REPORT

Title

Design and Implementation of a Line Follower Robot Using Arduino UNO

Abstract

This project presents the design, implementation, and testing of a line follower robot based on the Arduino UNO microcontroller. The robot uses an array of five infrared (IR) sensors to detect a predefined path and employs an L293D motor driver to control two DC motors. An optimized control algorithm with proportional error correction ensures smooth motion, accurate path tracking, and recovery from line loss. The system demonstrates an effective integration of sensors, control logic, and actuators, making it suitable for educational, robotic, and automation applications.

1. Introduction

Line Follower Robot Hardware Setup

Figure 1: Hardware setup of the Arduino-based line follower robot showing IR sensors, Arduino UNO, L293D motor driver, and DC motors.

Line follower robots are autonomous systems capable of detecting and following a visual path, typically a black line on a white surface. Such robots are widely used in robotics education, industrial material handling, and automated guided vehicles (AGVs). The objective of this project is to design a reliable and efficient line follower robot using simple hardware components and an optimized software control strategy.

2. System Overview

The system consists of an Arduino UNO as the central controller, five IR sensors for line detection, an L293D motor driver IC for bidirectional motor control, and two DC motors for locomotion. An external battery supplies power to the motors, while regulated 5V power is provided to the logic circuitry.

3. Hardware Components

Block Diagram of Line Follower Robot

Figure 2: Block diagram illustrating sensor inputs, control unit, motor driver, and actuators.

3.1 Arduino UNO

The Arduino UNO, based on the ATmega328P microcontroller, serves as the processing unit. It reads sensor inputs, computes control decisions, and generates PWM signals for motor control.

3.2 Infrared Sensor Array

Five IR sensors are arranged in a linear configuration to detect the position of the line relative to the robot. Each sensor provides a digital output indicating the presence or absence of the line.

3.3 L293D Motor Driver

The L293D IC is a dual H-bridge motor driver that enables bidirectional control of two DC motors. It isolates the microcontroller from high motor currents and allows speed control using PWM signals.

3.4 DC Motors

Two DC motors are used for differential drive. By varying the speed of each motor, the robot can move forward, turn left, turn right, or stop.

3.5 Power Supply

A 9V battery is used to power the motors. A voltage regulator provides a stable 5V supply to the Arduino and sensors.

4. Working Principle

Control Flow of Line Follower Algorithm

Figure 3: Flowchart of the line follower control algorithm using proportional error correction.

The IR sensors continuously scan the surface beneath the robot. When the central sensor detects the line, the robot moves forward. If the line shifts left or right, the controller calculates an error value based on sensor readings and adjusts motor speeds proportionally. This proportional correction mechanism ensures smooth turning and stable line tracking. In cases where all sensors detect white (line lost), the robot uses the last known error to recover the path.

5. Control Algorithm

An error-based proportional control strategy is implemented. Each sensor combination corresponds to a specific error value representing the deviation of the robot from the line center. The correction factor is calculated using a proportional gain constant, which dynamically adjusts motor speeds. This approach improves accuracy, reduces oscillations, and enhances overall performance compared to simple conditional logic.

6. Software Implementation

The control logic is implemented in embedded C using the Arduino IDE. The program continuously reads sensor inputs, computes the error, applies proportional correction, and updates motor speeds using PWM signals. The modular structure of the code allows easy tuning of speed and gain parameters.

7. Applications

• Autonomous line follower robots
• Educational robotics kits
• Industrial material transport systems
• Maze-solving and path-planning robots

8. Advantages

• Smooth and accurate line tracking
• Simple and cost-effective hardware
• Easily tunable control parameters
• Expandable for advanced control techniques (PID, maze solving)

9. Conclusion

The developed line follower robot successfully demonstrates autonomous navigation using sensor-based feedback and proportional control. The integration of Arduino UNO, IR sensors, and L293D motor driver provides a reliable and scalable platform for robotics applications. The project highlights the importance of control algorithms in improving system performance and serves as a strong foundation for more advanced autonomous robotic systems.

10. References

1. Arduino Documentation – https://www.arduino.cc
2. L293D Motor Driver Datasheet – Texas Instruments
3. ATmega328P Datasheet – Microchip Technology
4. Introduction to Autonomous Mobile Robots – Roland Siegwart