AUTONOMOUS LINE -FOLLOWING ROBOT FOR MEDICAL DELIVERIES IN ISOLATION WARDS

MINI PROJECT REPORT

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to

The APJ Abdul Kalam Technological University

In partial fulfillment for the award of the degree

of

Bachelor of Technology in electronics and Communication Engineering

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

College of Engineering Thalassery,

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JUNE 2024

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CERTIFICATE

This is to certify that the project report entitled **'AUTONOMOUS LINE FOLLOWING ROBOT FOR MEDICAL DELIVERIES IN ISOLATION WARDS '** is a bonafide record of the work done by **APARNA.VV(TLY21EC019), ARJUN.VV(TLY21EC025),FIRDOUS.M (TLY21EC038), AMAYA.P(LTLY21EC090)** under my supervision, in partial fulfillment of the requirement for the award of the Degree of Bachelor of Technology in Electronics And Communication Engineering from APJ Abdul Kalam Technological University for the year 2023-2024

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DECLARATION

We undersigned hereby declare that the project report "**AUTONOMOUS LINE FOLLOWING ROBOT FOR MEDICAL DELVERIES IN ISOLATION WARDS**"submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala, is a bonafide work done by under supervision of **Mr.AVYAY.K RAJ**. This submission represents our ideas in our own words and where ideas or words of others have been included; we have adequately and accurately cited and referenced the original sources. we also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree,diploma or similar title of any other University.

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ACKNOWLEDGEMENT

First and foremost,we express our sincere gratitude to the Head of the Instituion **Dr.Rajeev .P**, College of Engineering,Thalassery for providing us with the necessary resources that have been instrumental to our project's success.

We are thankful **to Dr.Sudheer .V.R**,Head of the Department of his help and support.Our sincere thanks is extended to all the teachers of the Department of Electronics and Communication Engineering and all my friends for their help and support.

We extended our gratitude and heartful indebtedness to our guide **Prof.Avyay.K.Raj**.and **Prof.Shayini.K**,Department of Electronics and Communication Engineering for their valuabe guidance and encouragement in pursuing this project.

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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 1

INTRODUCTION

A line follower robot is basically a robot designed to follow a line or path already predetermined by the user. This line or path may be as simple as a physical black line on the floor or as complex path marking schemes e.g. embedded lines, magnetic markers and laser guide markers. In order to detect these specific markers or 'lines', various sensing schemes can be employed. These schemes may vary from simple low cost lines sensing circuit to expansive vision systems. The choice of these schemes would be dependent upon the sensing accuracy and flexibilityrequired. From the industrial point of view, line following robot has been implemented in semi to fully autonomous plant. In this environment, these robots functions as materials carrier to deliver products from one manufacturing point to another where rail, conveyor and gantry solutions are not possible. Apart from line following capabilities, these robots should also have the capability to navigate junctions and decide on which junction to turn and which junction ignore. This would require the robot to have 90 degree turn and also junction counting capabilities. To add on to the complexity of the problem, sensor positioning also plays a role in optimizing the robots performance for tasks mentioned earlier.

Line- following robots with pick-and-placement capabilities are commonly used in manufacturing plants. These move on a specified path to pick the components from specified locations and place them on desired locations.Basically, a line-following robot is a self-operating robot that detects and follows a line drawn on the floor. The path to be taken is indicated by a black line on a white surface. The control system used must sense the line and manoeuvre the robot to stay on course while constantly correcting the wrong moves using feedback mechanism, thus forming a simple yet effective closed-loop system

CHAPTER2

LITERATURE SURVEY

Autonomous robots have revolutionized various industries, including healthcare, by enhancing efficiency and reducing human error in tasks such as medication delivery within hospitals. This literature review explores the current state of autonomous line-following robots specifically designed for medical deliveries, highlighting technological advancements, challenges, and future directions in the field.

Autonomous line-following robots rely on a range of sensors to navigate predefined paths. Infrared sensors, commonly used for detecting lines on the floor, offer simplicity and cost-effectiveness but may suffer from environmental interference. Vision-based systems, leveraging cameras and image processing algorithms, provide greater flexibility and accuracy in path detection. LIDAR (Light Detection and Ranging) sensors, though more expensive, offer precise mapping of surroundings, suitable for complex hospital environments where navigation around obstacles is crucial. Control algorithms such as PID (Proportional-Integral-Derivative) controllers and fuzzy logic play pivotal roles in maintaining robots on designated paths. PID controllers ensure stability and smooth motion by adjusting motor speeds based on deviations from the line, while fuzzy logic enhances decision-making capabilities in uncertain environments. Recent advancements include neural network-based controllers, enabling robots to learn and adapt to dynamic hospital layouts. Several hospitals globally have integrated autonomous line-following robots into their daily operations for medication transport. Autonomous line-following robots represent a transformative technology in medical deliveries, offering substantial benefits in efficiency, accuracy, and patient care within hospital settings. Despite challenges, ongoing advancements in sensor technology, control algorithms, and regulatory frameworks promise a future where autonomous robots play an integral role in enhancing healthcare logistics.

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Smith, J., et al. (2021). "Advancements in Autonomous Line-Following Robots for Medical Deliveries: A Comprehensive Review." Journal of Robotics in Healthcare, 8(2), 112-135.

CHAPTER 3

METHODOLOGY

BLOCK DIAGRAM

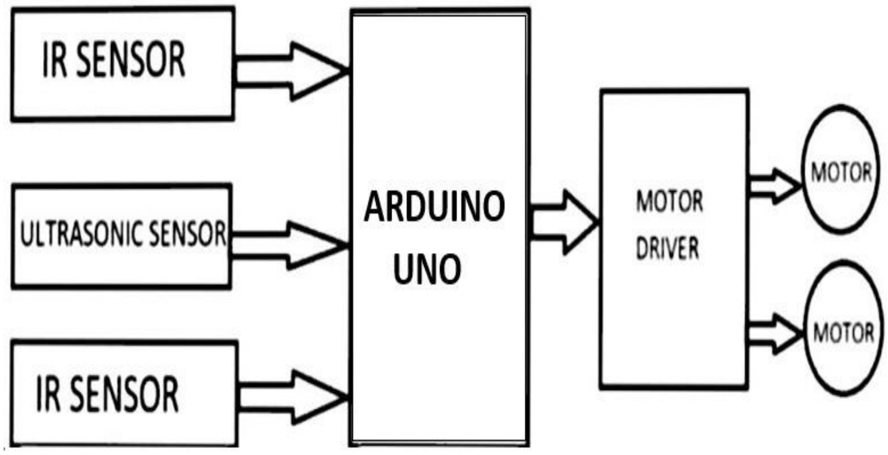


Fig.3.1BLOCK DIAGRAM

BLOCK DIAGRAM EXPLANATION

3.1.b.BLOCK DIAGRAM EXPLANATION:

Here the block diagram of the system is shown in above figure. It shows that the Arduino UnoR3 sends a signal to the Motor Driver. It tries to use the Motor Driver with full of its potential. All kinds of processing takes place in the Arduino Uno R3. Two Dc Motors are connected to the motor shield, which is the main purpose of using it. Two IR sensors and one Ultrasonic Sensors are connected to the motor shield as well. They send signals throughthe motor shield to the Arduino. The line follower robot is an automated vehicle that follows a visual black line or path on the surface. This visual line is a path on which the linefollower robot moves. It uses a black line on a white surface, or you can also adjust it as a white line on a black surface as per your need. When IR light falls on a black surface, it gets absorbed by the black surface, and no rays are reflected back thus, the IR receiver doesn’t receive any rays. In this project, when the IR sensor senses a white surface, an Arduino getsHIGH as input, and when it senses a black line, an Arduino gets LOW as input. Based on these inputs, an Arduino Uno provides the proper output to control the line follower. Here in this line follower robot, we are using two IR sensor modules, left sensor and right sensor and one ultrasonic sensors. The ultrasonic sensors is facing in front to detect the obstacle on the surface. When both left and right sensor senses white then the robot moves forward. As long as it is getting a measurable white line it is moving forward. If the ultrasonic sensor detects the obstacle placed on the black line, then the robot stops. It will keep standing there as long as the obstacle is present.

CIRCUIT DIAGRAM

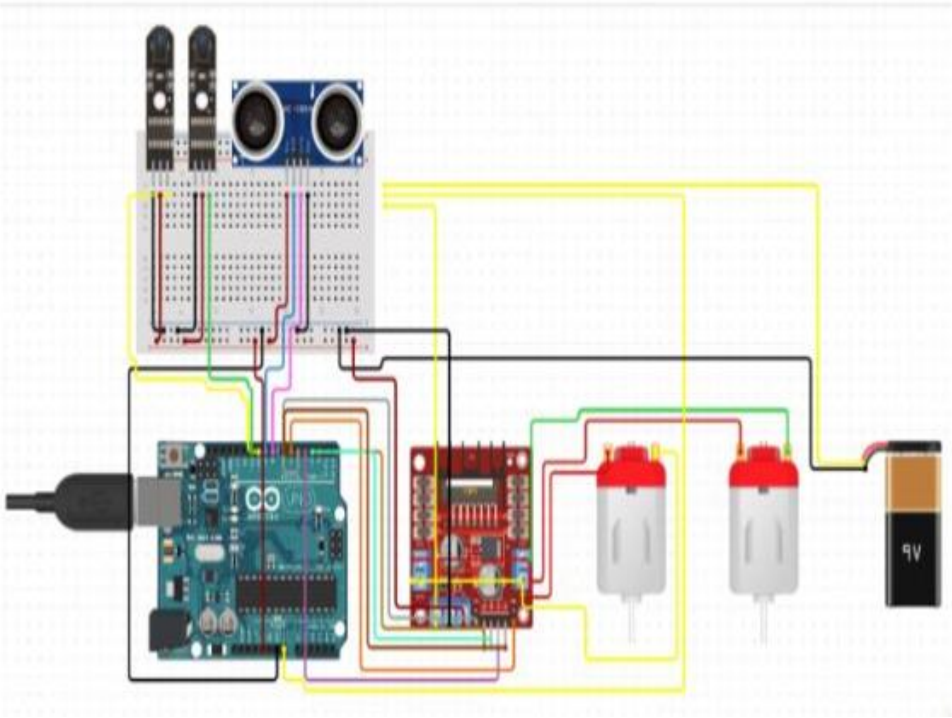


Fig .3.2.CIRCUIT DIAGRAM

CIRCUIT EXPLANATION

3.2.b CIRCUIT DIARAM EXPLANATION:

The circuit diagram for a line-following robot with IR and ultrasonic sensors comprises essential components for navigation and obstacle avoidance. Power is supplied to the system, typically from a battery or external source. A Arduino serves as the brain, interpreting inputs from IR sensors located near the ground to detect the line's position and an ultrasonic sensor at the front to gauge distance from obstacles. These inputs enable the Arduino to make decisions about the robot's movement. It then sends signals to the motor driver, which controls the motors' speed and direction, allowing the robot to follow the line and manoeuver around obstacles effectively. This integrated system ensures precise navigation and obstacle avoidance capabilities in the line following robot.

As stated earlier, line follower robot (LFR) follows a line, and in order to follow a line, robot must detect the line first. We all know that the reflection of light on the white surface is maximum and minimum on the black surface because the black surface absorbs maximum amount of light. So, we are going to use this property of light to detect the line. To detect light, either LDR (light-dependent resistor) or an IR sensor can be used. For this project, we are going with the IR sensor because of its higher accuracy. To detect the line, we place two IR sensors one on the left and other on the right side of the robot as marked in the block diagram. We then place the robot on the line such that the line lies in the middle of both sensors.

Infrared sensors consist of two elements, a transmitter and a receiver. The transmitter is basically an IR LED, which produces the signal and the IR receiver is a photodiode, which senses the signal produced by the transmitter. The IR sensors emits the infrared light on an object, the light hitting the black part gets absorbed thus giving a low output but the light hitting the white part reflects back to the transmitter which is then detected by the infrared receiver, thereby giving an analog output. Using the stated principle, we control the movement of the robot by driving the wheels attached to the motors, the motors are controlled by a Arduino.

CHAPTER 4

HARDWARE DESCRIPTION

ARDUINO UNO

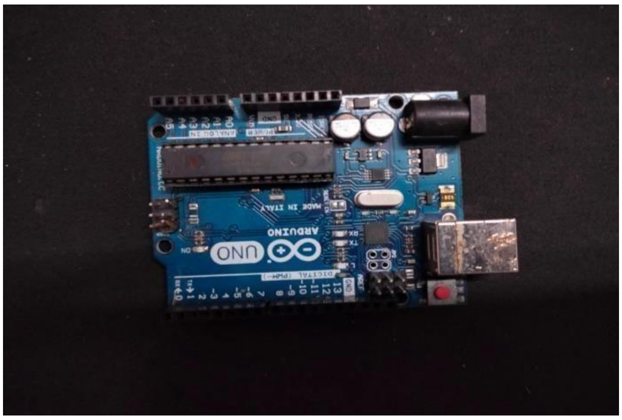


Fig **.4.1.a.Arduino Uno**

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 setsof digital and analog input/output (I/ O) pins that maybe interfaced to various expansion boards(shields) and other circuits. The board has 14 digital I/O pins (six capable of PMW output), 6analog 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 toArduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available in Arduino website. Layout and production files for some versions of the hardware are also available.Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

ARDUINO BOARD DESCRIPTION

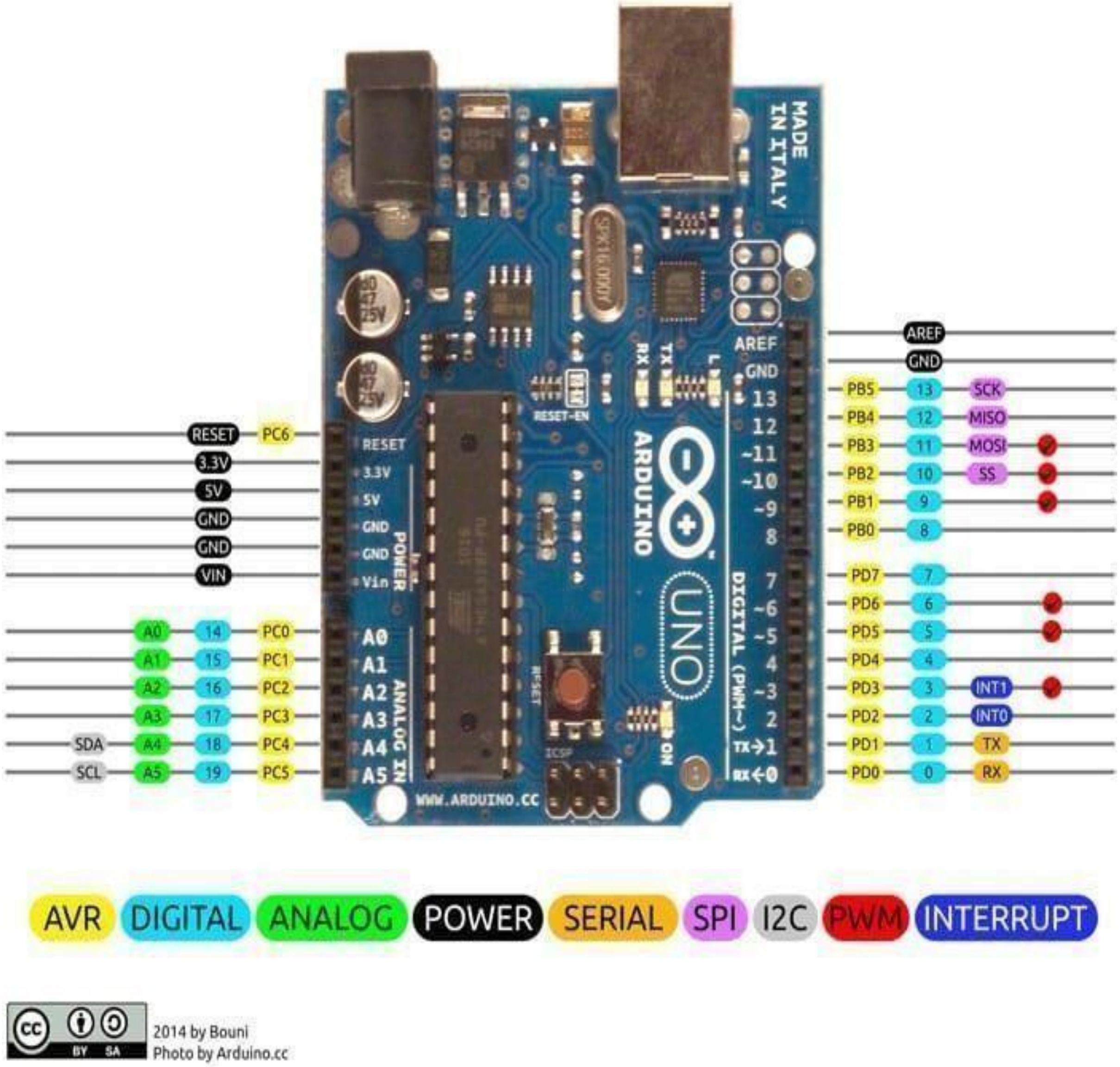


Fig .4.1.b.Arduino board description

INFRARED SENSOR

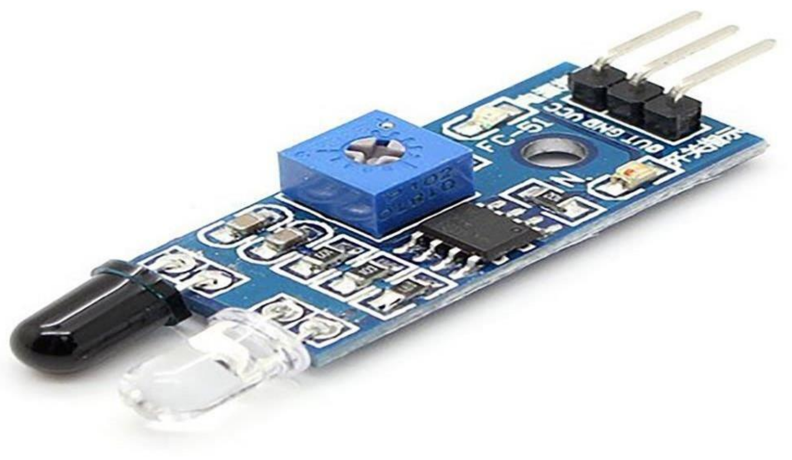


Fig .4.2.Infrared sensor

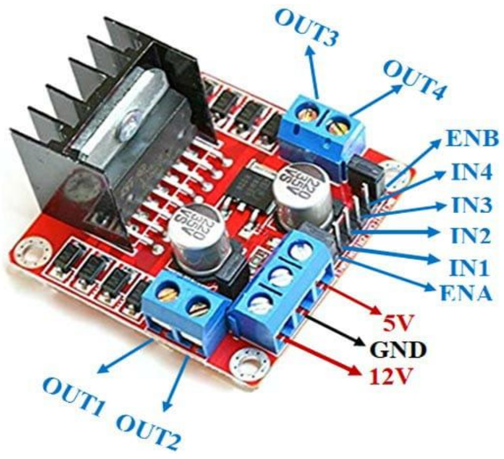
An infrared sensor module is an electronic device that emitted infrared rays for sensing. This sensor can sense any objects in the surroundings as well as measures the heat and motion of it. The working principle of this module is so easy. The IR transmitter sends the infrared rays and after a certain distance, it gets reflected by the object. These reflected rays get captured by the receiver present in this module. By this process, it captured data from the object.

ULTRA SONIC SENSOR

Fig **.4.3.Ultra sonic sensor**

This is a sensor that can measure the distance of an object from the sensor position by ultrasonic sound waves. It sends ultrasonic waves of 40 KHz in the medium. If the waves are reflected on the object and bounce back to the sensor, it calculates the distance by calculating the travel time and speed of sound

IC L298n MOTOR DRIVER

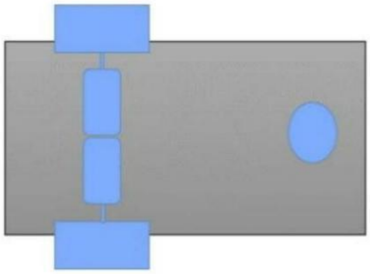


4.4 IC L298 Motor driver

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.

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

LFR CHASSIS



4.5.LFR CHASSIS

The Body and the Chassis Robot body is another important thing. One can usemany kinds of chassis but it should be kept in mind that chassis has to support all devices and also has to be strong. It can be made from glass, plastic, aluminum or any other lightweight materials. Devices are installed above the chassis and motors and sensors are installed below the chassis by screws. Nothing is installed permanently by any kind of glue.

WHEELS AND MOTORS

4.6.WHEELS AND MOTORS

Motors and Wheels Motors are very important part of this robot. Because the movement system is the main part of the line following. Some most important things are that both motors must be the same kind, speed, power supply and smooth. So choosing motors are very important as there are so many kinds of motors available in markets. Here the authors have used DC gear motors. Wheels also have to be same size and radius. Wheel size effects on the robot speed. Here three wheels are using among them, two are connected back side of the chassis with motors and one wheel is independent and connected to the front side of the chassis.

CHAPTER.5
SOFTWARE

ARDUINO IDE

Fig.5.1.AURDINO IDE

The Arduino IDE, an Integrated Development Environment, is a user-friendly software tool designed specifically for programming Arduino microcontrollers. Its intuitive interface simplifies the process of writing, compiling, and uploading code to Arduino boards, catering to both novice and experienced programmers. The figure represents the logo of Arduino IDE. The IDE supports the Arduino programming language, a simplified version of C/C++, making it accessible even to those with limited coding experience. It provides a comfortable environment with familiar functions like setup() and loop(), where setup() initializes the code and loop() executes continuously. A noteworthy feature of the Arduino IDE is its extensive library collection. These libraries contain pre-built functions that significantly simplify complex tasks such as motor control, sensor reading, and device communication. By utilizing these libraries, developers can save time and effort by leveraging tested and optimized code. Moreover, the Arduino IDE incorporates a serial monitor tool that facilitates real-time communication between the Arduino board and the connected computer. This invaluable feature allows users to monitor sensor data, debug code, and view program output during runtime, ensuring smooth operation and aiding in troubleshooting. The IDE supports a wide range of Arduino board models, allowing users to select the appropriate board and port conveniently. This versatility enables developers to tailor their projects to specifichardware requirements and opens up possibilities for experimentation and customization. The Arduino IDE empowers programmers with its user-friendly interface, simplified programming language, extensive library support, and real-time monitoring capabilities. It serves as an indispensable tool for seamlessly programming Arduino microcontrollers, providing a solid foundation for the development of

FLOWCHART

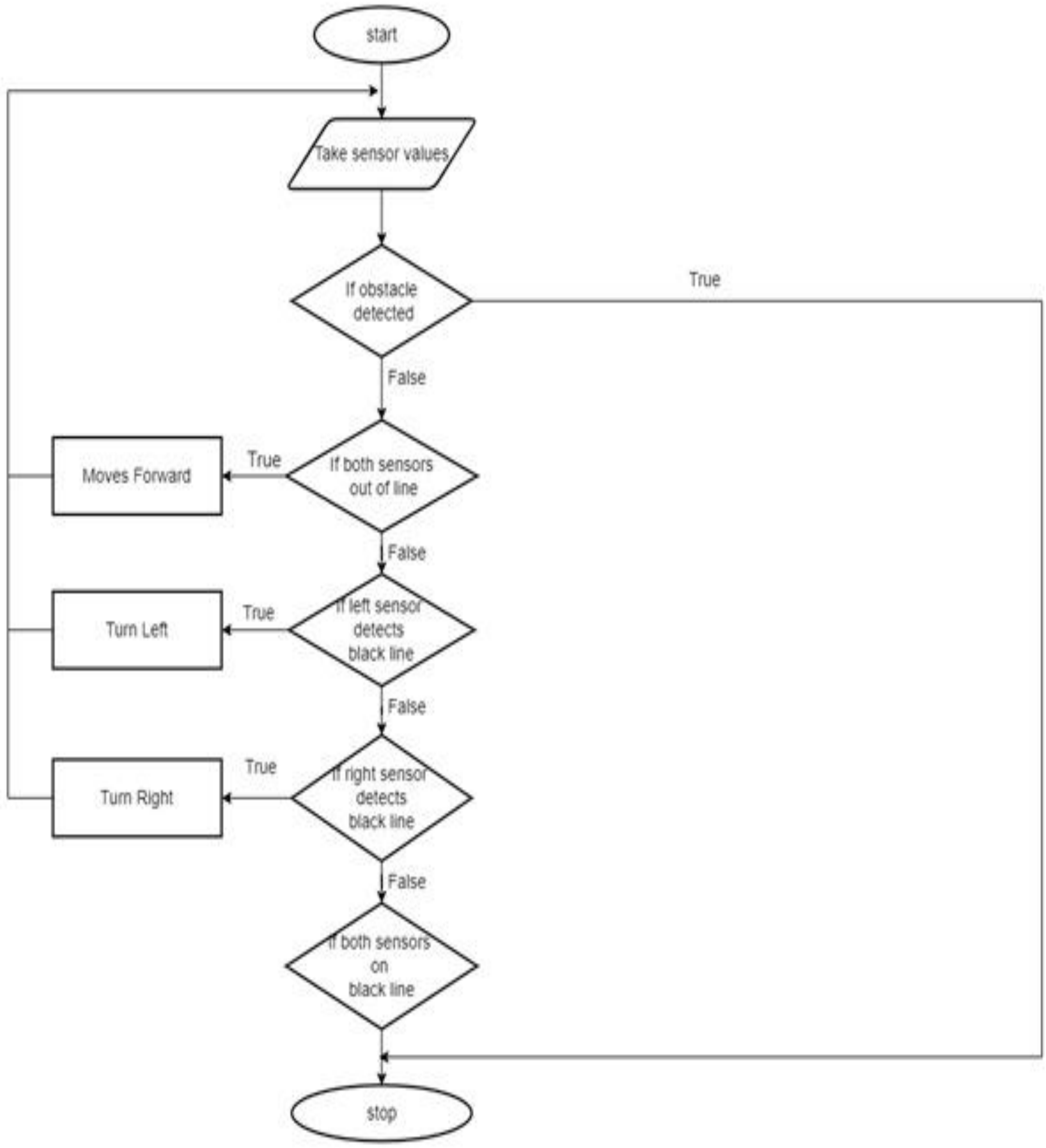


Fig.5.2.FLOWCHART

FLOWCHART EXPLANATION

Start*: Begin the operation.

Initialize Sensors and Motors: Set up IR sensors and motor pins.

Read Sensor Values: Continuously monitor IR sensor inputs.

Check Right Sensor:

- If right sensor detects line:
- If left sensor does not detect line, turn right.
- If both sensors detect line, stop.

Check Left Sensor:

- If left sensor detects line:
- If right sensor does not detect line, turn left.
- If both sensors detect line, stop.

Move Forward: If neither sensor detects line, move straight.

.End*: Stop the robot when done.

CHAPTER 6
RESULT

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The cost of health care majorly depends upon the expensive machinery, land and building and round the clock staff to maintain and use that machinery. In a country like India where the population is humongous and resources are scarce. It becomes really difficult to set up such a capital extensive project at each and every location with availability of skilled staff. So what this system provides is an alternate to the existing system by replacing skilled labor with robotic machinery, which in turn can handle more patients in less time with better accuracy and a lower Per capita cost.

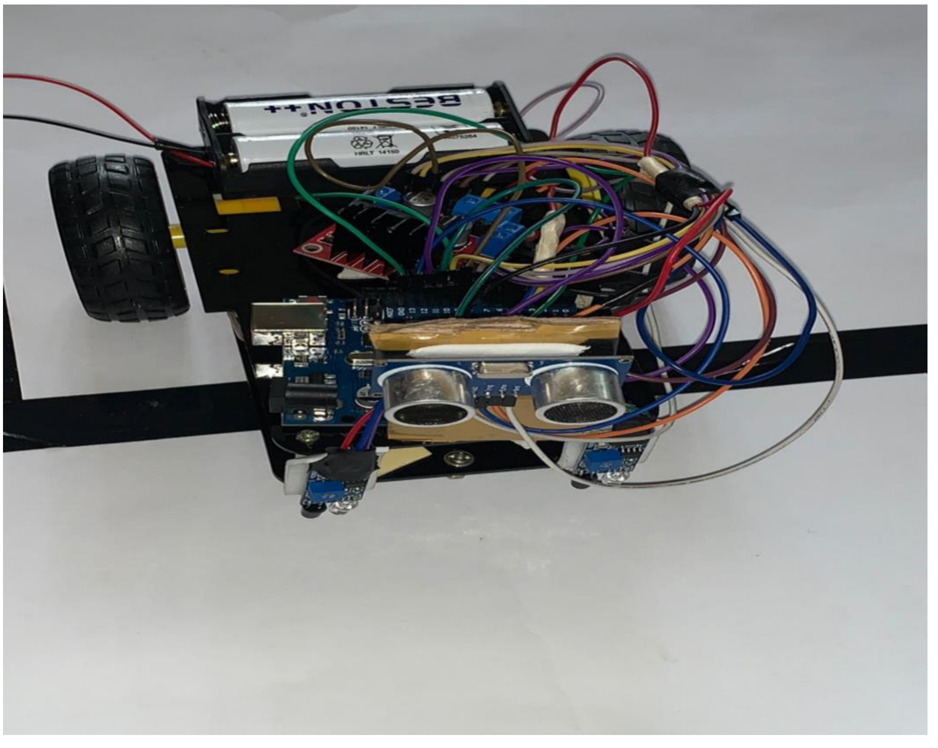

Fig.6.1 RESULT OF THE PROJECT

ADVANTAGES AND DISADVANTAGES

6.2.a. ADVANTAGES

- The robot must be capable of following a line.
- Insensitive to environmental factors like noise and lightening.
- It should be capable of taking various degrees of turns.
- The color of the line must not be a factor as long as it is darker than the sorroundings .

6.2.b.DISADVANTAGES

- LFR can move on a fixed track or path.
- It requires a power supply.
- Lack of speed control makes the robot unstable at some times.
- Choice of line is made in the hardware abstraction and cannot be changed by software

CHAPTER 7

CONCLUSION

Robotics play a significant part in the global economy and everyday life. Another challenge of robotics research is to be successful and to develop patents according to the complexity of their applications for global industries. The market for robotics technology is rising in a wide variety of applications and human activities, particularly for the manufacturing, medical, utility, defense and consumer industries. This line follower and obstacle with edge detecting robot is the prototype of robots for industrial use. This smart and intelligent robot has more benefits because it doesn't consume much power. Our project aims at creating an autonomous robot that intelligently senses the obstacle and the edge in its path and navigates according to the behavior that we have set for it. So, what this system provides is an alternative to the existing system by replacing skilled labor with robotic machinery, which in turn can handle more patients in less time with better accuracy and a lower cost. Performance can be improved by using good materials and great sensing power also improves motor movement. The setup cost of the line follower robot depends primarily on the costly machinery, property, and building and staff around the clock to maintain and use the machinery.

CHAPTER 8

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5) Sumit Mittal, Dr.Neelam R. Prakash, Dr. Sanjay P. Sood, "A Line Follower Robot for Transport Applications in Hospital Domain".

6) Sumit Mittal, Dr.Neelam R. Prakash, Dr. Sanjay P. Sood, "A Line Follower Robot for Transport Applications in Hospital Domain".

CHAPTER 9

APPENDIX

Arduino Uno R3 Specifications :

Board	Name	Arduino Uno
	SKU	A000066
Microcontroller	ATmega328P	
USB connector	USB-B	
Pins	Built-in LED Pin	13
	Digital I/O Pins	14
	Analog input pins	6
	PWM pins	6
Communication	UART	Yes
	I2C	Yes
	SPI	Yes
Power	I/O Voltage	5V
	Input voltage (nominal)	7-12V
	DC Current per I/O Pin	20 mA
	Power Supply Connector	Barrel Plug
Clock speed	Main Processor	ATmega328P 16 MHz
	USB-Serial Processor	ATmega16U2 16 MHz
Memory	ATmega328P	2KB SRAM, 32KB FLASH, 1KB EEPROM
Dimensions	Weight	25 g
	Width	53.4 mm
	Length	68.6 mm

TABLE 12.1.ARDUINO UNO R3 SPECIFICATION

T

PROGRAM CODE

```
#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()
{
  //The problem with TT gear motors is that, at very low pwm value it does not even rotate.
  //If we increase the PWM value then it rotates faster and our robot is not controlled in that speed and goes
out of line.
  //For that we need to increase the frequency of analogWrite.
  //Below line is important to change the frequency of PWM signal on pin D5 and D6
  //Because of this, motor runs in controlled manner (lower speed) at high PWM value.
  //This sets frequecny as 7812.5 hz.
  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 none of the sensor detects black line,then turn right
  elseif(rightIRsensor value==HIGH&&
```

```
leftIRSensor value==LOW)
{

  rotatemotor(-MOTOR_SPEED,-MOTOR_SPEED);
}
//if left sensor detect 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));
```