



Line-Following Robot Documentation

A comprehensive guide to building, programming, and calibrating your Arduino-based Line-Following Robot.



1. Project Overview

The Line-Following Robot automatically tracks and follows a contrasting line on the ground using infrared (IR) sensors and dual DC motors. It's a foundational robotics project ideal for:

- Learning embedded systems and motor control
- Understanding sensor feedback and closed-loop behavior
- Exploring autonomous navigation basics

Key Features:

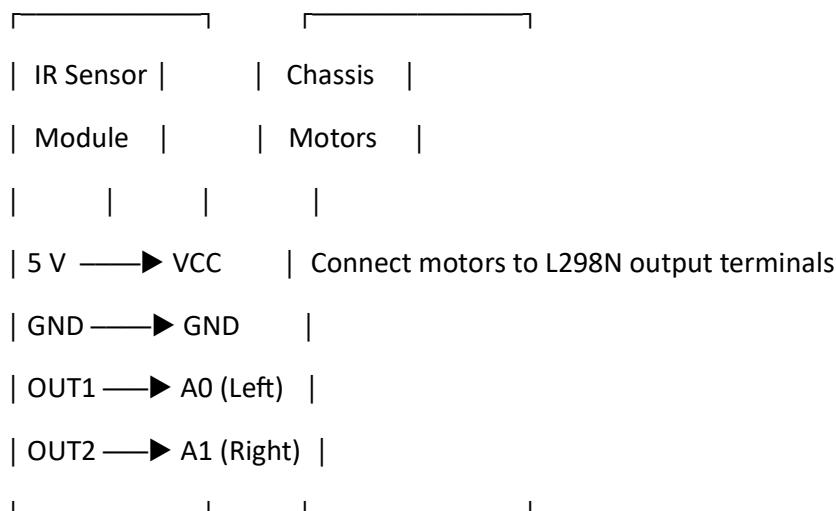
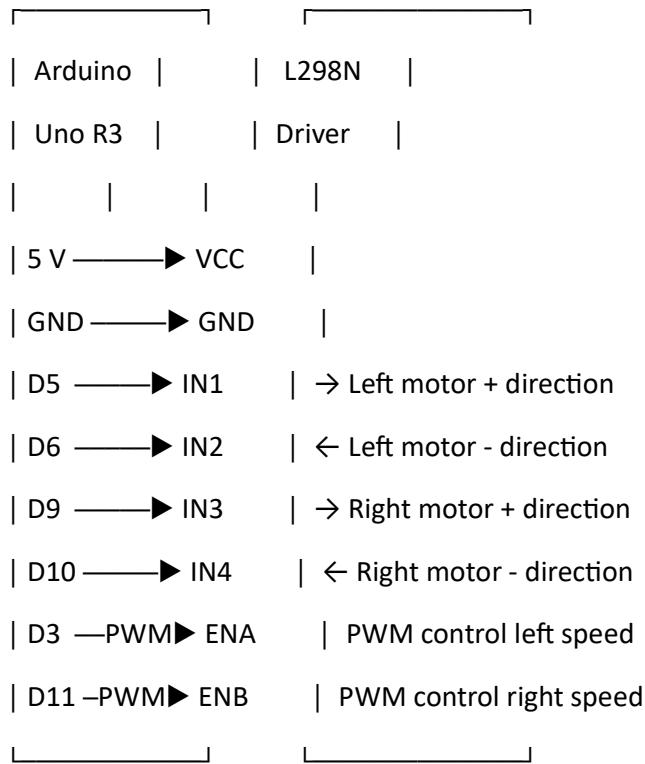
- Uses two IR reflectance sensors to detect black line on white surface
 - Dual H-bridge (L298N) driver controls speed and direction of DC motors
 - Adjustable speed and turn sensitivity
 - Fully autonomous, no remote control needed
-



2. Components & Specifications

Emoji Component	Qty Specification / Notes
🔧 Arduino Uno R3	1 ATmega328P, 16 MHz, 5 V logic
👀 IR Line Sensor Module	1 2-channel TCRT5000 or QRE1113
⚙️ L298N Motor Driver Module	1 Dual H-bridge, up to 2×2 A
🔌 DC Geared Motors	2 3–6 V, 120 RPM typical
🏎️ Chassis & Wheels	1 2-wheel plus front caster
🔋 Battery Pack	1 6–9 V (4xAA, Li-ion, etc.)
🌙 Jumper Wires	Set 22 AWG male/female
🎛️ Potentiometer (optional)	1 For L298N enable pin voltage adjustment

3. Wiring & Connections



Notes:

- Ensure common ground between Arduino, sensors, and motor driver.
- Use PWM pins (D3, D11) to vary motor speed smoothly.

4. Working Principle

1. Line Detection:

- IR sensors emit infrared light and measure reflection.
- White surface: high reflection → sensor output HIGH (1).
- Black line: low reflection → sensor output LOW (0).

2. Decision Logic:

Left Sensor Right Sensor Action

HIGH	HIGH	Move Forward
LOW	HIGH	Veer Right
HIGH	LOW	Veer Left
LOW	LOW	Stop / Search Line

3. Motor Control:

- analogWrite(ENA, speed) sets left motor speed.
- digitalWrite(IN1/IN2) controls left motor direction.
- Similar mapping for right motor using ENB, IN3, IN4.

Code Breakdown:

- **Setup:** configure all I/O pins.
- **Loop:** read sensor states, decide action, call motor functions.
- **Motor Helpers:** functions to abstract forward, turn, and stop logic.

6. Assembly & Calibration

1. **Mount Components:** attach Arduino, sensor module, motors to chassis.
2. **Wire Connections:** follow the wiring diagram; secure jumper wires.
3. **Power Up:** supply regulated 6–9 V to motor driver; USB for Arduino.
4. **Initial Test:** place on white surface, verify motors respond.

5. **Line Test:** draw ~2 cm black tape line; adjust sensor height (~1 cm above).
 6. **Calibration:**
 - If robot veers, tweak baseSpeed or invert sensor logic.
 - You can add thresholds or smoothing (e.g., read analog value and compare).
-

7. Troubleshooting Tips

-  **No Movement:** check power rails, battery charge, ENA/ENB PWM signals.
 -  **Always Turn:** swap sensor leads or invert digital logic.
 -  **Vibration:** secure loose wires; add rubber dampers under sensors.
-

Ready to Go!  Build, test, and watch your robot trace its path autonomously! Feel free to expand with Bluetooth control or maze-navigation algorithms.