DESIGN AND IMPLEMENT LINE FOLLOWING ROBOT

CSE350 PROJECT FINAL REPORT, SECTION: 12, GROUP: 05

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***Abstract*—This project is about building a line follower robot that can detect and follow a predefined (typically a black line). The main idea is to use infrared (IR) sensors to detect the line and an Arduino to control the motors so the robot can stay on track. The main purpose is to develop a cost-effective robot that can follow a path without any manual control. The primary motivation behind this project is to gain practical experience with sensors, microcontrollers and how to make a robot move on its own using basic control logic.**

***Index Terms*—Line follower robot, Arduino, Infrared (IR) sensors, microcontroller.**

I. IMPLEMENTATION

A. *EQUIPMENTS AND COMPONENTS*

- L298N Dual H-Bridge Motor Driver Module
- Arduino Uno R3
- 4WD Robotics Chassis with Motors & Wheels
- DC 3–12V N20 Gear Motor with Mount Bracket & 43mm Wheel
- Battery Holder (3-AA)
- 3 pcs 3000mWh Lithium Battery
- 2 pcs IR Sensor Module
- Switch
- Jumper Wires

B. *THEORY AND WORKING PRINCIPLE*

The line follower robot works based on the principle of light reflectivity. A black surface absorbs more infrared (IR) light, while a white surface reflects it. The IR sensor modules detect this difference and send signals to the Arduino Uno. If the sensor detects white, it sends a digital HIGH signal. If the sensor detects black, it sends a digital LOW signal. The Arduino then processes these signals and decides how the motors should move using the L298N motor driver module. Depending on the sensor readings, the robot either moves forward, turns left, or turns right, ensuring it always stays on the predefined black line.

C. *CIRCUIT DIAGRAM*

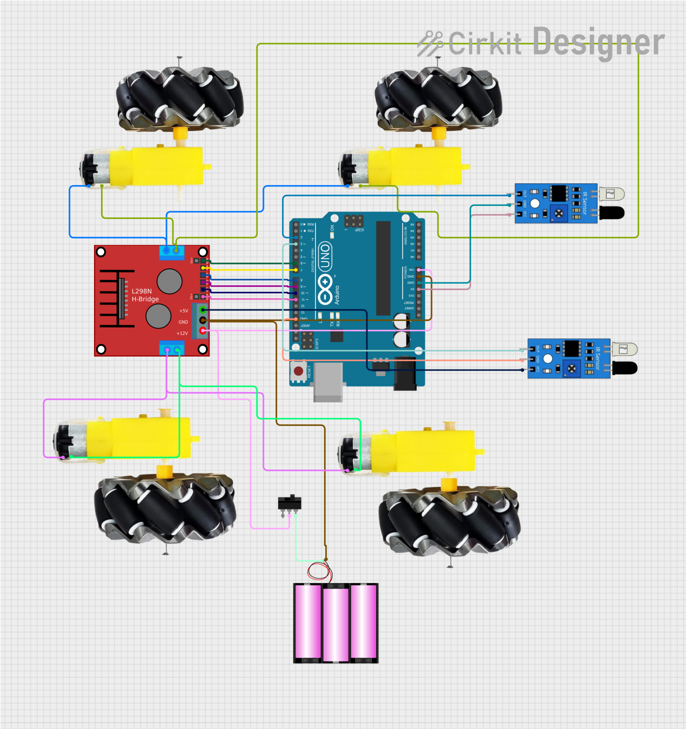

Fig. 1. Circuit diagram of the line follower robot.

D. *LFR ARDUINO UNO CODE*

```
// Motor A
const int ENA = 11; // PWM pin for Motor A
const int IN1 = 10; // IN1 pin for Motor A
const int IN2 = 9;  // IN2 pin for Motor A

// Motor B
const int ENB = 6;  // PWM pin for Motor B
const int IN3 = 8;  // IN3 pin for Motor B
const int IN4 = 7;  // IN4 pin for Motor B

// IR Sensors
const int IRSensorLeft = 2;   // Left IR sensor
const int IRSensorRight = 3;  // Right IR sensor

// Speed variables
int baseSpeed = 60; // Forward speed
int turnSpeed = 85; // Turning speed

void setup() {
  // Motor pins
  pinMode(ENA, OUTPUT);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(ENB, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);

  // Sensors
  pinMode(IRSensorLeft, INPUT);
  pinMode(IRSensorRight, INPUT);

  // Debugging
  Serial.begin(9600);
  Serial.println("Line Follower Ready...");
}

void loop() {
  bool leftSensor = digitalRead(IRSensorLeft);   // 1 = black, 0 = white
  bool rightSensor = digitalRead(IRSensorRight); // 1 = black, 0 = white

  Serial.print("Left: ");
  Serial.print(leftSensor);
  Serial.print(" | Right: ");
  Serial.println(rightSensor);

  // Movement logic
  if (leftSensor == 0 && rightSensor == 0) {
    moveForward();    // Both see white     go straight
  }
  else if (leftSensor == 1 && rightSensor == 0) {
    turnLeft();       // Left sees black     turn left
  }
  else if (leftSensor == 0 && rightSensor == 1) {
    turnRight();      // Right sees black     turn right
  }
  else {
    stopMotors();     // Both black     stop
  }
}

// Functions
void moveForward() {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  analogWrite(ENA, baseSpeed);

  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  analogWrite(ENB, baseSpeed);
}

void turnRight() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  analogWrite(ENA, turnSpeed);

  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  analogWrite(ENB, turnSpeed);
}

void turnLeft() {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  analogWrite(ENA, turnSpeed);

  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  analogWrite(ENB, turnSpeed);
}

void stopMotors() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  analogWrite(ENA, 0);

  digitalWrite(IN3, LOW);
  digitalWrite(IN4, LOW);
  analogWrite(ENB, 0);
}
```

E. *PROJECT WORKFLOW*

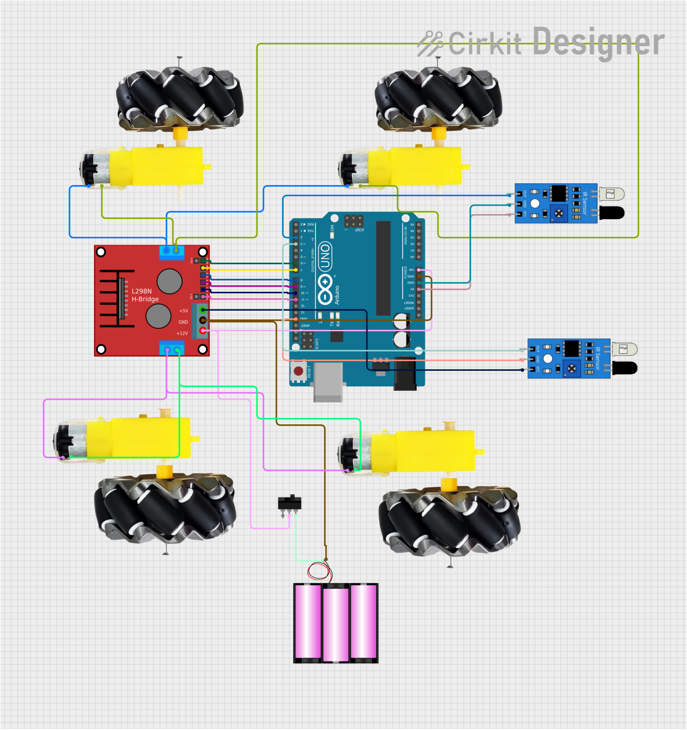

Fig. 2. Flowchart

F. FACED CHALLENGES AND SOLUTIONS:

During our LFR project, we had to reposition the IR sensor multiple times. Initially, it couldn't align properly with the line due to the motor's excessive speed. We then reduced the forward speed and increased the turning speed. After that, we carefully calibrated the IR sensor to ensure accurate detection of the black line.

II. CONCLUSION

The Line Follower Robot (LFR) project uses Arduino UNO, L298N motor driver, and IR sensors to follow a line on the ground automatically. The robot accurately detects and tracks the line, demonstrating basic autonomous navigation skills. Future improvements could include adding obstacle detection, wireless control, and smarter algorithms for advanced performance.

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REFERENCES

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