Project Report: Line Follower Robot

Introduction

The Line Follower Robot is an autonomous mobile robot designed to detect and follow a predefined path using infrared (IR) sensors. It is one of the most common educational projects in robotics and embedded systems because it demonstrates the integration of hardware components, control algorithms, and programming skills.

The main principle of operation is based on the difference in reflectivity between a black line and a white surface. The robot continuously senses its environment and adjusts its motion accordingly to stay on track.

Objectives

- To design and implement a mobile robot capable of following a black line on a white surface.
- To integrate sensors, motor drivers, and a microcontroller into a working system.
- To apply control techniques (PID) for smoother and more accurate navigation.
- To demonstrate a practical application of embedded systems and automation.

Components Used

1. Arduino Uno – acts as the microcontroller for decision-making.
2. L298N Motor Driver – controls the DC motors based on Arduino signals.
3. 2 DC Motors with wheels – provide movement.
4. 4 IR Sensors – detect the black line against the white background.
5. Power Bank – powers the Arduino and motors.
6. Chassis and supporting hardware – for mechanical assembly.
7. Connecting wires – for circuit implementation.

Working Principle

- The IR sensors emit infrared light and detect whether it is reflected or absorbed by the surface.
- White surfaces reflect IR light, while black lines absorb it, creating a clear distinction in sensor readings.

- The Arduino processes these readings and determines the position of the line relative to the robot.
- Using PID control, the robot adjusts the speed of the left and right motors to correct its path and follow the line smoothly.

Circuit Connections
- Sensors: connected to Arduino pins D2, D3, D4, and D11.
- Motor Driver (L298N):
  - ENA → D5, IN1 → D7, IN2 → D8
  - ENB → D6, IN3 → D9, IN4 → D10
- Motors: connected to OUT1/OUT2 and OUT3/OUT4 of L298N.
- Power: Arduino powered via USB from a power bank; GND is common across all components.

Software Implementation

The control program is written in C++ using the Arduino IDE. It implements a PID algorithm to calculate corrections based on sensor readings. The motor speeds are dynamically adjusted to maintain smooth tracking of the line, even at curves or intersections.

Applications
- Industrial automation and material handling (AGVs).
- Warehouse management and logistics robots.
- Prototypes for autonomous vehicle navigation.
- Educational tools for learning robotics and embedded systems.

Conclusion

The Line Follower Robot successfully demonstrates the principles of autonomous navigation using simple and cost-effective components. Through the integration of hardware and software, the system is capable of detecting and following a line in real-time.

The project provides a practical foundation for more advanced robotics concepts, such as wireless control, obstacle avoidance, and machine vision. By fine-tuning the PID parameters, the robot can achieve smoother motion and higher accuracy, making it a valuable platform for both educational and research purposes.