Automatic Speed Control in Restricted Areas using RF Modules

# Abstract

This project proposes and demonstrates an automatic vehicle speed regulation system that can be deployed in restricted areas such as school zones, hospitals, and crowded streets. The prototype uses RF transmitters placed at specific locations to transmit zone codes that represent speed limits. A receiver mounted in the vehicle captures this data, and the microcontroller regulates the motor driver accordingly to ensure compliance with the designated speed limit. The driver is also notified using a buzzer and LCD display.

# Introduction

Road accidents caused by overspeeding are a major safety concern worldwide. Particularly in areas such as schools and hospitals, controlling vehicle speed is crucial for safety. Current systems rely on manual enforcement such as signboards, traffic police, or speed cameras. These are either reactive or depend heavily on driver compliance. The proposed system aims to automate speed regulation by using low-cost RF modules and a simple Arduino-based prototype.

# System Architecture

The system is divided into two parts:  
1. Transmitting Side (Roadside Unit): RF transmitters placed in restricted zones transmit a unique code corresponding to the speed limit (e.g., 30 km/h, 40 km/h).  
2. Receiving Side (Vehicle Unit): The vehicle is equipped with an RF receiver, Arduino Uno, motor driver (L293D), and DC motor to represent the propulsion system. The received data is decoded, and the vehicle speed is automatically adjusted.

Additionally, a notification unit consisting of an LCD and buzzer alerts the driver of the active zone and the corresponding speed limit.

# Hardware Components

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| Component | Function |
| Arduino Uno | Microcontroller to decode signals and regulate motor speed |
| RF Transmitter (433 MHz) | Broadcasts speed limit codes in restricted zones |
| RF Receiver | Mounted on vehicle, captures the transmitted code |
| Motor Driver (L293D) | Controls DC motor speed using PWM signals |
| DC Motor | Represents the vehicle engine in prototype |
| LCD Display (16x2) | Displays current speed limit and zone information |
| Buzzer | Alerts driver upon entering a restricted zone |

# Working Principle

1. RF transmitters installed in specific zones broadcast speed limit codes.  
2. The RF receiver in the vehicle continuously listens for signals.  
3. When a signal is received, the Arduino decodes the code into a specific speed limit.  
4. The current motor PWM value is compared with the desired speed limit.  
5. If the vehicle is overspeeding, the PWM is reduced gradually, thereby reducing speed.  
6. The LCD displays the zone speed limit, and the buzzer alerts the driver.  
7. Once the vehicle exits the restricted zone, the speed is restored to normal.

# Prototype Results

The prototype was successfully implemented using a toy car model. Different zones were simulated with 30 km/h and 40 km/h limits. The RF transmitters transmitted codes, and the vehicle adjusted its speed gradually to comply with the speed limit. Notifications were displayed on the LCD, and the buzzer sounded on entering new zones. This demonstrates the feasibility of using RF-based communication for speed regulation.

# Future Scope

- Replace RF modules with GPS-based detection for more reliable and scalable deployment.  
- Integrate with real vehicle systems using CAN bus.  
- Use IoT-enabled modules to log speed limit compliance in the cloud.  
- Add braking integration to enforce speed control more effectively.  
- Build a mobile app for parents/authorities to monitor compliance.

# Conclusion

This project provides a proof-of-concept solution for automatic speed regulation in restricted zones. While implemented on a small-scale prototype with RF modules, the system demonstrates the potential for real-world applications in enhancing road safety. With further development using GPS, IoT, and vehicle communication networks, this system could significantly reduce overspeeding-related accidents.