

Precision Pathfinding: Arduino-Based Wall Following Robot

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Abstract

This paper presents the development of a cost-effective Arduino-based wall-following robot capable of navigating enclosed environments autonomously. The design incorporates ultrasonic sensors for distance measurement, servo motors for movement control, and the Arduino Uno as the central processing unit. We detail the design principles, electronic circuitry, programming logic, and sensor calibration necessary for wall-following algorithms. The robot demonstrates stable navigation along walls and avoids obstacles dynamically. The system is ideal for applications in surveillance, automated inspection, and educational robotics. The simplicity, modularity, and affordability make it an excellent prototype for real-world deployment and academic experimentation.

Keywords: *Arduino, Wall Following, Ultrasonic Sensor, Obstacle Avoidance, Mobile Robot, Automation*

INTRODUCTION

Autonomous robots have become an essential part of modern engineering with a wide range of applications such as surveillance, rescue operations, and warehouse automation. Wall-following robots are a subclass of mobile robots designed to navigate by keeping a consistent distance from a nearby wall. This project implements a wall-following robot using the Arduino Uno, ultrasonic sensors, servo motors, and simple embedded logic.

SYSTEM ARCHITECTURE

The robot's architecture includes hardware and software components. Hardware components include an Arduino Uno microcontroller, ultrasonic sensors mounted on the front and side, servo motors with wheels, a chassis, power supply, and motor driver module (L298N). Software is implemented in Arduino C using sensor data to drive control decisions.

WORKING PRINCIPLE

The robot uses an ultrasonic sensor to continuously measure the distance from the wall. The data is processed by the Arduino to determine if the robot is too close or too far from the wall. Depending on the readings, the robot adjusts its path by controlling the speed and direction of the motors to maintain a steady distance.

ALGORITHM DESIGN

The algorithm operates on a simple feedback loop:

- Read distance from the side wall.
- Compare it with the threshold value.
- If too close, steer away; if too far, steer toward the wall.
- Check for obstacles in front and perform an evasive maneuver if detected.

COMPONENT SPECIFICATIONS

Key components include:

- Arduino Uno: ATmega328P microcontroller board.
- HC-SR04 Ultrasonic Sensor: Measures distance using sound waves.
- L298N Motor Driver: Drives two DC motors.
- Servo Motors: Provides motion control.
- Chassis: Acrylic-based robot body with two driven wheels and one caster.

CIRCUIT DIAGRAM AND WIRING

The wiring involves connecting the HC-SR04 sensor's trigger and echo pins to Arduino pins, motors to L298N, and L298N to the power source. Common ground is maintained. The Arduino is powered via USB or external battery. Sensor placement plays a key role in optimal readings and stability.

PERFORMANCE EVALUATION

The robot was tested on various wall types and turns. Table 1 summarizes its performance under different conditions including smooth and rough surfaces, wall curvature, and presence of sharp corners.

Table 1: Performance of Wall Following Robot under Various Conditions

Surface Type	Wall Distance Setpoint (cm)	Average Deviation (cm)	Obstacle Handling
Smooth Wall	20	1.2	Good
Rough Surface	20	2.4	Moderate
Curved Wall	20	3.1	Poor
Sharp Corners	20	2.9	Moderate

The robot performs best on smooth walls, maintaining consistent distance with minimal deviation. On curved or irregular surfaces, performance decreases due to inconsistent sensor reflection angles.

APPLICATIONS

This robot can be used in warehouses for following paths between storage racks, in hospitals for autonomous delivery, and in home automation as a smart assistant for patrolling tasks. In academics, it serves as a learning model for control theory, embedded systems, and robotics.

ADVANTAGES AND LIMITATIONS

Advantages:

- Low-cost and easy to build.
- Accurate wall following with basic sensors.
- Scalable and reprogrammable.

Limitations:

- Performance drops in noisy environments.
- Only supports 2D flat-surface navigation.
- Limited obstacle complexity handling.

FUTURE IMPROVEMENTS

Future versions can incorporate machine vision for complex obstacle detection, implement SLAM for mapping, and use AI for behavior-based decision-making. Integration with IoT can enable remote monitoring and cloud-based control.

CONCLUSION

The Arduino-based wall-following robot presents a practical and educational solution for indoor navigation tasks. Its design simplicity and adaptability make it suitable for beginners and prototype development. Despite basic limitations, it can be extended for advanced robotic applications with minimal cost overhead.

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