Wireless Red/Green Signal Alert System for Trains

1. Introduction

The Indian Railway network is one of the largest in the world, and managing signals efficiently is critical for train safety. Traditionally, train drivers rely on visual observation of trackside signals to determine whether to stop or proceed. This can be challenging, especially at high speeds or in adverse conditions.

This project demonstrates a **Wireless Red/Green Signal Alert System** that transmits track signal information wirelessly to the train, allowing automatic alerts and motor control. This system is implemented as a demo using **Arduino Nano as the transmitter** and **Arduino Uno as the receiver**, along with 433 MHz RF modules.

2. Objective

- To provide wireless communication of track signals (RED/GREEN) to a moving train.
- To display signal status on a **16×2 LCD** on the train.
- To automatically control a motor:
    - **RED Signal → Stop Motor**
    - **GREEN Signal → Run Motor Slowly**
- To create an interactive and student-friendly demonstration of RF-based train signaling.

3. System Overview

3.1 Components

Transmitter (TX) Side – Signal Post

- Arduino Nano
- 433 MHz RF Transmitter Module

- Red & Green LEDs
- 220Ω Resistors

Receiver (RX) Side – Train

- Arduino Uno
- 433 MHz RF Receiver Module
- 16×2 LCD Display
- L293D / L298N Motor Driver
- DC Motor
- Optional: Buzzer / Alert LED

3.2 Block Diagram

TX Side:
Red/Green LED → Arduino Nano → 433 MHz TX → RF Signal

RX Side:
RF Receiver → Arduino Uno → LCD Display + Motor Driver → Motor

3.3 Working Principle

1. **Signal Post (TX Side):**
    a. Arduino Nano monitors the signal status or uses a timed simulation.
    b. When the signal is RED, Nano turns on the **Red LED** and transmits "RED" via RF.
    c. When the signal is GREEN, Nano turns on the **Green LED** and transmits "GREEN" via RF.
2. **Train (RX Side):**
    a. Arduino Uno continuously reads RF data.
    b. Upon receiving "RED", the LCD displays "RED SIGNAL STOP" and the motor stops.
    c. Upon receiving "GREEN", the LCD displays "GREEN SIGNAL GO" and the motor runs slowly.
    d. If no signal is detected, the motor stops and the LCD shows "NO SIGNAL".

4. Hardware Connections

4.1 TX Side (Nano)

Component	Connection
Red LED	Pin 8 → 220Ω → GND
Green LED	Pin 9 → 220Ω → GND
RF TX Module DATA	Pin 12
RF TX Module VCC	5V
RF TX Module GND	GND

4.2 RX Side (Uno)

Component	Connection
RF RX DATA	Pin 11
RF RX VCC	5V
RF RX GND	GND
LCD RS	Pin 7
LCD EN	Pin 6
LCD D4-D7	Pins 5-2
Motor Driver IN1	Pin 9
Motor Driver IN2	Pin 10
Motor Driver ENA	5V or PWM pin
Motor	OUT1 & OUT2

5. Software Overview

5.1 TX Code (Arduino Nano)

- Sends "RED" or "GREEN" messages via 433 MHz RF module.
- Turns on the corresponding LED for visual indication.

5.2 RX Code (Arduino Uno)

- Receives RF messages.
- Decodes signal type.
- Updates 16×2 LCD display.
- Controls motor: stop for RED, run slowly for GREEN.

Libraries Used:

- VirtualWire (for RF communication)
- LiquidCrystal (for LCD display)

6. Advantages of the System

- Simple and low-cost demonstration for students.
- Provides visual (LCD) and operational (motor) feedback.
- Eliminates the need for a controller at the signal post (TX side optional).
- Expandable: multiple signals, DIP switches for addressing, IoT integration.
- Safe and educational for classroom or exhibition purposes.

7. Conclusion

This project demonstrates a **wireless signaling system for trains** using Arduino Nano, Arduino Uno, and 433 MHz RF modules. It shows the integration of microcontrollers, RF communication, LCD displays, and motor control.

Students can **explain every step of the system**: signal detection, wireless transmission, reception, decoding, display, and motor actuation. The demo is attractive, interactive, and educational, making it ideal for classroom exhibitions or science fairs.

8. Future Enhancements

- Use a single TX module with Arduino Nano to encode multiple signal states.
- Add DIP switches to assign unique addresses to multiple signals.
- Integrate IoT for real-time monitoring via mobile or cloud.
- Add safety features like obstacle detection for trains.