# ABSTRACT:

This paper presents the design and implementation of an infrared line-following robot, which utilizes infrared sensors to detect and track a designated line on various surfaces. The robot is equipped with a microcontroller that processes sensor inputs to adjust its movement in real-time, ensuring precise navigation along the line. Key components include an array of infrared emitters and receivers for line detection, motor drivers for controlling wheel movement, and a robust feedback loop for maintaining stability and speed. Experimental results demonstrate the robot's capability to navigate complex paths, including curves and intersections, with high accuracy. This project highlights the potential applications of infrared technology in autonomous navigation systems and provides insights into enhancing line-following algorithms for improved performance.

# INTRODUCTION:

Line-following robots have garnered significant interest in the field of robotics due to their simplicity and versatility in various applications, from educational tools to automated transport systems. This paper focuses on the development of an infrared line-following robot, which leverages infrared sensors for effective line detection and tracking. The ability to autonomously navigate predefined paths makes such robots ideal for tasks in environments where traditional navigation methods may fail.

Infrared sensors are chosen for their effectiveness in detecting contrasting colors and their resilience in different lighting conditions. By employing a feedback control system, the robot can adapt its trajectory in real-time, ensuring precise alignment with the line. This adaptability allows for seamless navigation around curves, intersections, and obstacles.

The aim of this project is to explore the fundamental principles of line-following robotics while contributing to advancements in sensor technology and control algorithms. The outcomes of this research not only enhance the understanding of autonomous navigation systems but also provide a foundation for future innovations in robotics and automation. In the following sections, we will outline the design methodology, system components, experimental setup, and results of the infrared line-following robot.

# COMPONENTS:

The line following robot has the following main components are:

1. Arduino Uno
2. L298N Motor driver
3. IR Sensor
4. Two DC Geared Motors

5. Two wheels

6. Jumper wires

7. Batteries (7 – 12 volts DC)

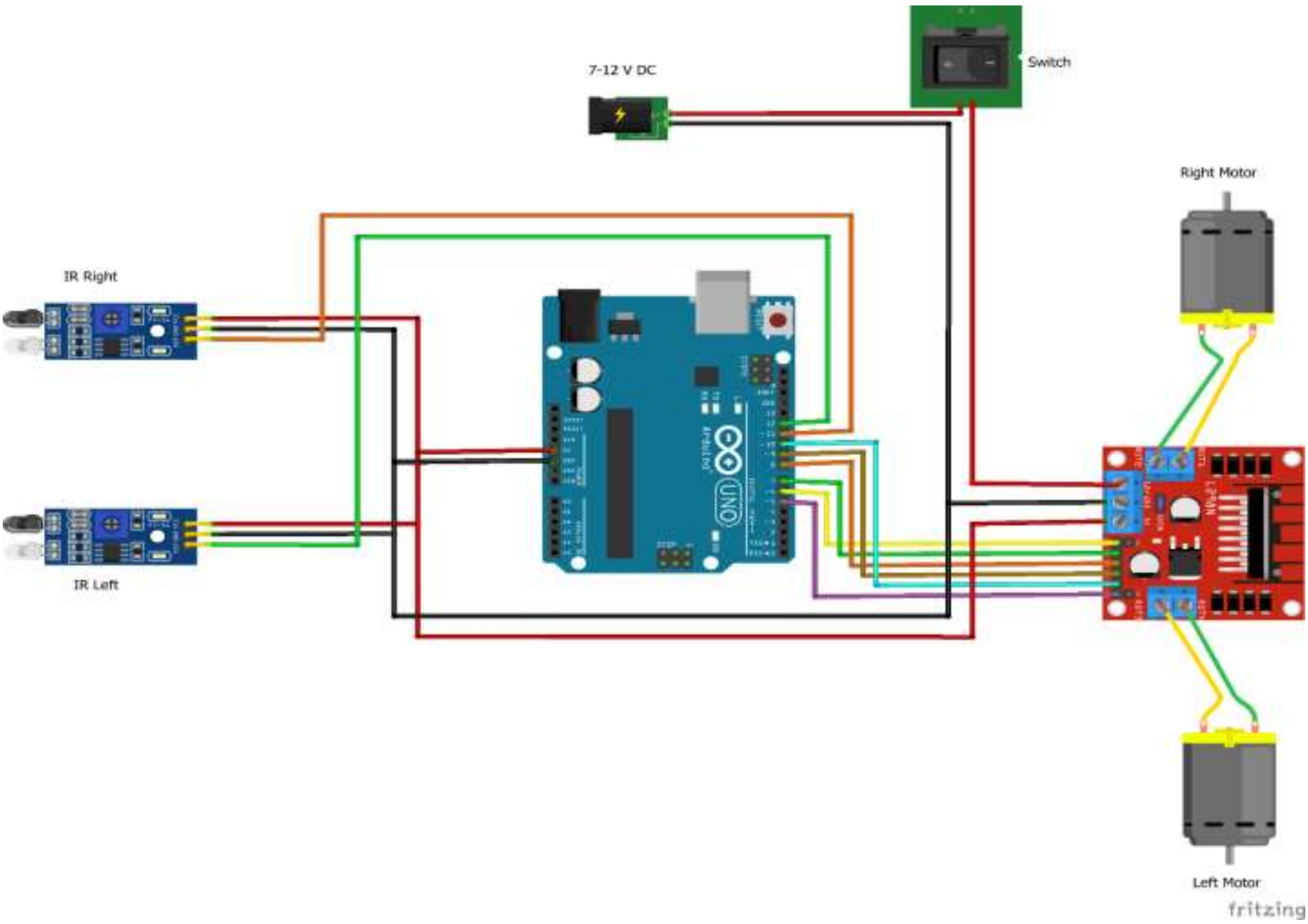
# TOOLS:

Some tools names are given below:

1. Soldering Iron
2. Glue gun
3. Screwdriver
4. Non Electric wires
5. Wire Strippers

5.Connecting wires

# CIRCUIT DIAGRAM:



# WORKING:

The infrared line-following robot operates by utilizing infrared sensors to detect the presence of a line, typically a dark surface, against a lighter background. Initially, the robot initializes its hardware components, setting up the motor and sensor pins to prepare for operation. In the main loop, it continuously reads the states of the left and right infrared sensors. When both sensors detect the line (output LOW), the robot moves straight ahead, effectively following the path.

If the right sensor detects the line (HIGH) while the left does not, the robot adjusts its course by turning right, which helps realign it back onto the line. Conversely, if the left sensor is active (LOW) while the right is not, the robot turns left. In cases where neither sensor detects the line (both HIGH), the robot stops, indicating it may have lost the line or reached a potential intersection.

The robot's movement is controlled through the `rotateMotor()` function, which adjusts the speed and direction of each motor based on the sensor input. Positive speed values make the motors rotate forward, while negative values reverse them, enabling sharp turns. Additionally, the code incorporates a modified PWM frequency, allowing the motors to operate smoothly even at low speeds, which is crucial for maintaining control during navigation.

This continuous feedback loop not only enables the robot to adaptively follow the line but also allows it to navigate around corners and intersections with precision. The use of infrared sensors provides resilience to variations in lighting conditions, ensuring consistent performance. Overall, this system exemplifies fundamental principles of robotics, integrating sensor feedback, decision-making algorithms, and motor control to achieve autonomous navigation.

Now Arduino knows that there is something in front of the sensor and Arduino send some instruction to the motor driver and motor driver trigger the motors. and the Arduino robot starts to move forward we need to run all motor forward.

Now, what about the sensors. IR sensor works on infrared light which can also detect the object near to it. So, there is two IR sensor one is at the left side of ultrasonic sensor and other is at the right side of the ultrasonic sensor. when anything comes near to the left sensor Arduino got the information that there is something is near to the left sensors and according to the code, the robot will turn to the left. and the same process for the right sensor. So this is how the human following robot works.

-  ARDUINO


It is the brain of our project. It can give all the command to their sub ordinate components which should by operated by the human behaviour. And it also gives feedback to the other components and human. So that it can be the used as a medium of communication between human and robots & vice versa. It has specification of 8-bit CPU, 16 MHZ clock speed, 2 KB SRAM 32 KB flash Memory, 1 KB EEPROM.

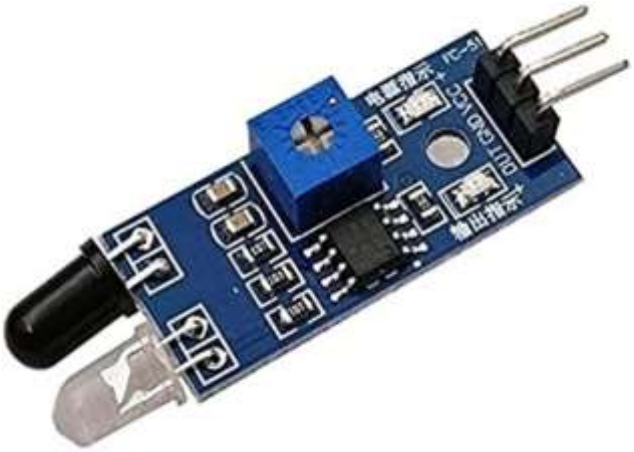
-  DC MOTORS

BO Motor is a device that converts any form of energy into mechanical energy or imparts motion. In constructing a robot, motor usually plays an important role by giving movement to the robot. Here 4 BO motor are used to drive the robot.

- MOTOR DRIVER

The Motor Driver is a driver module for motors that allows you to use Arduino to control the working speed and direction of the motor. The Motor driver can either be powered by Arduino directly or by an external 6V~15V power supply via the terminal input.

- INFRARED SENSOR



Infrared (IR) sensors are crucial components in many robotic applications, particularly in line-following robots. They function by emitting infrared light and detecting the reflected light from surfaces, allowing them to discern between different colors or materials based on their reflectivity.

# APPLICATIONS:

1 Object controlling
2.Wireless car controlling
3.Verifing the intensity

# APPENDIX:

```
#define IR_SENSOR_RIGHT 11

#define IR_SENSOR_LEFT 12

#define MOTOR_SPEED 180


//Right motor

int enableRightMotor=6;

int rightMotorPin1=7;

int rightMotorPin2=8;


//Left motor

int enableLeftMotor=5;

int leftMotorPin1=9;

int leftMotorPin2=10;


void setup()

{


  TCCR0B = TCCR0B & B11111000 | B00000010 ;


  // put your setup code here, to run once:

  pinMode(enableRightMotor, OUTPUT);
```

```
  pinMode(rightMotorPin1, OUTPUT);
  pinMode(rightMotorPin2, OUTPUT);

  pinMode(enableLeftMotor, OUTPUT);
  pinMode(leftMotorPin1, OUTPUT);
  pinMode(leftMotorPin2, OUTPUT);

  pinMode(IR_SENSOR_RIGHT, INPUT);
  pinMode(IR_SENSOR_LEFT, INPUT);
  rotateMotor(0,0);
}


void loop()
{

  int rightIRSensorValue = digitalRead(IR_SENSOR_RIGHT);
  int leftIRSensorValue = digitalRead(IR_SENSOR_LEFT);

  //If none of the sensors detects black line, then go straight
  if (rightIRSensorValue == LOW && leftIRSensorValue == LOW)
  {
```

```
    rotateMotor(MOTOR_SPEED, MOTOR_SPEED);
  }
  //If right sensor detects black line, then turn right
  else if (rightIRSensorValue == HIGH && leftIRSensorValue == LOW )
  {
      rotateMotor(-MOTOR_SPEED, MOTOR_SPEED);
  }
  //If left sensor detects black line, then turn left
  else if (rightIRSensorValue == LOW && leftIRSensorValue == HIGH )
  {
      rotateMotor(MOTOR_SPEED, -MOTOR_SPEED);
  }
  //If both the sensors detect black line, then stop
  else
  {
    rotateMotor(0, 0);
  }
}


void rotateMotor(int rightMotorSpeed, int leftMotorSpeed)
{
```

```
if (rightMotorSpeed < 0)
{
  digitalWrite(rightMotorPin1,LOW);
  digitalWrite(rightMotorPin2,HIGH);
}
else if (rightMotorSpeed > 0)
{
  digitalWrite(rightMotorPin1,HIGH);
  digitalWrite(rightMotorPin2,LOW);
}
else
{
  digitalWrite(rightMotorPin1,LOW);
  digitalWrite(rightMotorPin2,LOW);
}

if (leftMotorSpeed < 0)
{
  digitalWrite(leftMotorPin1,LOW);
  digitalWrite(leftMotorPin2,HIGH);
}
```

```
 else if (leftMotorSpeed > 0)

 {

   digitalWrite(leftMotorPin1,HIGH);

   digitalWrite(leftMotorPin2,LOW);

 }

 else

 {

   digitalWrite(leftMotorPin1,LOW);

   digitalWrite(leftMotorPin2,LOW);

 }

 analogWrite(enableRightMotor, abs(rightMotorSpeed));

 analogWrite(enableLeftMotor, abs(leftMotorSpeed));

}
```

# CONCLUSION:

In conclusion, the infrared line-following robot demonstrates an effective and straightforward approach to autonomous navigation using infrared sensors and motor control. By continuously monitoring the sensor inputs and making real-time adjustments to its movement, the robot successfully follows a defined path, showcasing its ability to navigate curves and intersections with precision. The implementation of PWM for motor control enhances the robot's responsiveness, allowing it to operate smoothly at various speeds. This project not only illustrates the fundamental principles of robotics but also highlights the potential for further advancements in sensor technology and control algorithms. Future improvements could include incorporating additional sensors for obstacle detection or refining the decision-making logic to enhance performance in complex environments. Overall, this robot serves as an excellent platform for understanding and developing line-following algorithms and autonomous systems in robotics.