International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 1 (2026)

ijerst.editor@gmail.com

editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 22, No. 1, 2026

Peer Reviewed, Referred & Indexed Journal

Research Paper

DESIGN AND DEVELOPMENT OF A REMOTE-CONTROLLED CAR USING ARDUINO UNO: A PROTOTYPE APPROACH

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Abstract

Remote-controlled vehicles play an important role in robotics education, automation research, and real-world applications such as surveillance, hazardous environment monitoring, and autonomous navigation. This paper presents the design, development, and testing of a low-cost remote-controlled car prototype based on the Arduino Uno microcontroller. The proposed system integrates a wireless communication module, motor driver circuitry, and DC motors to achieve reliable real-time control. The prototype emphasizes simplicity, modularity, and scalability, allowing further enhancement toward autonomous or sensor-based operation. Experimental results demonstrate effective directional control, stable communication, and satisfactory performance under laboratory conditions. The developed prototype serves as a foundation for advanced robotic vehicle research and educational applications.

Keywords: Arduino Uno · Remote-controlled car · Wireless control · Embedded systems · Robotics prototype

Received: 02-01-2026 Accepted: 05-02-2026 Published: 12-02-2026

1 Introduction

Recent advancements in embedded systems and microcontroller platforms have significantly simplified the development of robotic and remote-controlled systems. Low-cost development boards such as Arduino Uno have enabled students and researchers to rapidly prototype intelligent machines with minimal hardware complexity. Remote-controlled vehicles represent a fundamental application of embedded control systems and are widely used in robotics education, defense research, industrial inspection, and exploration of hazardous environments.

Traditional remote-controlled cars rely on dedicated control circuits, which lack flexibility and expandability. In contrast, microcontroller-based systems allow integration of sensors, communication modules, and intelligent control algorithms. This paper focuses on the design and implementation of a remote-controlled car using Arduino Uno, emphasizing modular hardware design and efficient software control.

The objective of this work is to develop a functional prototype capable of forward, reverse, left, and right motion through wireless commands. The system is designed with future scalability in mind, enabling integration of obstacle detection, camera modules, or autonomous navigation algorithms.

2 System Overview

The remote-controlled car system consists of three main subsystems:

1. **Control Unit** – Arduino Uno microcontroller
2. **Communication Unit** – Wireless control interface
3. **Actuation Unit** – Motor driver and DC motors

The Arduino Uno acts as the central controller, receiving commands wirelessly and generating control signals for motor actuation through a motor driver module.

3 Hardware Components

A. Arduino Uno

Arduino Uno is based on the ATmega328P microcontroller and operates at 16 MHz. It provides digital and analog input/output pins, making it suitable for controlling motors and interfacing with wireless modules. Its low power consumption, ease of programming, and large community support make it ideal for prototyping robotic systems.

B. Motor Driver Module

A motor driver (such as L298N or L293D) is used to control the direction and speed of DC motors. Since Arduino cannot directly drive motors due to current limitations, the motor driver acts as an interface between the microcontroller and motors.

C. DC Motors and Chassis

Two DC geared motors are used to provide motion to the vehicle. Differential drive configuration enables directional movement by controlling the speed and direction of each motor independently.

D. Wireless Communication Module

Wireless control can be implemented using Bluetooth (HC-05), RF modules, or Wi-Fi modules. In this prototype, a Bluetooth module enables communication between the car and a mobile device or controller.

E. Power Supply

A rechargeable battery supplies power to the motors and control circuitry. Voltage regulation ensures stable operation of the Arduino board.

4 Software Design

The Arduino Uno is programmed using the Arduino Integrated Development Environment (IDE). The software logic follows these steps:

1. Initialize communication and motor control pins
2. Receive wireless command
3. Decode command
4. Generate corresponding motor control signals
5. Execute movement action

Commands such as forward, backward, left, right, and stop are mapped to specific motor driver inputs.

5 Control Algorithm

The control logic is based on simple decision-making using conditional statements. Each received command triggers a predefined motor response.

Algorithm Steps:

1. Start system
2. Wait for command
3. If command = Forward → Move forward
4. If command = Backward → Move backward
5. If command = Left → Turn left
6. If command = Right → Turn right
7. If command = Stop → Halt motors

This simple control approach ensures reliable and real-time response.

6 Experimental Results and Discussion

The prototype was tested under indoor laboratory conditions. The vehicle responded accurately to all control commands with minimal latency. The Bluetooth communication range was sufficient for short-distance operation, and the motor driver provided stable speed control.

The system demonstrated:

- Smooth directional control
- Reliable wireless communication
- Low power consumption
- Stable operation under repeated commands

The results confirm the feasibility of using Arduino Uno for low-cost remote-controlled vehicle applications.

7 Applications

The developed prototype can be applied in:

- Robotics education and training
- Surveillance and monitoring systems
- Inspection of hazardous environments
- Research on autonomous vehicle navigation
- Defense and rescue operations (with enhancements)

8 Limitations and Future Work

Although the prototype performs effectively, it has certain limitations:

- Limited operating range
- No obstacle detection
- Manual control only

Future enhancements include:

- Integration of ultrasonic or IR sensors
- GPS-based navigation
- Camera-based vision system
- Autonomous control using AI algorithms
- IoT-based remote monitoring

9 Conclusion

This paper presented the design and development of a remote-controlled car using Arduino Uno as a prototype system. The proposed design demonstrates a simple, flexible, and cost-effective approach to robotic vehicle development. Experimental validation confirms reliable operation and responsiveness. The prototype serves as a strong foundation for further research in autonomous vehicles, intelligent robotics, and embedded control systems.

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