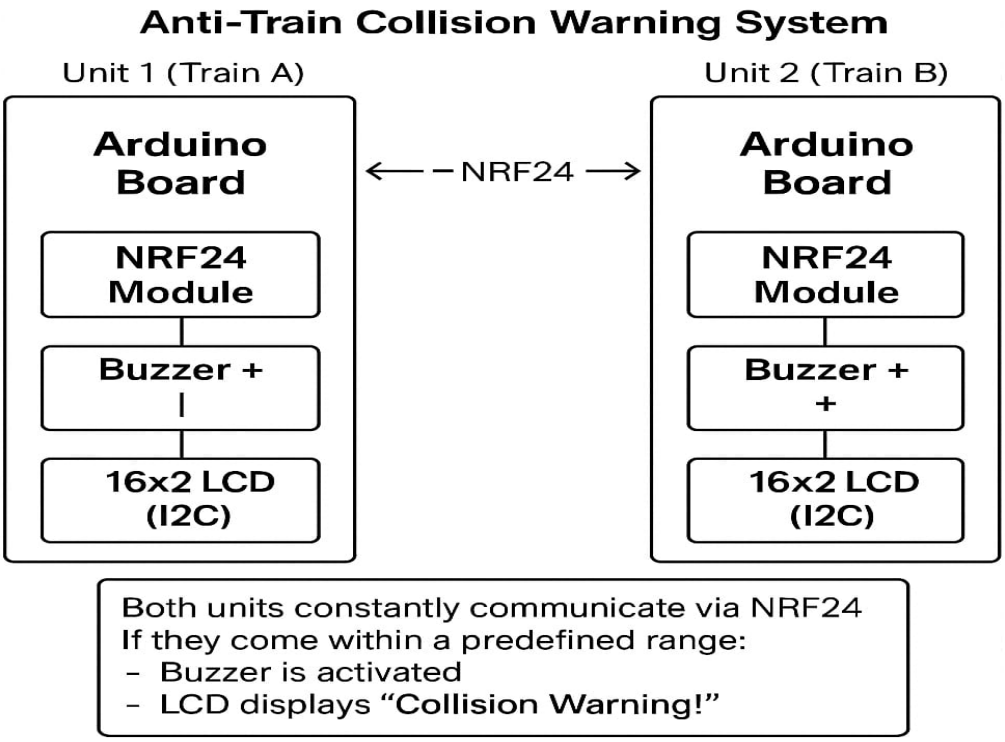
1. Hardware Components: - Arduino Uno: Main microcontroller platform. It is commonly used 16x2 I2C LCD Display a tool that provides visual notifications and alertness about the system. Pin 7 is the Active Buzzer which when another train is detected, is activated and emits an audible warning. Capacitor (10uF) safeguards against irregular power transmission by the NRF24L01 module

2. Communication Setup: The NRF24L01 module's communication system is peer-to-peer. Arduino sends and receives a "ping" every 500ms. The arrival of a message indicates the existence of a second train.

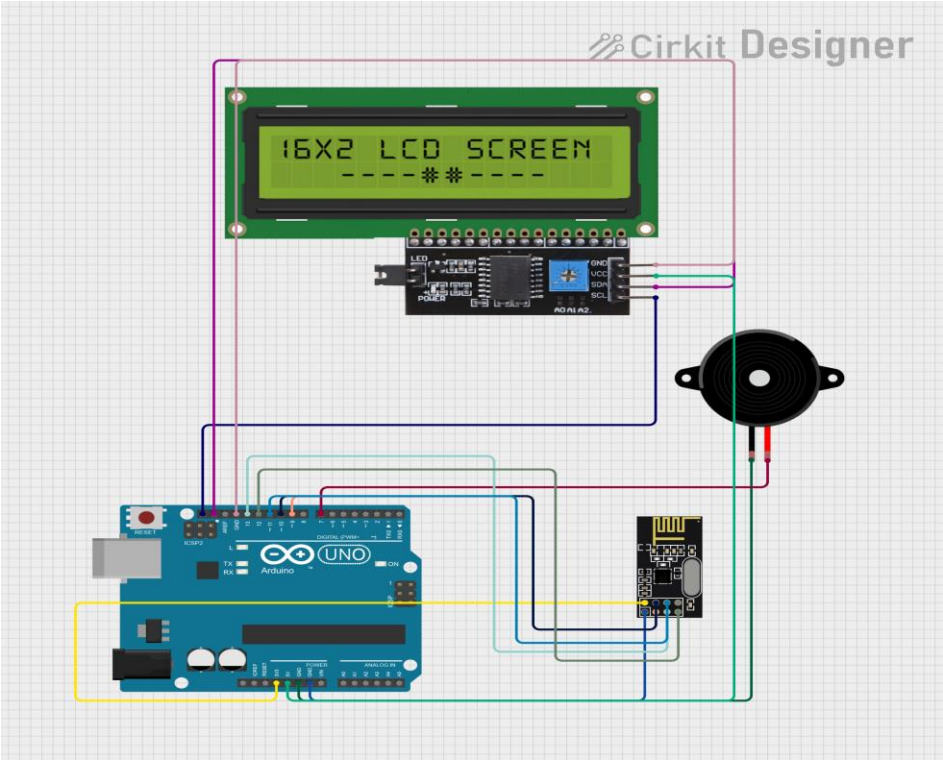
3. Alert Mechanism: LCD screens flash up such grim messages as "Train Detected" and "!!! WARNING !!!" A buzzer sounds for 200 milliseconds at 1000 hertz on sensing. It goes to no message mode after 3 seconds and the buzzer stops.

4. Startup Diagnostics: When the power button is pressed the power-on self test (POST) occurs. Check whether NRF24L01 is connected and functioning with the help of radio.isChipConnected(). - Activates a test beep on the buzzer for 200ms.

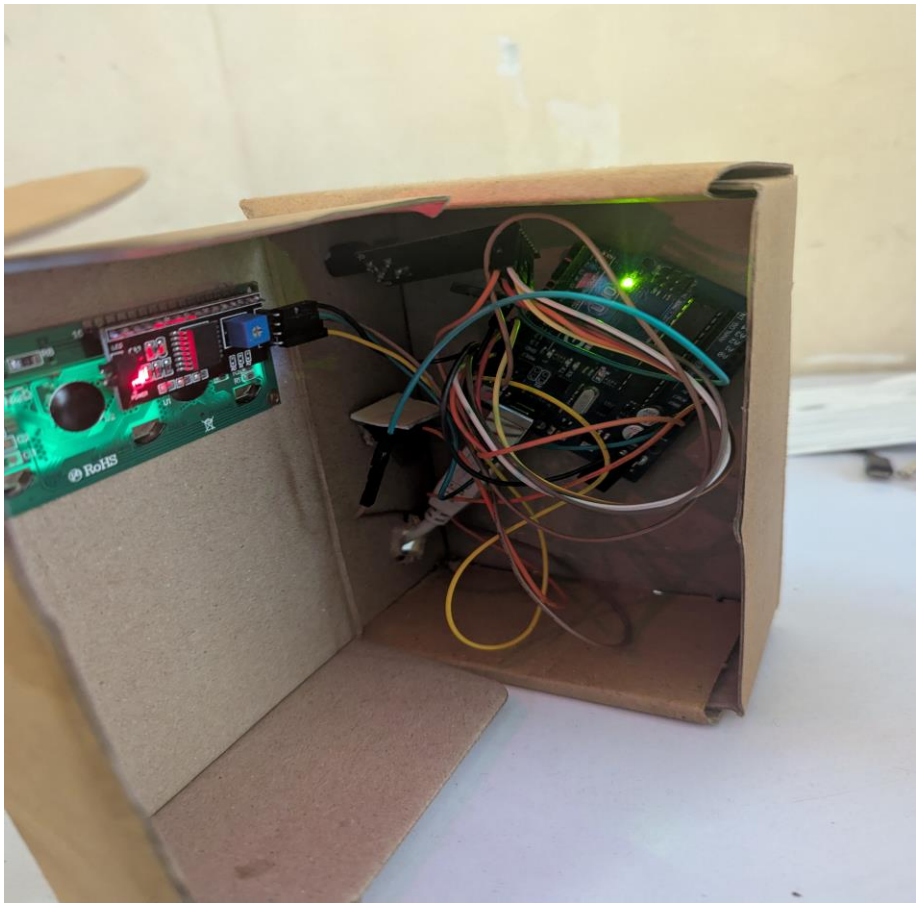
Displays the results on the LCD scre



Circuit Diagram




Waiting Signal



Testing and Results

The system was tested in both indoor and outdoor.

Communication was perfect and successful. The range was no less than 400 meters and not more than 600 meters.

The buzzer and LCD were functioning well. It signaled another train was in the area.

The system displayed a latency less than 500ms to detect proximity.

The amount of false positives, was very small. It was thanks to the RF channel selection, as well as message filtering.

Advantages

- Independent of GPS or internet.

-Work can occur in tunnels. It can also happen in remote locations. The same is true for places with poor communication infrastructure.

- Low power consumption.

- Easily expandable for multi-train detection.

Limitations

- Communication range limited by NRF24L01 (can be improved using PA+LNA version).

- No directional awareness (only detects presence, not distance or direction).

- Assumes all trains are equipped with this system.

Future Scope

-Automatic deceleration with integration to train braking systems.

-Using LoRa or UWB modules provides longer and more accurate distance-based warnings.

- Adding GPS + GSM for central monitoring.

- OLED display integration for clearer messages.

- Solar-powered, standalone modules.

Conclusion

The Anti-Train Collision Warning System example shows that with simple hardware and smart logic much improvement in safety can be made in railways. Using two-

way RF communication, real-time proximity warnings can be provided to both trains, reducing the risk of collision. While it cannot fully substitute conventional systems, it is a reliable secondary alert system that can function in infrastructure-deprived areas.

References

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