Line Follower Robot

Introduction

A Line Follower Robot is an autonomous robot that follows a pre-defined path, usually a black line on a white surface (or vice versa). This is achieved using infrared (IR) sensors that detect the contrast between the path and the background.

The Arduino Uno, along with motor drivers, sensors, and DC motors, controls the movement of the robot, adjusting its direction based on real-time sensor feedback..

Components Required

1. Arduino Uno
2. IR Sensors (Reflective) 2
3. Motor Driver Module (L298N or L293D)
4. DC Motors (2) .
5. Wheels and Chassis.
6. Power Source (Battery 9V or Li-ion 12V).
7. Jumper wires

Arduino Uno

Arduino Uno is a microcontroller board based on the **ATmega328P** chip. It is widely used in electronics and robotics due to its simplicity, ease of programming, and extensive community support. In a **line follower robot**, Arduino Uno acts as the **brain** that processes sensor inputs and controls motor outputs to navigate the path effectively.
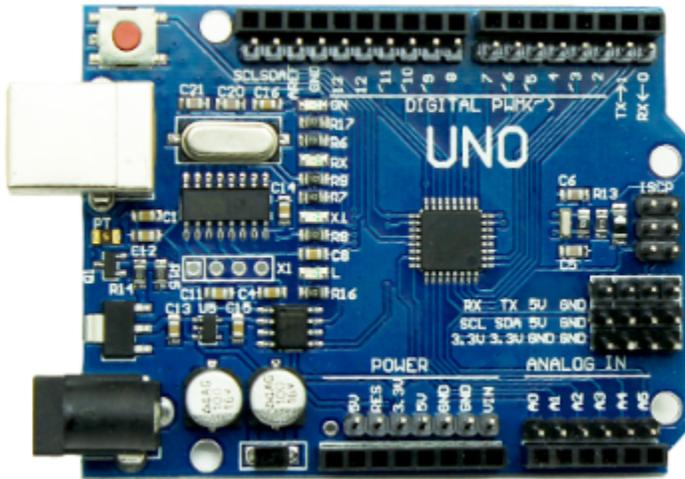
1. Microcontroller: ATmega328P

- **The brain of the board** that processes inputs and controls outputs.

- Has a **clock speed of 16 MHz**, meaning it can execute **16 million instructions per second**.

- Provides a **stable and efficient** performance for various applications.

2. Operating Voltage: 5V

- The board operates at **5V logic level**, which is the voltage used for digital communication.

- Compatible with most sensors and modules that use **5V power supply**.

- Can be powered via **USB (5V) or an external power source (7V-12V)**.

3. Digital I/O Pins: 14 (6 PWM)

- **14 Digital Pins** (D0 to D13) can be used as **input or output** for sensors, LEDs, buttons, motors, etc.

- **6 of these pins (3, 5, 6, 9, 10, 11) support PWM (Pulse Width Modulation)**.

- **PWM allows speed control of motors or dimming of LEDs**.

4. Analog Input Pins: 6 (A0 to A5)

- Used for **reading sensor data** such as temperature, light intensity, or potentiometers.

- Can **read voltage variations from 0V to 5V** and convert them into digital values (0-1023).

- Essential for projects requiring **real-world data processing**.

5. USB Connection: Standard USB-B

- Used for **programming the board and providing power** (5V).

- Connects to the computer using a **USB-B cable**, which is also used in printers.

- **Allows serial communication** between the Arduino and the computer (for debugging and monitoring).

6. EEPROM Storage: 1 KB

- **EEPROM (Electrically Erasable Programmable Read-Only Memory)** stores data even when the power is turned off.

- Used for **saving small amounts of data** like sensor calibration values or user preferences.

- Limited to **1 KB (1024 bytes)**, so it's mainly used for storing **important settings**.

IR Sensor

An Infrared (IR) sensor consists of:

- IR LED (Transmitter): Emits infrared light.

- Photodiode (Receiver): Detects the reflected IR light.

- Comparator Circuit: Converts the received signal into a digital output (HIGH or LOW).

Working Principle in Line following Robot

- **White surfaces** reflect **most of the IR light**.

- **Black surfaces** absorb **most of the IR light**.

- The sensor detects **differences in reflection**, allowing the robot to follow a black line on a white surface.

Motor Driver Module (L298N or L293D)

A motor driver module (L298N or L293D) acts as an interface between the Arduino and the DC motors, allowing the line follower robot to move forward, turn, or stop based on the signals from the IR sensors.

Why is a motor driver module needed ?

- Arduino cannot directly power motors, as it provides only 5V at a low current.

- Motors require more power (typically 6V–12V and high current).

- Motor drivers act as a bridge, taking signals from the Arduino and controlling the motor speed and direction.

- H-Bridge Mechanism: Allows motors to rotate in both directions (forward & backward).

DC Motors and wheels

 DC (Direct Current) motors are the driving force behind a line follower robot, enabling it to move forward, turn, and stop based on IR sensor inputs.

A line follower robot typically uses two DC motors, one on each side.

- Each motor controls one wheel.

- The motor driver module (L298N or L293D) determines motor speed and direction.

- IR sensors provide feedback, adjusting the robot's movement based on the detected line.

Left Motor	Right Motor	Robot Movement
Forward	Forward	Move Forward
Stop	Forward	Turn Left
Forward	Stop	Turn Right
Stop	Stop	Stop

Power Source
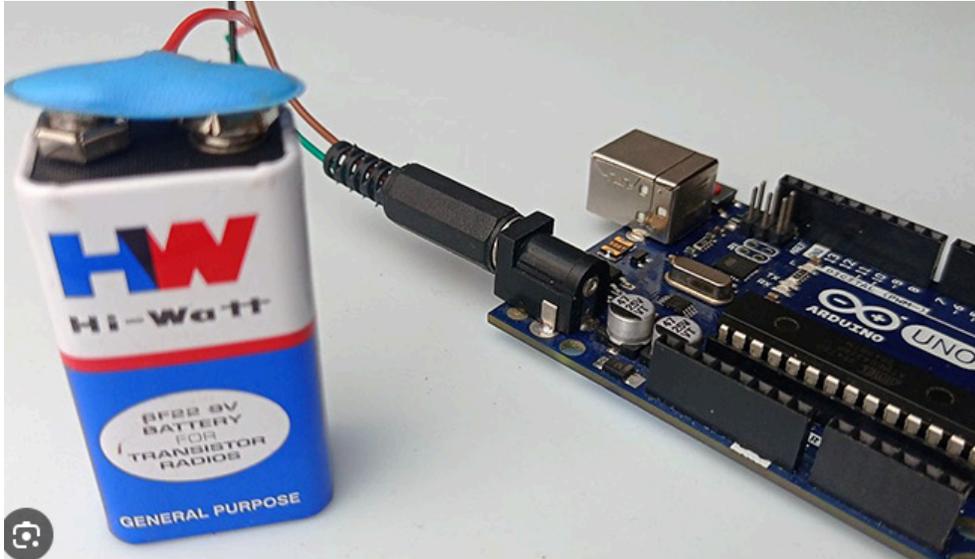
A line follower robot requires a reliable power source to operate motors, sensors, and the Arduino board. The choice of battery affects the robot's speed, efficiency, and runtime.

Why a battery is needed?

- Supplies power to the Arduino Uno (5V logic).

- Provides sufficient voltage and current to DC motors via the motor driver (L298N or L293D).

- Powers **IR sensors** to detect the line.

Basic Working Mechanism Of line follower Robot

The robot moves by continuously checking the line's position using IR sensors and adjusting its movement using DC motors. The basic working principle involves:

1. IR Sensors Detect the Line

   - IR sensors emit infrared light and detect reflected light from the surface.

   - A black line absorbs IR light, while a white surface reflects IR light.

   - The sensors send signals to the Arduino Uno.

2. Arduino Uno Processes the Sensor Data

   - If the left sensor detects the line, the robot turns left.

   - If the right sensor detects the line, the robot turns right.

   - If both sensors detect the line, the robot moves forward.

   - If no sensor detects the line, the robot stops or searches for the line.

3. Motor Driver Controls the DC Motors

   - The L298N or L293D motor driver receives signals from the Arduino.

   - It supplies power to the left and right motors, controlling their speed and direction.

   - The robot adjusts its movement to stay on track.

Left Sensor	Right Sensor	Action
ON (Detects Line)	OFF	Turn Left
OFF	ON (Detects Line)	Turn Right
ON	ON	Move Forward
OFF	OFF	Stop or Search

Circuit Connection

1. IR Sensors → Arduino Uno (Digital Pins)

2. Motor Driver (L298N) → Arduino Uno (PWM Pins)

3. DC Motors → Motor Driver (OUT1, OUT2 for Left Motor; OUT3, OUT4 for Right Motor)

4. Power Supply → Arduino (Vin) and Motor Driver (12V input)

Arduino Uno Pin Connections for Line Follower Robot

Component	Arduino Uno Pin
Left IR Sensor	Digital Pin 2
Right IR Sensor	Digital Pin 3
Left Motor (L298N OUT1, OUT2)	Digital Pins 5, 6
Right Motor (L298N OUT3, OUT4)	Digital Pins 9, 10
Power (Battery 9V or 12V)	Vin & GND

How Arduino Controls the Robot's Movement

1. Moving Forward:

    - Both sensors detect white (no line), so Arduino commands both motors to move forward.

2. Turning Left:

    - Left sensor detects the black line; Arduino stops the left motor and moves only the right motor.

3. Turning Right:

    - Right sensor detects the black line; Arduino stops the right motor and moves only the left motor.

4. Stopping:

    - Both sensors detect black (intersection or error), so Arduino stops both motors.