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DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING,
RAJSHAHI-6204, BANGLAGLADESH.

Course No: ETE-3200
Course Title: Project Design Based on Communication System(Sessional)
Project Name: Line Follower Robot Using Arduino Uno

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Table of Contants

ABSTRACT

Line Following is one of the most important aspects of robotics. A Line Following Robot is an autonomous robot which is able to follow either a black line that is drawn on the surface consisting of a contrasting color. It is designed to move automatically and follow the line. The robot uses arrays of optical sensors to identify the line, thus assisting the robot to stay on the track. The array of four sensor makes its movement precise and flexible. The robot is driven by DC gear motors to control the movement of the wheels. The Arduino Uno interface is used to perform and implement algorithms to control the speed of the motors, steering the robot to travel along the line smoothly.This project aims to implement the algorithm and control the movement of the robot by proper tuning of the control parameters and thus achieve better performance.In addition the LCD interface is added in order to display the distance travelled by the robot. It can be used industrial automated equipment carriers, small household applications, tour guides in museums and other similar applications, etc.

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Chapter-01

Introduction,Theory & Objective

Introduction:

Line Following is one of the most important aspects of robotics. A Line Following Robot is an autonomous robot which is able to follow either a black line that is drawn on the surface consisting of a contrasting color. It is designed to move automatically and follow the line. The robot uses arrays of optical sensors to identify the line, thus assisting the robot to stay on the track. The array of four sensor makes its movement precise and flexible. The robot is driven by DC gear motors to control the movement of the wheels. The Arduino Uno interface is used to perform and implement algorithms to control the speed of the motors, steering the robot to travel along the line smoothly.This project aims to implement the algorithm and control the movement of the robot by proper tuning of the control parameters and thus achieve better performance.In addition the LCD interface is added in order to display the distance travelled by the robot. It can be used industrial automated equipment carriers, small household applications, tour guides in museums and other similar applications, etc.

Theory:

A Robot is any machine which is completely automatic, i.e. it starts on its own, decides its own way of work and stops on its own. It is actually a replica of human being, which has been designed to ease human burden. It can be controlled pneumatically or using hydraulic ways or using the simple electronic control ways

The line fallowing robot is one of the self-operating robots. That detects and follows a line drawn on the area. The line is indicated by white line on a block surface or block line on a white surface. This system must be sense by the line. This application is depends upon the sensors. Here we are using five array sensors for path detection purpose. That is proximity sensor and IR sensor. The proximity sensor used for path detection and IR sensor used for obstacle detection. These sensors mounted at front end of the robot. The Arduino Uno is an intelligent device the whole circuit is controlled by the Arduino Uno

Objectives:

- To learn about the line following robot using Arduino uno
- To know about the working method of line follower robot using Arduino uno
- To know about the application and advantages of line following robot using Arduino uno
- To learn about the future plan of line following robot using Arduino uno.

Chapter-02

Component Description

Introduction:

In this section, the required components are described. Here a brief description is given about each component of the circuit diagram. The components which are used in this project such as arduino uno, L298N motor driver,IR sensor array module, BO motor, motor wheel, Robot chassis,wires etc.

Hardware Required:

- Arduino Uno
- L298N motor driver
- 5 Array IR sensor module
- 7.4 or 9V battery
- BO motor
- Motor wheel
- Castor wheel
- Robot chassis
- Wires
- Screw

Required Software:

- Arduino-1.8.16(Arduino Coding)

Hardware Description

Arduino Uno:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Fig-01: Arduino Uno

L298N Motor Driver:

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. 78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.

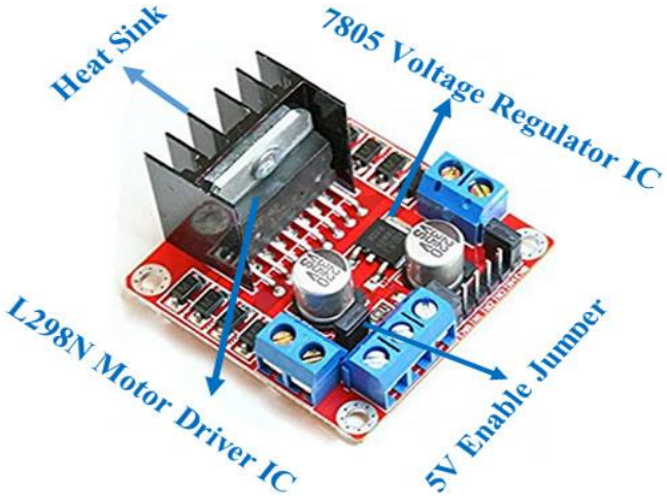

Fig-02: L298N Motor Driver

5 Array IR Sensor:

A 5 IR sensor use with TCRT5000 have a compact construction where the emitting-light source and the detector are arranged in the same direction to sense the presence of an object by using the reflective IR-beam from the object. The operating wavelength is app. 5 cm. The detector consists of a phototransistor. There are 5 sensors connected in an array to form a TCRT 5000 Sensor Module which can be used effectively in different robotic applications such as, Line following robot, Shaft encoder, Obstacle avoidance use.

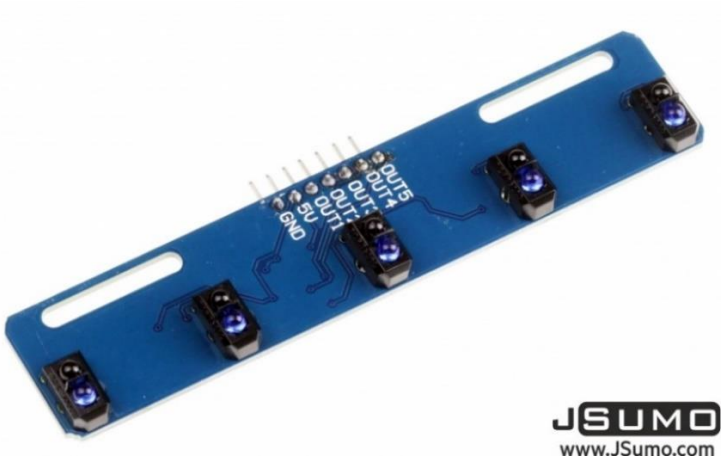

Fig-03: 5 Array IR Sensor

Battery Operated (BO) Gear Motor:

Bo motor (Battery Operated) lightweight DC geared motor which gives good torque and rpm at lower voltages. Here you can get bio motor with varying rated speed. This motor can run at approximately 200 rpm when driven by a single Li-Ion cell. Great for battery operated lightweight robots.

The motor has the ability to operate with minimum or no lubrication, due to inherent lubricity. The motor is ideal for DIY enthusiasts. This motor set is inexpensive, small, easy to install, and ideally suited for use in a mobile robot car. They are commonly used in our 2WD platforms.

Fig:04: Battery Operated Gear Motor

Lithium -ion Battery:

A lithium-ion battery is a rechargeable battery. It is commonly used in portable devices such as mobiles, laptops, electronics, and electric vehicles. Also, they are growing in popularity for military and aerospace applications.

Lithium-ion battery provides 3.7V at storage mode and 4.2V at full charge mode. In this project, we have connected two lithium-ion batteries in series so that the total battery voltage will be 8.4V at full charge

Fig-05: 3.7V Lithium-ion Battery

Motor Wheel:

We have used two motor wheel. These motor wheel are adjustable to the DC gear motor. We have used stable tires in the wheel for the robot can move correctly in the line.

Fig-06: Motor wheel

Robot Chassis:

We have used a suitable robot chassis for the line follower robot. We have used three wheel smart robot chassis. In robot chassis, two motor wheel and one castor wheel is used for the line follower robot.

Fig-07: 2 Wheel Robot Chassis

Software Description

Arduino IDE 1.8.16:

Arduino IDE 1.8.16 is used for writing a programme and inserting it into Arduino Uno using USB cable which connects Arduino and the computer.

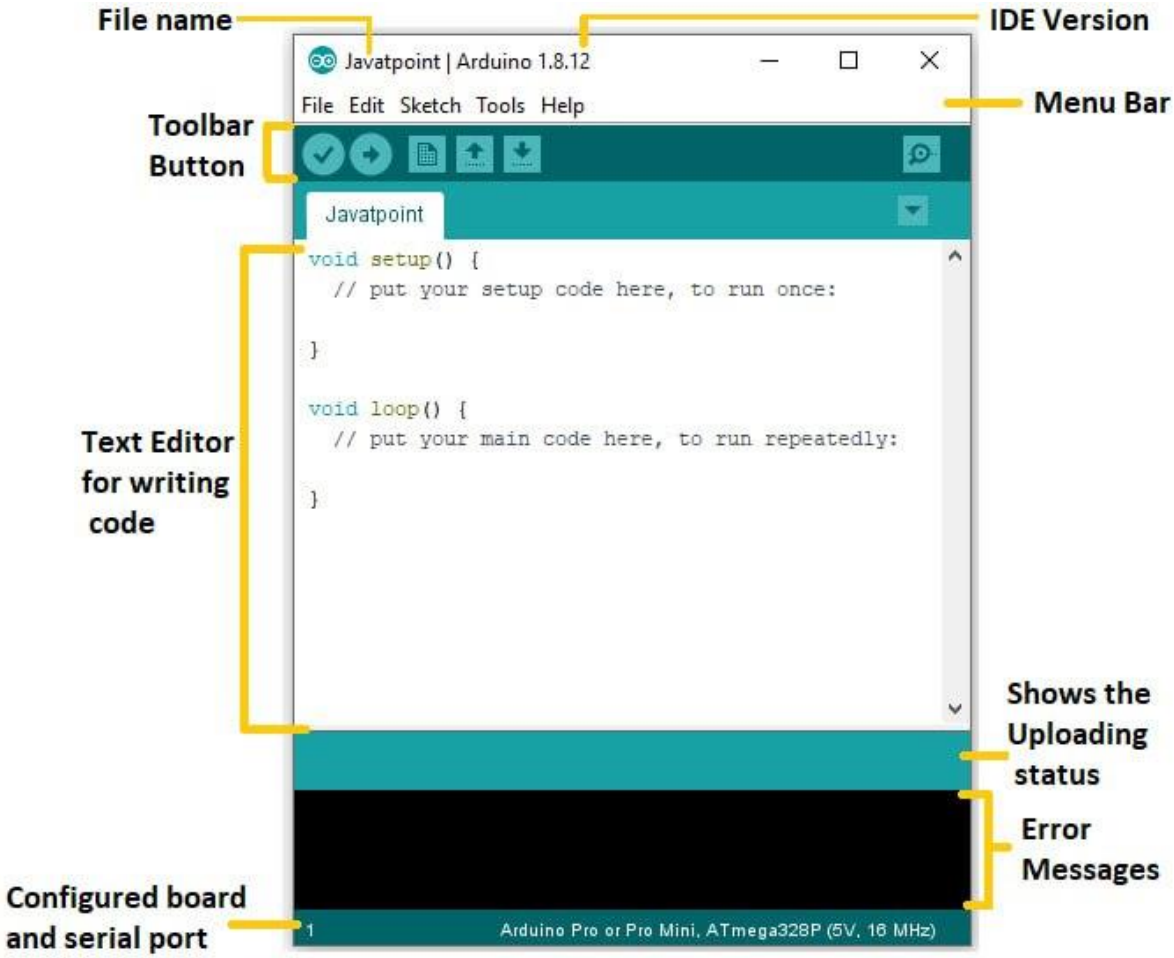

Fig-08: Arduino IDE 1.8.16 software

Chapter 03

Design and Implementation

Circuit Diagram:

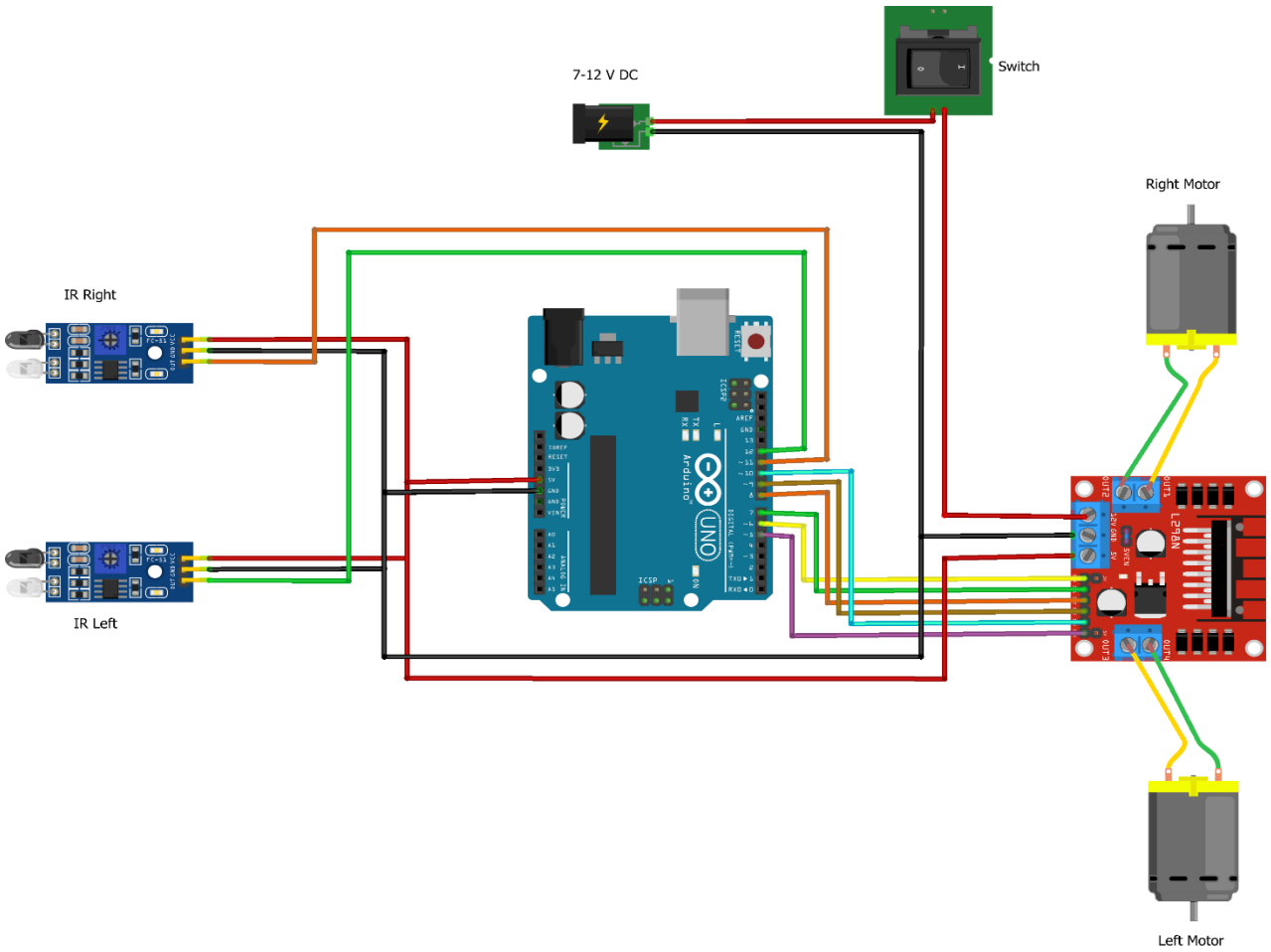

Fig-09:Circuit Diagram of Line Follower Robot

Block Diagram of Line Follower Robot:

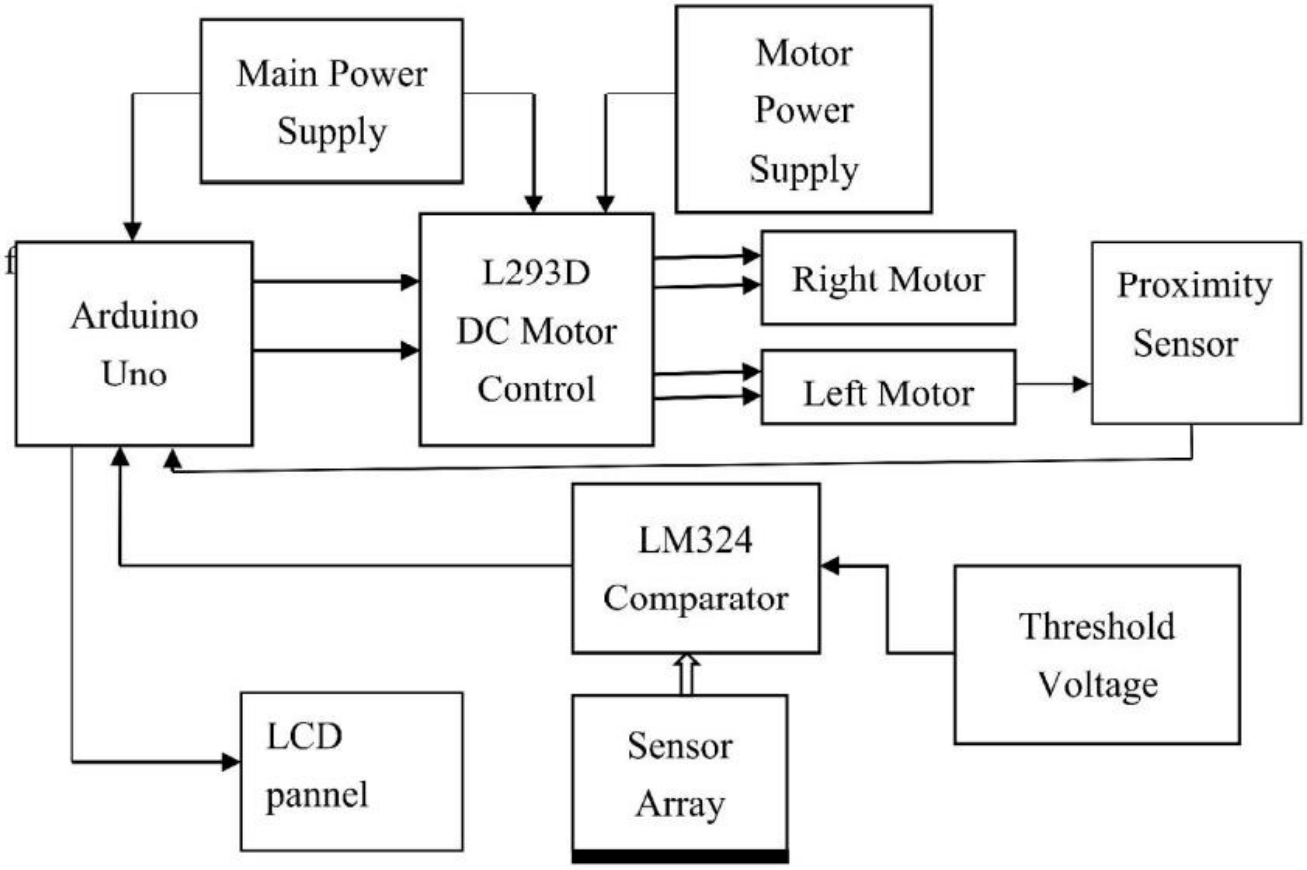

Fig-10: Block Diagram of Line Follower Robot

Source Code:

```
#define IR0 0
#define IR1 1
#define IR2 2
#define IR3 3
```

```
#define IR4 4
#define MOTOR_SPEED 150
//Right motor
int enableRightMotor=6;
int rightMotorPin1=7;
int rightMotorPin2=8;

//Left motor
int enableLeftMotor=5;
int leftMotorPin1=9;
int leftMotorPin2=10;

void setup()
{

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

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


  pinMode(IR0, INPUT);
  pinMode(IR1, INPUT);
  pinMode(IR2, INPUT);
  pinMode(IR3, INPUT);
  pinMode(IR4, INPUT);
```

```
}

void forward()
{
  digitalWrite(leftMotorPin1, HIGH);
  digitalWrite(leftMotorPin2,LOW);
  digitalWrite(rightMotorPin1, HIGH);
  digitalWrite(rightMotorPin2, LOW);
}
void stopp()
{
  digitalWrite(leftMotorPin1, LOW);
  digitalWrite(leftMotorPin2,LOW);
  digitalWrite(rightMotorPin1, LOW);
  digitalWrite(rightMotorPin2, LOW);
}

void right()
{
  digitalWrite(leftMotorPin1, HIGH);
  digitalWrite(leftMotorPin2,LOW);
  digitalWrite(rightMotorPin1, LOW);
  digitalWrite(rightMotorPin2, HIGH);
}
void left()
{
  digitalWrite(leftMotorPin1, LOW);
  digitalWrite(leftMotorPin2,HIGH);
  digitalWrite(rightMotorPin1, HIGH);
  digitalWrite(rightMotorPin2, LOW);
```

```
}
void loop()
{

 int R0 = digitalRead(IR0);
 int R1 = digitalRead(IR1);
 int R2 = digitalRead(IR2);
 int R3 = digitalRead(IR3);
 int R4 = digitalRead(IR4);
  analogWrite(enableRightMotor,MOTOR_SPEED);
  analogWrite(enableLeftMotor,MOTOR_SPEED);
  if ((R0 == HIGH || R1 == HIGH) && R2 == LOW && (R3 == HIGH || R4 == HIGH))
  {
    forward();
  }
  if ((R0 == LOW && R1 == LOW) && R2 == LOW && (R3 == LOW && R4 == LOW))
  {
     stopp();
  }
  if ((R0 == HIGH || R1 == HIGH) && R2 == HIGH && (R3 == LOW|| R4 == LOW))
  {
     right();
  }
  if (R0 == HIGH && R1 == HIGH && R2 == LOW && R3 == LOW && R4 == HIGH)
  {
     right();
  }
if ((R0 == LOW || R1 == LOW) && R2 == HIGH && (R3 == HIGH || R4 == HIGH))
  {
     left();
```

}

}

Flow Chart of Line Follower Robot:

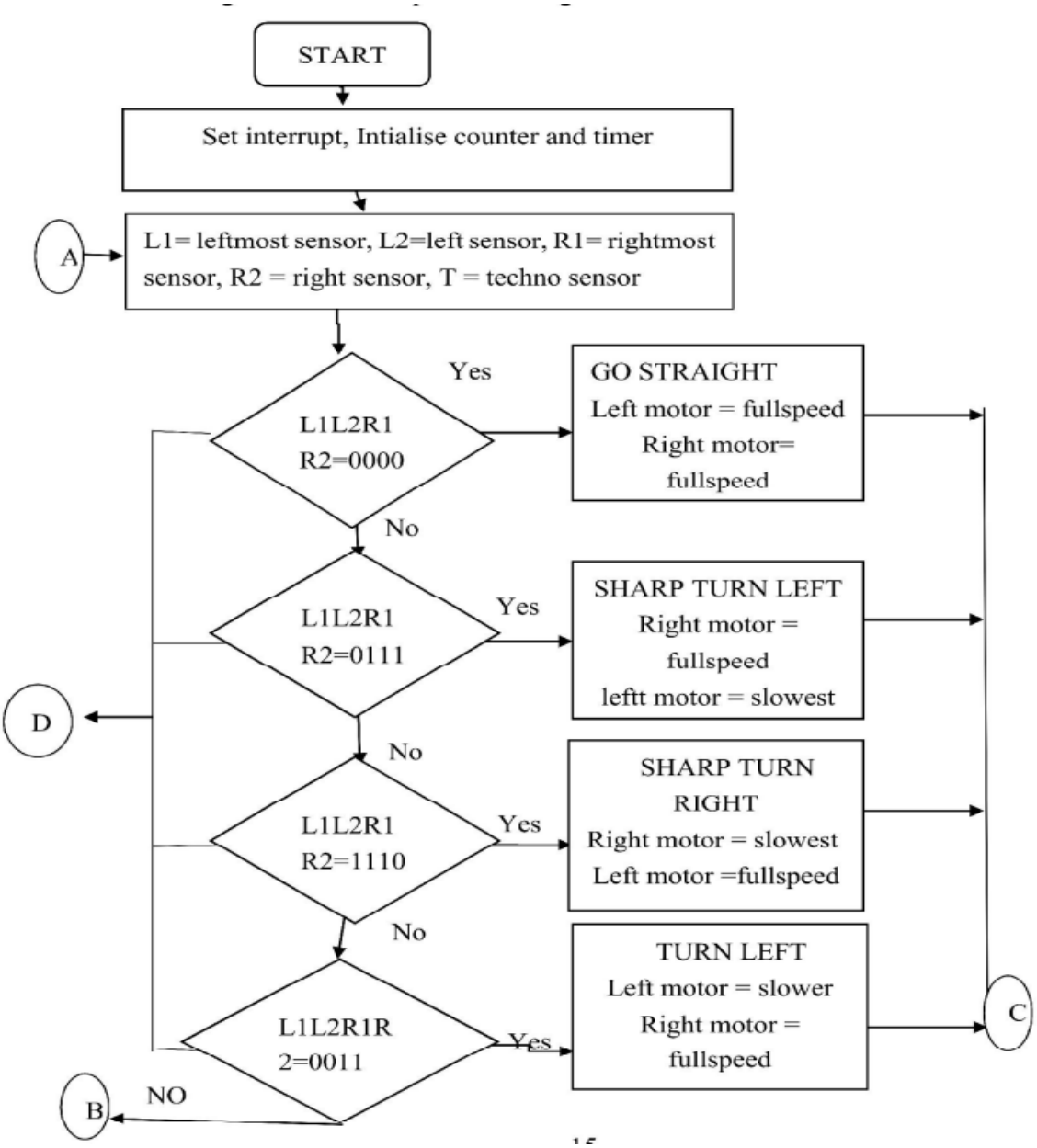

Fig-11: Flow Chart-1 of Line Follower Robot

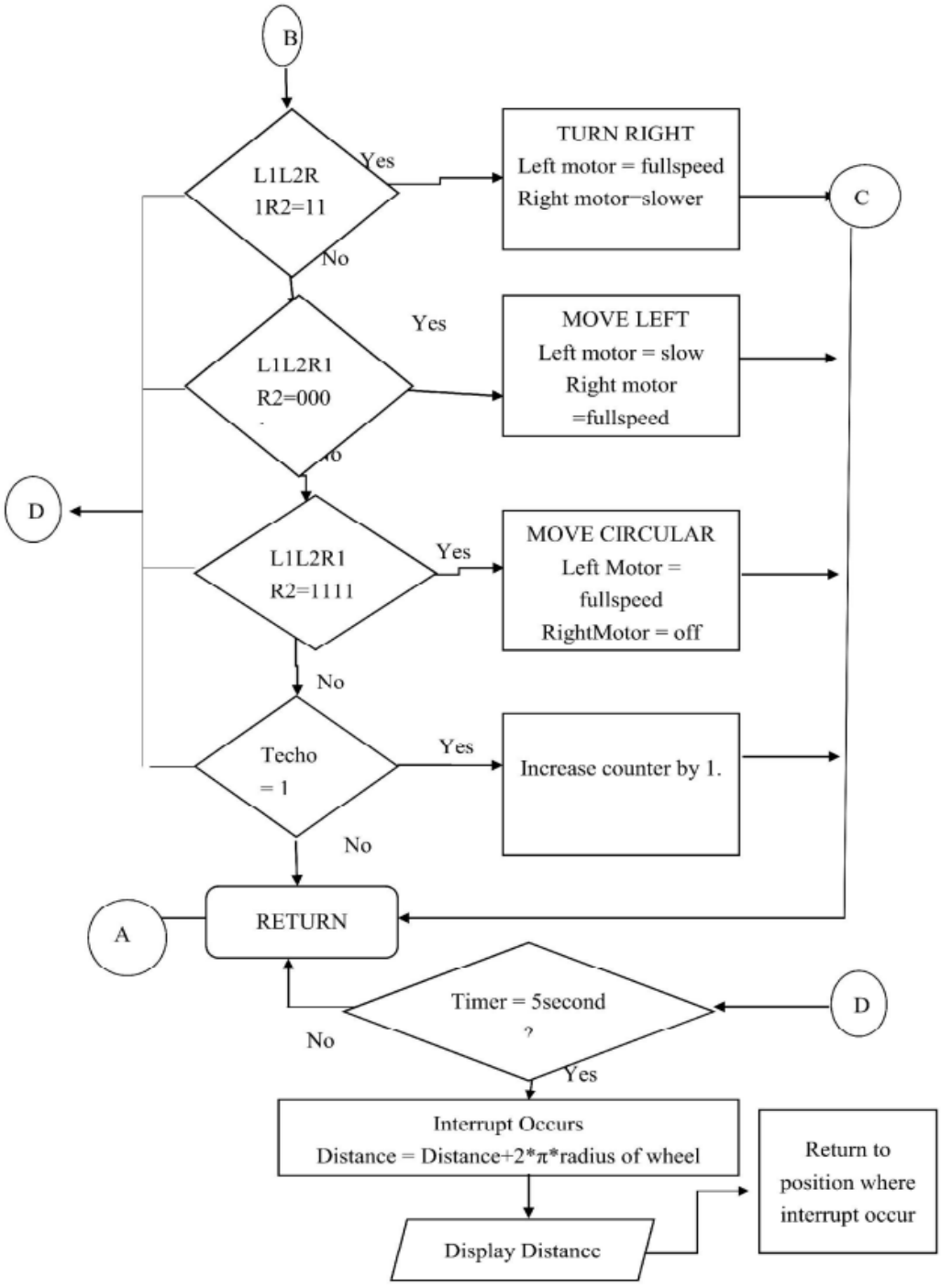

Fig-12: Flow Chart-2 of Line Follower Robot

Working Process of the Project:

In this project, we have used five array IR transmitter and IR receiver sensor to detect the line. When IR sensor transmit the infrared ray on white surface ,then the ray is reflected on photo diode. Then, Voltage is generated. When the infrared ray falls in the black surface,then the black surface is absorbed the light then the light is not reflected ,thus the photo diode is not received any ray. Here in this line follower robot when sensor senses white surface then IC gets 1 as input and when senses black line IC gets 0 as input

Sensor section: This section contains 5 Array IR Sensors which includes IR diodes, potentiometer, Comparator (OpAmp) and LED's. Potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at comparator's second terminal. Then comparator compares both voltages and generates a digital signal at output. Here in this line follower circuit we have used two comparator for two sensors. LM 358 is used as comparator. LM358 has inbuilt two low noise Op-amps.

Control Section: IC L298N is used for controlling whole the process of line follower robot. This IC reads these signals and send commands to driver circuit to drive line follower.

Driver section: Driver section consists motor driver and two DC motors. Motor driver is used for driving motors. So we add a motor driver circuit to get enough voltage and current for motor. IC L298N sends commands to this motor driver and then it drive motors. Here in this project we are using two IR sensor modules namely left sensor and right sensor. When both left and right sensor senses white then robot move forward. forward.

Track For the Line Following Robot:

In this project, we have used this track of the experiment. In this track, we have completed 5 check point out of 7 check point including sine wave, half circle, loop ,90 degree angle and 168 degree angle.

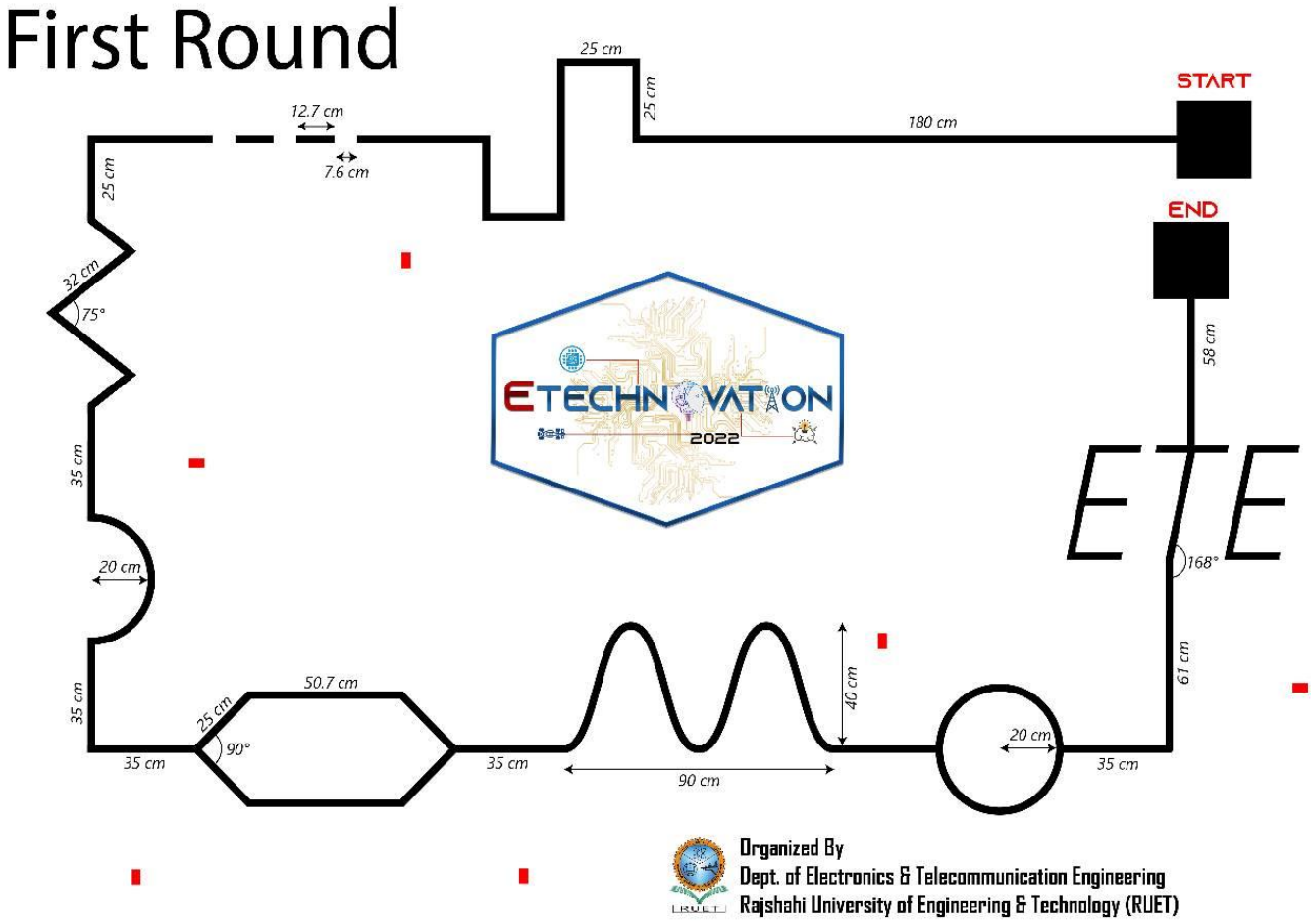

Fig-11: Line Follower Robot Track.

Pictures of Line Follower Robot:

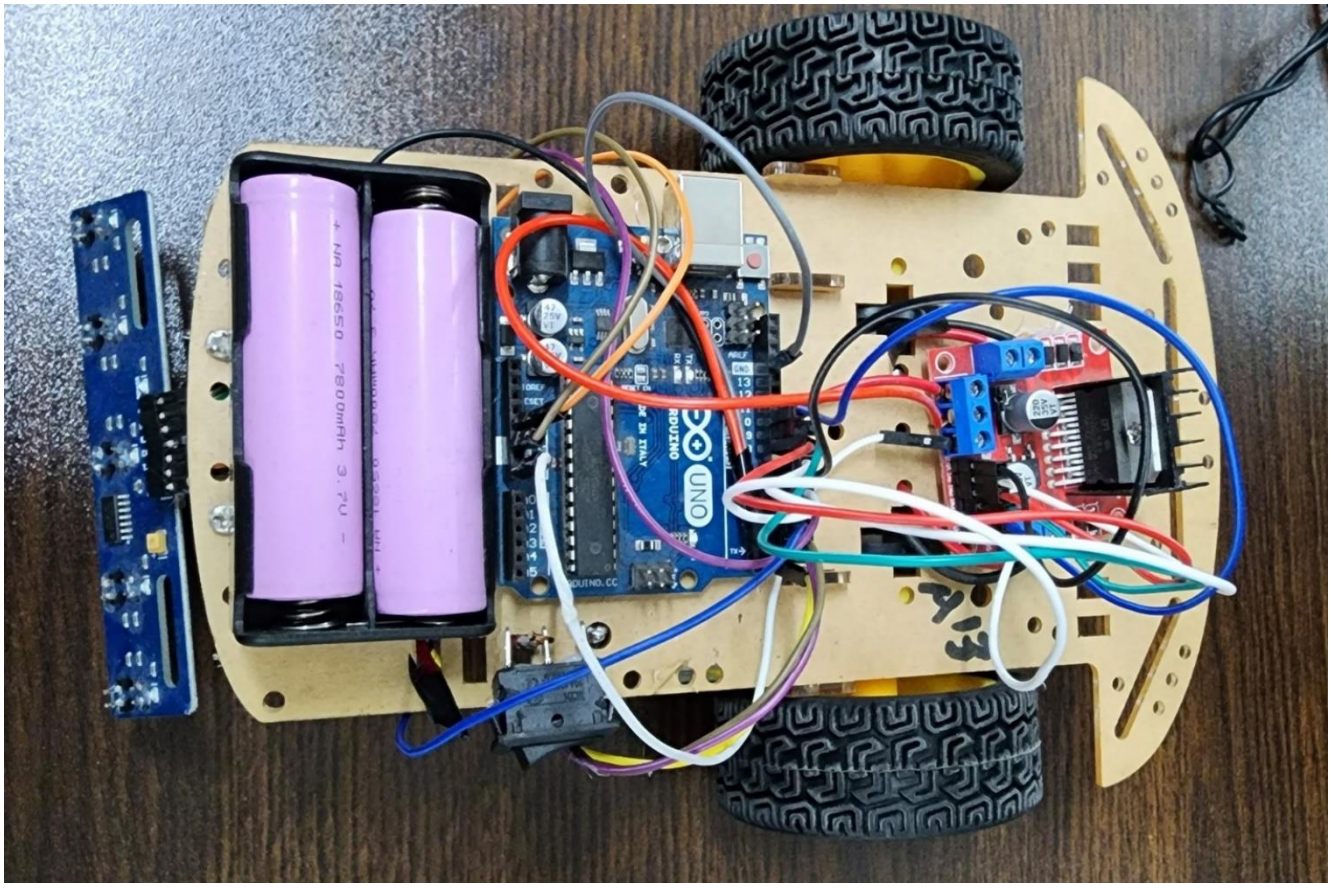

Fig-12: Picture of Complete Line Follower Robot.

Chapter-04

Application,Advantages ,Disadvantages,Discussion & Conclusion

Application:

Line followers can be used to deliver mail within an office building It can be used to deliver medications in a hospital. The technology has been suggested for running buses and other mass transit systems ,and may endup as part of autonomous cars navigating the freeway. The line follower can be used in guidance system for industrial robots moving on shop floor. AN example might be in a warehouse where the robots follow 'tracks' to and from the shelves they stock and retrieve from. A line follower robot can be used in military as spy kids or in many other applications.

- Industrial Applications: These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts.
- Automobile applications: These robots can also be used as automatic cars running on roads with embedded magnets.
- Domestic applications: These can also be used at homes for domestic purposes like floor cleaning etc.
- Guidance applications: These can be used in public places like shopping malls, museums etc to provide path guidance

Advantages:

- Robot movement is automatic
- It is used for long distance applications
- Simplicity of building
- Fit and forget system
- Used in home, industrial automations etc.

Disadvantages:

The system has restricted to the following limitation. The ir sensor cannot be work in the day light it works only in the dim light or room light . Few curves are not made efficiently, and must be avoided The turning radius should be of minimum 50m to take smooth U-turning of robot The width of the path must be of 35mm so that it can cover minimum 2 sensors. The path should be plane and obstacle free. The steering mechanism is not easily implemented in huge vehicles and• impossible for non-electric vehicles.

Discussion & Conclusion:

In this project, we have learnt about the working method of line follower robot using Arduino Uno. We have also learnt about the applications, advantages and future plan about the line follower robot.In the line follower robot, we have used five array infrared ray (IR) sensor for detecting the line. When the IR sensors send the infrared ray on white surface, the ray is reflected into the photo diode .Then, the photo diode generates voltage and the robot is moved to the line. But when the IR sensor send the infrared ray on black surface then the surface is absorbed the light that's way the light is not reflected on photo diode. Line follower robot is applicable in many sector. We can used it in industries as a equipment carriers. A line follower can be used in military application as a spy kid. Line follower robot can be used as a virtual waiter in resturants.

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