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LINE FOLLOWING WITH OBSTACLE AVOIDANCE AUTONOMOUS NURSING ASSISTANT ROBOT

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ABSTRACT

The goal of this project is to create a line-following robot with the ability to avoid obstacles. The robot will be equipped with an infrared sensor array to detect the black line on the ground, and an ultrasonic sensor to detect obstacles. A microcontroller will be used to process the sensor data and generate control signals for the robot's motors. The robot's behavior will be determined by a set of algorithms that combine line following and obstacle avoidance techniques. This research will demonstrate the feasibility of designing an autonomous robot that can navigate through a track with a black line while avoiding obstacles. In this study, a line-following, obstacle-avoidance robot that serves as a nursing assistant is developed. The robot can safely move food, medicine, blood samples, and other items around a hospital on its own initiative and in accordance with user instructions. A nurse can call the robot from any location using wireless connectivity. The robot will automatically travel a path to the caller nurse in response to the call. After that, the caller placed any further materials.

Keywords: Nursing Assistance Robot, Microcontroller, Infrared Sensors, Motor Driver, DC Motor, Ultrasonic Sensor, Servo Motor, Bluetooth, Audio Module.

I. INTRODUCTION

The creation of autonomous robots has gained significant attention in the robotics community. The goal of autonomous robotics is to build machines that can function independently of human control. The idea of autonomous robots has sparked the creation of sophisticated machines that can carry out difficult jobs in dangerous or difficult-to-reach locations. The design of a line- following robot with obstacle avoidance skills is the main topic of this research study. In most of the hospital there is to many general wards and in every general ward there is more than 6 patients are get treated but problem is number of nurses are not enough availability. Also, nurses have to collect, report, medicines and necessary medical equipment's.

Now these kinds of jobs are done by the nurses, but robot will help the nurses to mobile these important materials and documentation. That's why the propose of robot to use in hospital as nurse assistant robot, where robot will deliver medicines, blood samples food from inventory to patient's wards. The line follower robot is an excellent illustration of an autonomous device that is led by feedback.

system and follows a certain route or trajectory that is indicated by either a visible black line in a white area, a visible white line in a black region, or an intangible magnetic field.[1]- [2] There are many uses for the amazing and straightforward control mechanism used by queue follower robots, including industrial logistics, public transportation, restaurants, the agricultural sector, and fire safety [3], Library inventory management system (LIMS) [4] etc. Rabiul Hossein Rafi et al. developed a line-following robot to lower irrigation water loss for irrigation-based applications. [5].

II. LITERATURE SURVEY

Robots that follow lines are widely used because they are easy to use and dependable. The simplest robots are equipped with just two light sensors and a line that contrasts sharply between white on a dark surface and black on a bright floor. The Stanford Carts, which featured cameras and an image processing system, were the first line-following robots. [6].

The main goal of any robot is to do the work of humans. Depending on their intended usage, many types of autonomous nursing assistant robots are developed for use in real-world applications. For the greatest outcomes in any working setting, good supervision is crucial. To move items from one location to another, enterprises can utilize this clever and intelligent line robot. This robot's set-it-and-forget-it functionality, which makes it completely independent after it is placed along the planned path, is its main advantage when used for cargo delivery. The robot does not require manual control. Due of this, line tracking robots are more effective and practical than other types of traditional robots. Because there is no dedicated path for the robot, conventional obstacle avoidance robots cannot assist in the transportation of products. It won't make the essential decision and instead will move arbitrarily to avoid obstructions. The obstacle avoidance robot's mobility cannot be controlled [10].

Meanwhile, there are additional beneficial uses for this line-following robot. By giving this common route robot the capacity to recognize obstacles, it can develop intelligence and smarts [10].

Earlier versions of this type of robot were created for transportation-related industrial automation. Thanks to developments in technology, this type of robot is now utilized in Amazon's warehouse management. Unsurprisingly, Amazon has debuted "SCOUT," a delivery robot that visits consumers' homes to leave goods. It follows a similar premise even though it isn't a robot that follows lines. At Masdar City, this transportation robot has recently undergone a revival. In this case, individuals also used it as a means of transportation for themselves, not only goods [11].

The black line is followed by our machine. If it veers off the black line, it stops, and if it comes across an obstacle along the way, it detects it in the programmer from a specific distance. The instructions for controlling the robot switch from the line-following module to the obstacle-avoiding module when the distance between the obstruction and the robot is at its shortest value. The control is sent back to the line follower module once the robot avoids the obstruction and finds the black line once more. One ultrasonic sensor on our robot's servo motor allows it to identify objects up to 1800 in front of it [12].

Our nation's population is growing quickly, and with more people comes the need for effective service management. A facility like a hospital requires 24-hour surveillance. Insufficient staff members and careless nurses pose a serious risk to patients' lives. However, moving items like food, clothing, bedding, and other equipment from one location to another is a challenge. Of course, the easy but ineffective response to this is to hire more employees. The age of technology and automation is now. Automation will be much more productive if it is implemented in healthcare facilities [13].

III. SYSTEM OVERVIEW

The Robot Circuit and the Request and Feedback Circuit were the two distinct parts of the complete system. "Fig. 1" depicts the request and feedback circuit's block diagram.

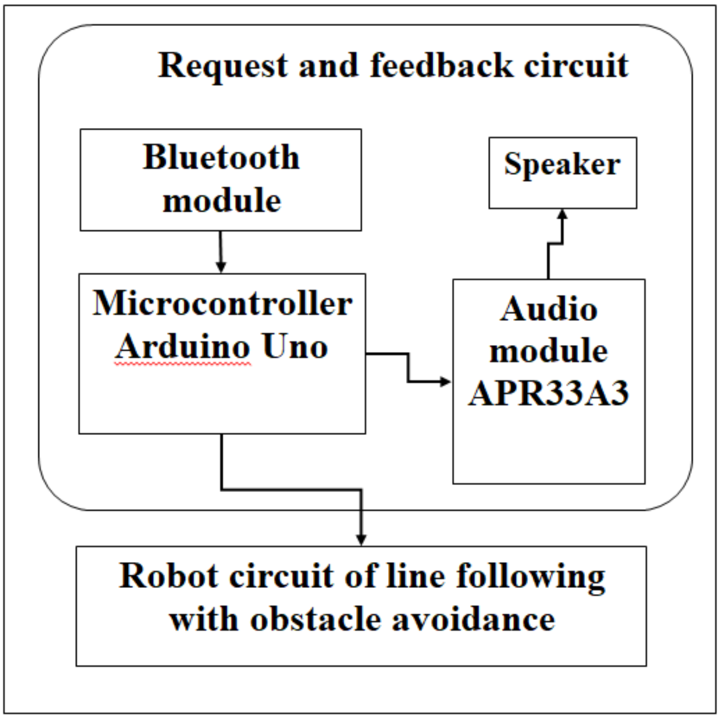

Fig no 1: Block Diagram Audio Section

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The primary purpose of the request and feedback circuit is to respond to or provide feedback to the user after receiving a request from the user. A user can communicate with the robot through Bluetooth while using an Android device; the Bluetooth input is read by the microcontroller, which can then transfer the detected signal in the proper format to the robot circuit.

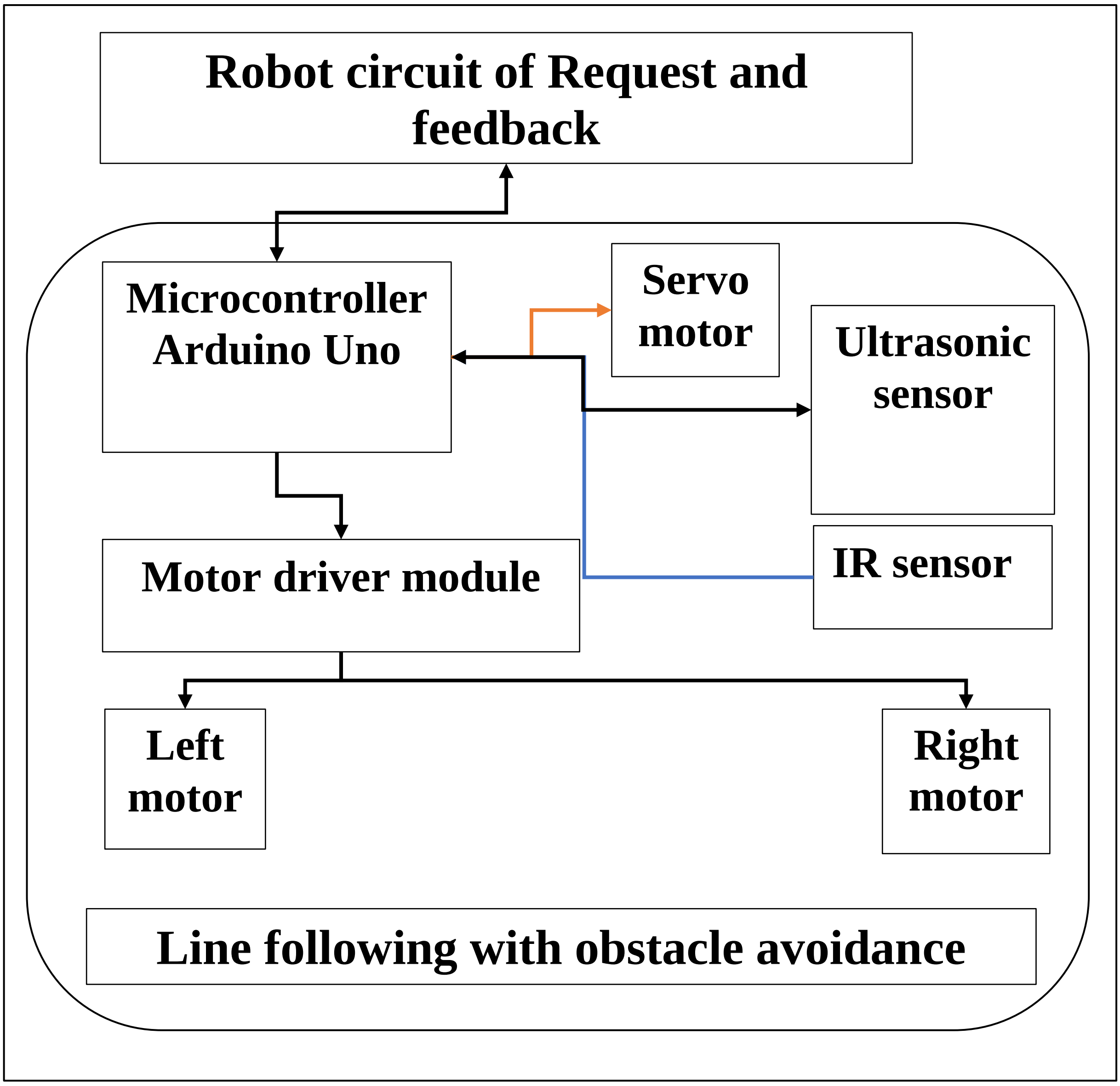

Fig no 2: Block Diagram of Robot

The robot circuit block schematic is displayed in "Fig. 2". To determine the route, the robot features an IR sensor array with three IR Rx-Tx (Receiver-Transmitter) pairs. The robot is moved to follow a course using two DC motors coupled by a motor driver with a microprocessor. The ultrasonic sensor's job is to find obstacles in the robot's path. If a robot encounters a roadblock [7].

IV. SYSTEM DESIGN

This section provides a description of the methods used to create the system prototype. The procedure for development entails take request from user and give feedback to them, implement line following, detection of obstacle, run on line path and transfer necessary items like medicine, food, blood sample etc.

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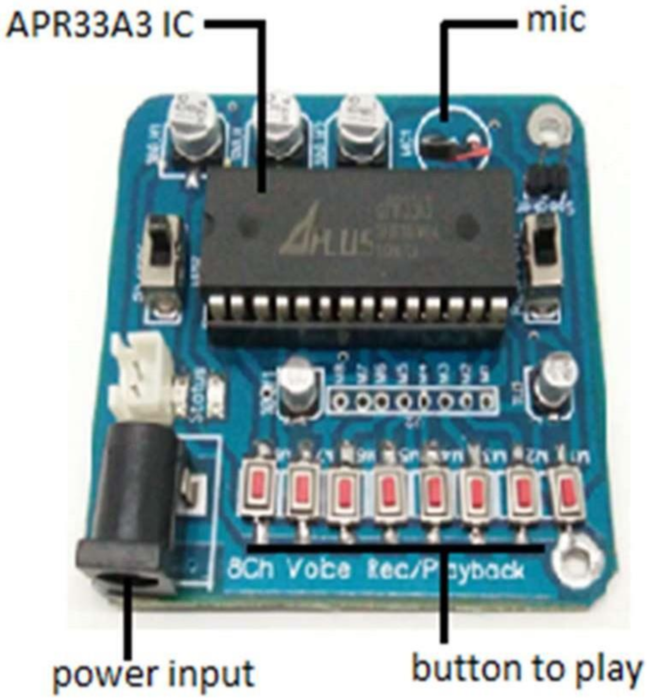

Fig no 3: Audio Modul

The aPR33A also has high-performance audio digital-to-analog converters (DACs) and analogue-to-digital converters (ADCs). series' audio processing capability. The aPR33A series is a completely integrated system that combines analogue input, digital processing, and analogue output functions with high performance and unmatched integration.

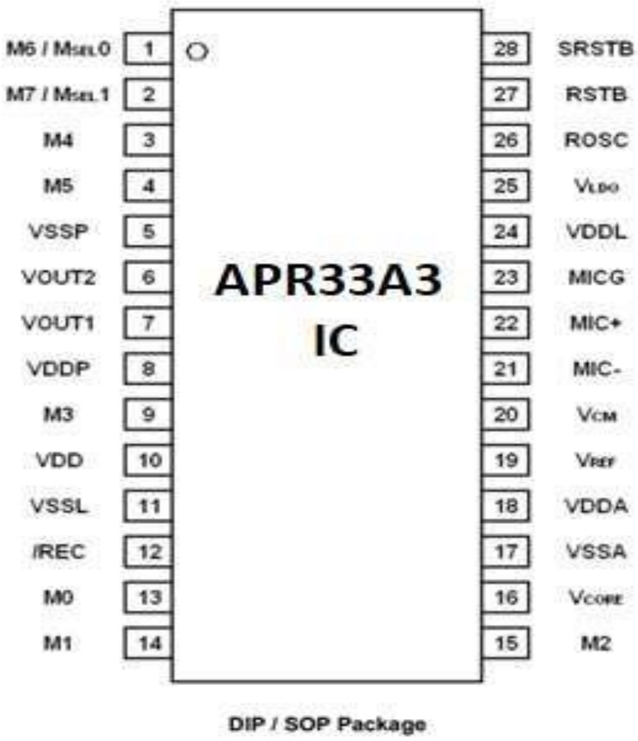

Fig no 4: APR33A3 Audio Modul IC

The aPR33A series E2.1 is specifically made for simple key triggers; users may record and play averagely 1, 2, 4 or 8 voice messages by switching, and they can change the sample rate by using resistors of various resistor values to suit their needs. We are using this record and playback module in our robot for giving feedback in the form of voice messages so that user can inter-react robot easily. And circuit is show in fig no. 5 or block diagram

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is shown in fig no.1.

LINE FOLLOWER

We are using IR sensor for line detection. The sensor detects reflected light from its own infrared LED to function. It can identify bright or dark areas (lines) or even things directly in front of it by measuring the quantity of reflected infrared radiation [8].

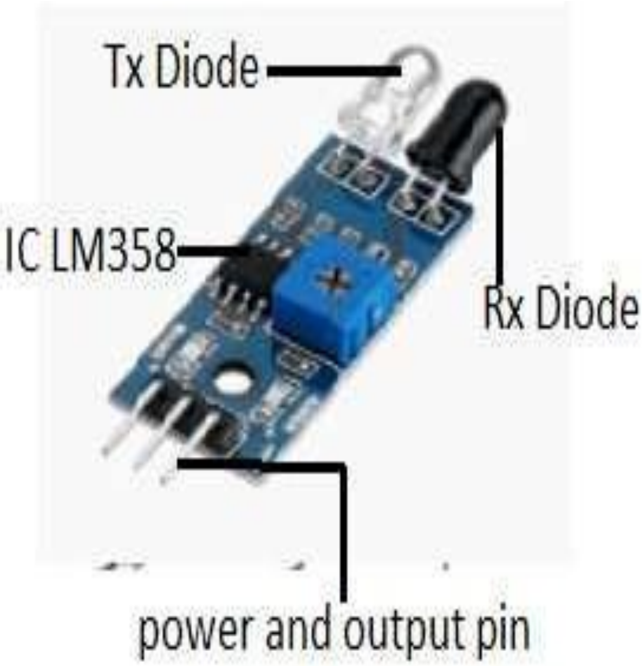

Fig no.6: IR Sensor

The black line is detected with the array of IR sensors installed underneath the robot close to the caster wheel. To maximize accuracy and smoothness of operation, we employ three sets of IR transmitter and receiver, which is the minimal amount needed to implement the line following approach. The idea behind line followers is that light reflects on white surfaces but not on black. Based on the reflection of the IR signal from the surface by the item, the receiver alerts the Arduino board to the presence of a black line. The motor shield, which regulates the speed at which the motors turn, receives a signal from the Arduino board using this information [9].

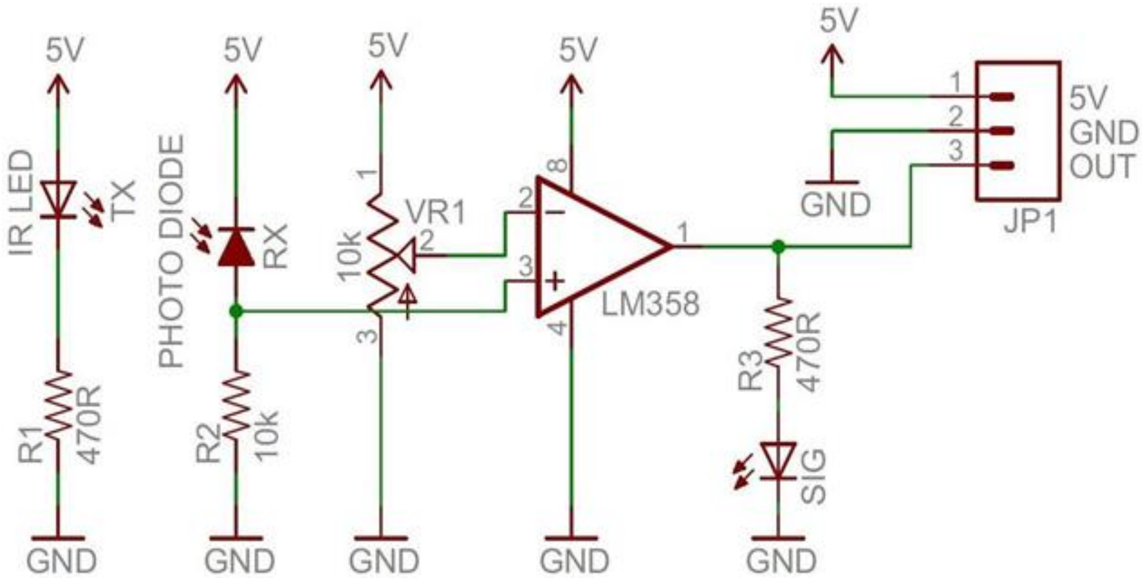

Fig no.7: IR Sensor Circuit Diagram

The left and right motors' unique speeds determine which way the robot will turn. Depending on whether the left motor accelerates more swiftly than the right motor, the robot will turn to the right or the opposite. Both

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motors must be moving at the same speed for the robot to travel straight forward.

The relationship between the robot movement and the sensor inputs is depicted in this flowchart.

FLOW CHART OF LINE FOLLOWER

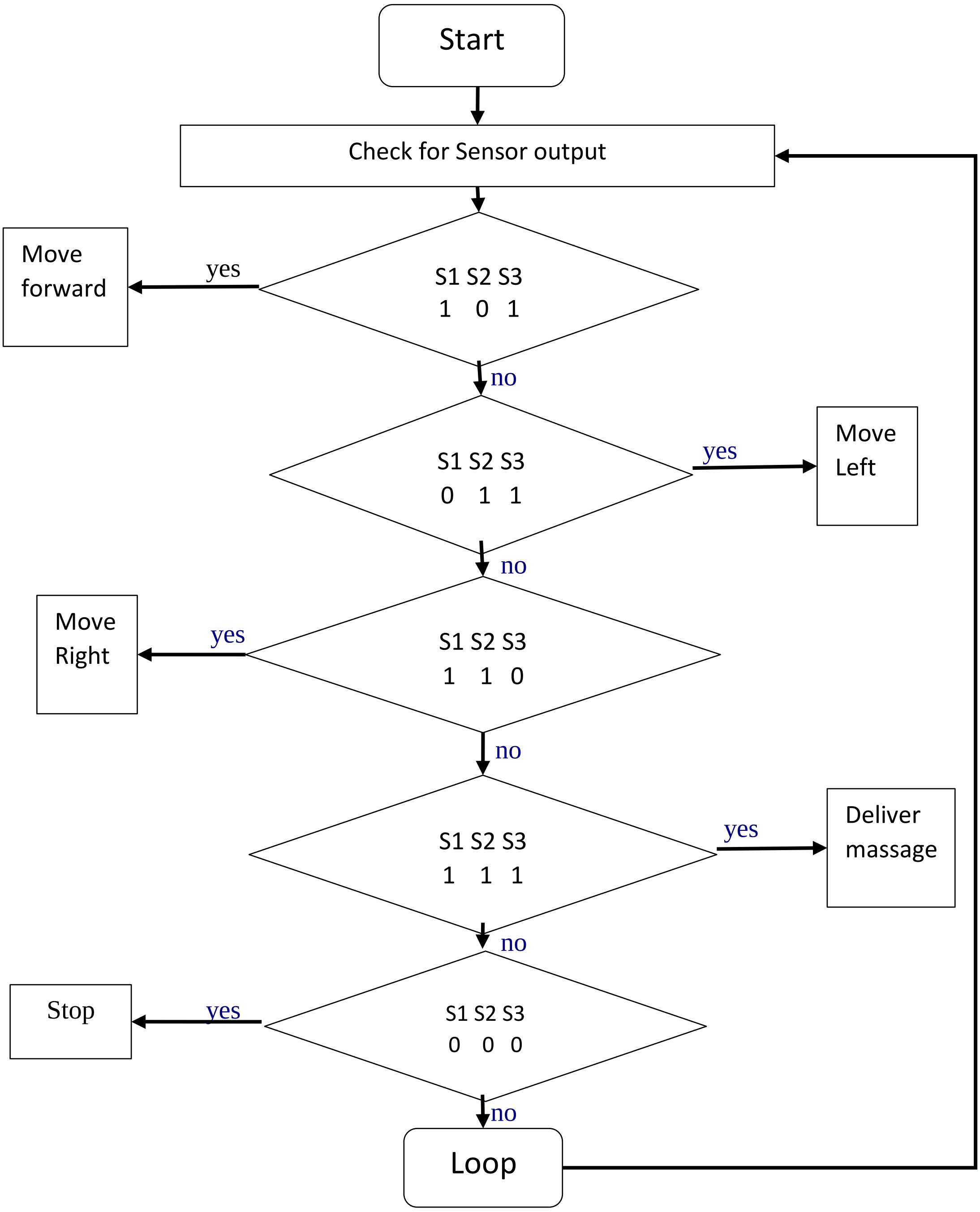

Fig no.8 Flow Chart

The sensors' corresponding high and low values are shown by the numbers 0 and 1, respectively. Contrarily, if the surface is black, the wave won't be reflected, the sensor output is logically low (0) if the surface is black since the wave won't be reflected there; if the wave is reflected, the surface must be white, in which case the sensor output is logically high (1).

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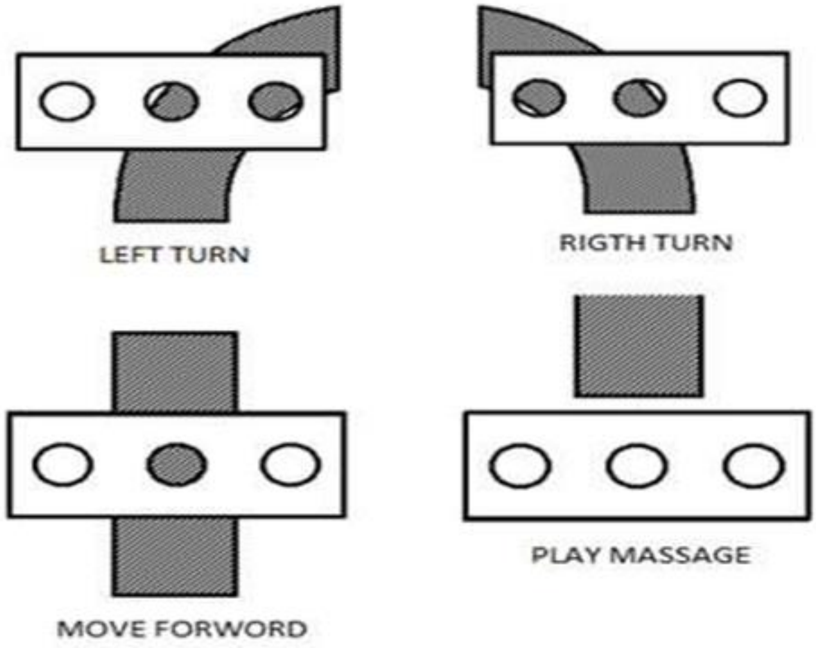

Fig no. 9: Diagram Movement of Robot

OBSTACLE DETECTION

In this lesson, we build the circuit and explain how the robot navigates its environment to avoid obstacles and keep going forward. For this we are using ultrasonic sensor for obstacle avoiding and it is mounting head of the robot

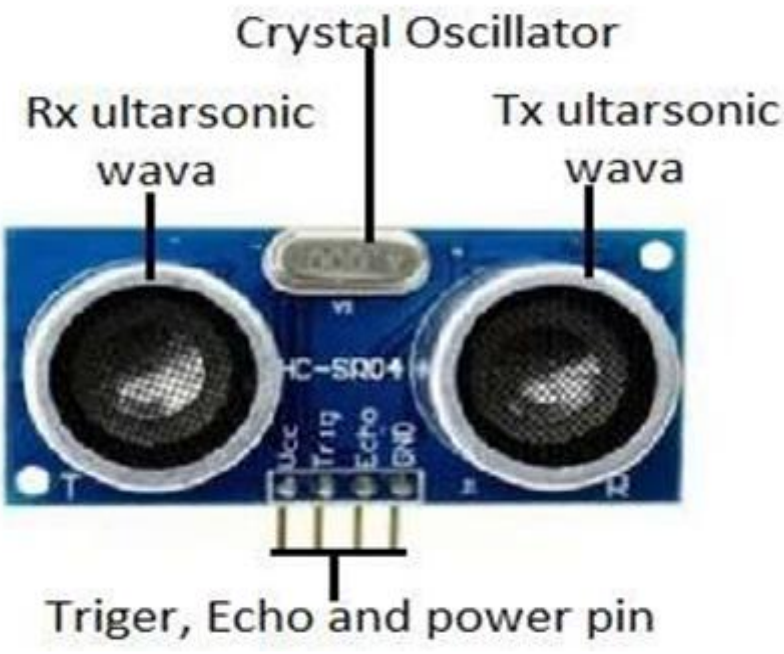

Fig no.10 Ultrasonic Sensor

The circuit of ultrasonic sensor and connection of jumper wire shown in this diagram which is given below.

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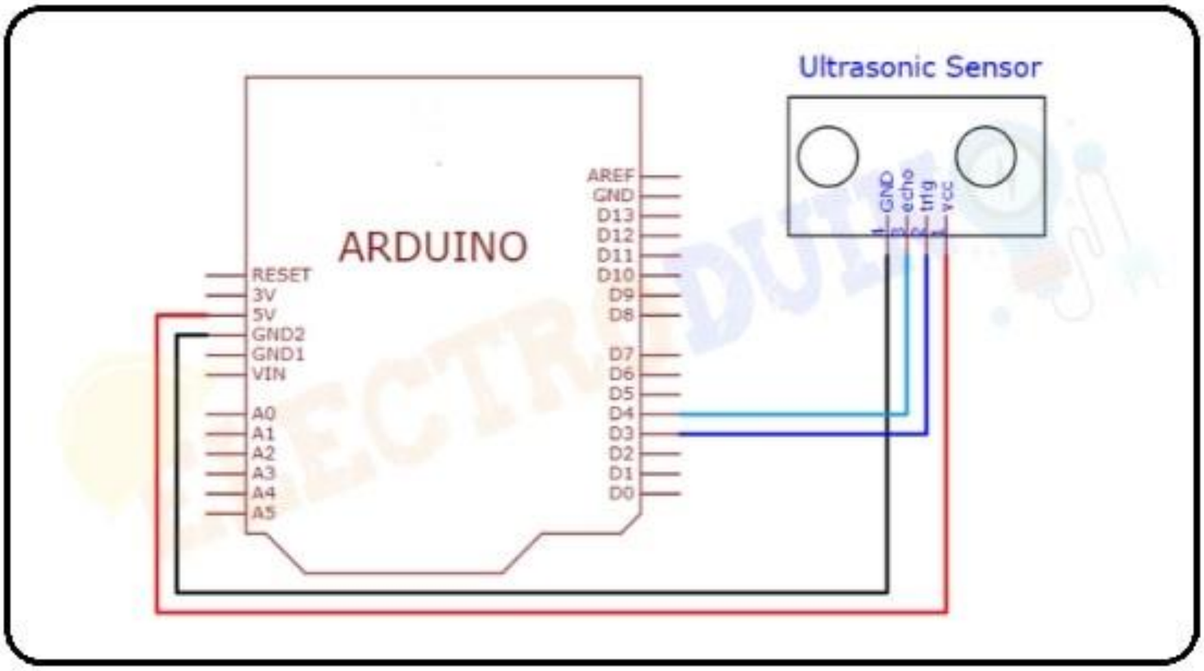

Fig no.11 Connection Diagram Of ultrasonic(source: www.google/images)

To examine the impediment from three aspects, the robot head rotates 180 degrees. This robot's brain is an Arduino board that uses information from an ultrasonic sensor to determine how far an obstacle is from the robot. Arduino determines the direction of the obstacle based on the servo motor's angle. A formula is used to determine the distance by knowing the wave's speed and the interval between the triggered wave and the echo.

Distance =(speed*time)/2

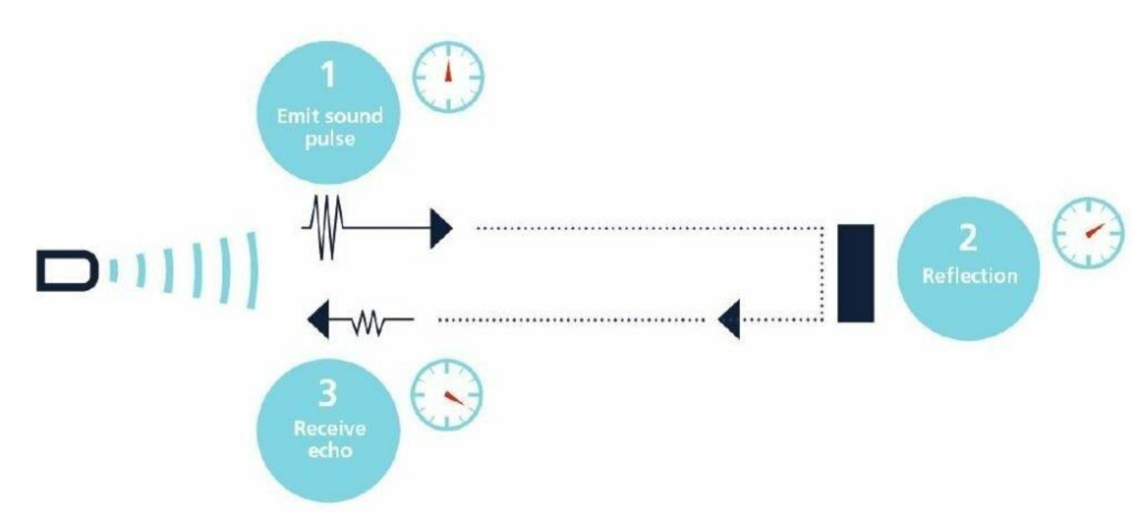

Fig no.12 Working Of ultrasonic sensor (source: www.google/images)

The route favors the one with the widest opening when there is an obstruction by checking the gaps in both directions. It advances in that direction, off the path, and travels around an obstruction until it crosses a black line.

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FLOW CHART OF OBSTACLE DETECTION

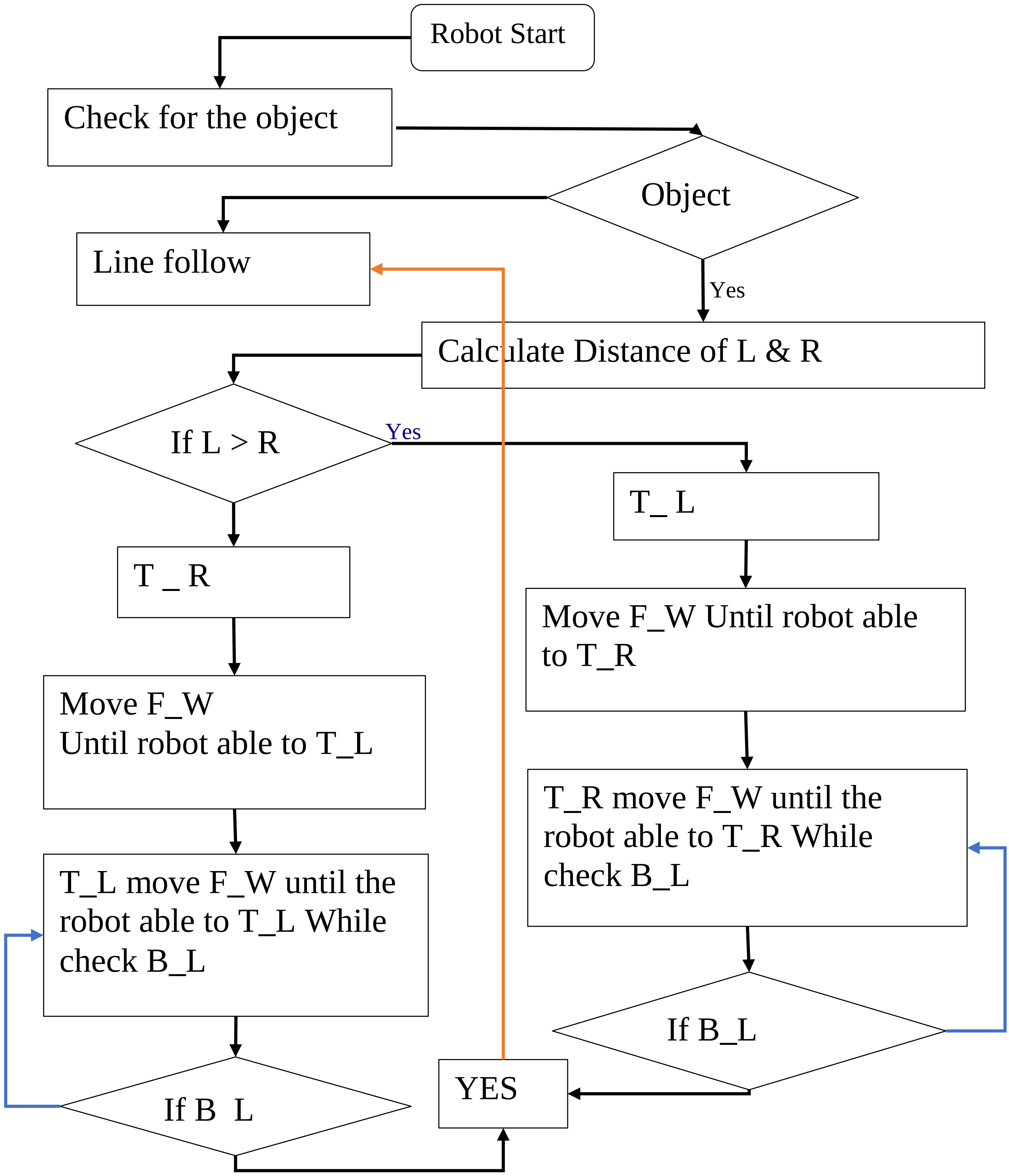

Fig no.13 Flow Chart

R = Right.

L = Left.

T_L = Turn Left.

T_R = Turn Right.

F_W = Forward Move.

B_L =Black Line.

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It proceeds along its route after locating the black line. When the distance between the object and the robot is closer than the threshold distance, which is set in the programmer, the obstacle-avoiding module is activated.

V. WORKING OF ROBOT

Now, how the robot run on black line and avoid the obstacle in front of it.

Step 1 - Right motor stops while left motor continues to travel when left sensor enters white (for black line tracer) zone, causing the robot to turn to the right and return to the white line show in Fig.14

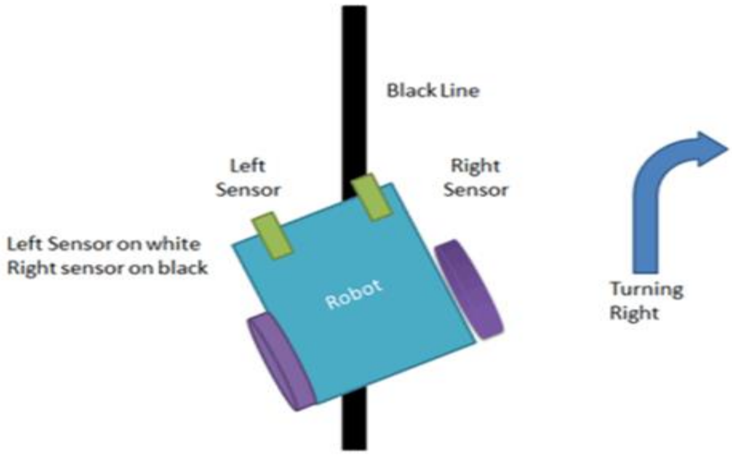

Fig.14 Turning left (source: www.google/images)

Step 2 - Since the first sensor on the right is facing the black line, its response will be low, while that of the other sensors will be high. i.e., the left wheel is allowed to move freely while the right wheel is kept stationary until the center sensor's reaction drops.

Step 3 - When the right sensor enters the white area, the left motor stops while the right motor keeps moving, causing the robot to turn to the left and return to the white line show in Fig.15

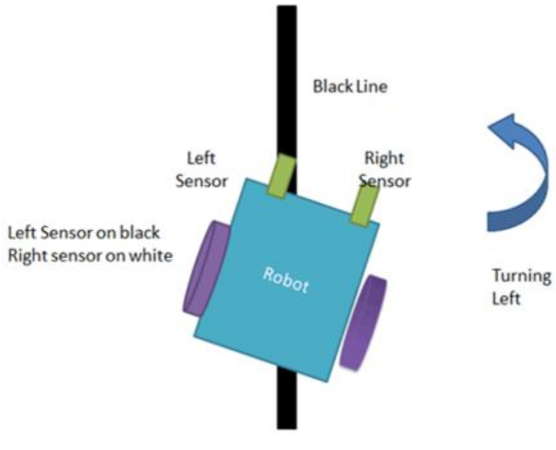

Fig.15 Turning right (source: www.google/images)

Step 4 - The middle sensor will always be on the line, and as the line is black in color, it won't reflect the radiation back, thus its response will always be low. In contrast, the responses of the other two sensors, which will be on the bright surface, will always be high. Robot advances when both sensors are on the black line show in Fig 16.

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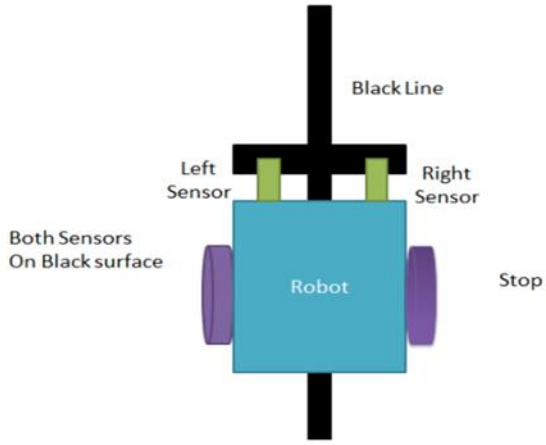

Fig.16 Stop the robot (source: www.google/images)

Step 5 - When none of the three lines are identified, the robot moves in a circle until one is located if all three sensors are on a brighter surface in which case, they will all be high.

Step 6 - To examine the impediment from three aspects, the robot head rotates 180 degrees. This robot's brain is an Arduino board that uses information from an ultrasonic sensor to determine how far an obstacle is from the robot. Arduino determines the direction of the obstacle based on the servo motor's angle.

Step 7 - Measuring the distances in both directions, it chooses the path that passes through the obstruction with the biggest gap. It advances in that direction, off the path, and travels around an obstruction until it crosses a black line. It finds the black line and continues along its path. When the distance between the object and the robot is closer than the threshold distance, which is set in the programmer, the obstacle-avoiding module is activated.

VI. COMPONENTS USED

HARDWARE REQUIRED

1. ARDUINO

We are Arduino Uno as a brain of our robot.

Fig no.17 Arduino Uno

An 8-bit ATmega328P microcontroller is the Arduino Uno. On a single circuit board, Arduino houses a variety of components and interfaces.

Processor: 16 MHz ATmega328

Flash memory: 32 KB

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SRAM: 2KB • EEPROM: 1KB

Clock Speed: 16 MHz

Operating Voltage: 5V

Input Voltage: 7-12 V

Number of analog inputs: 6

Number of digital I/O: 14 (6 of them PWM)

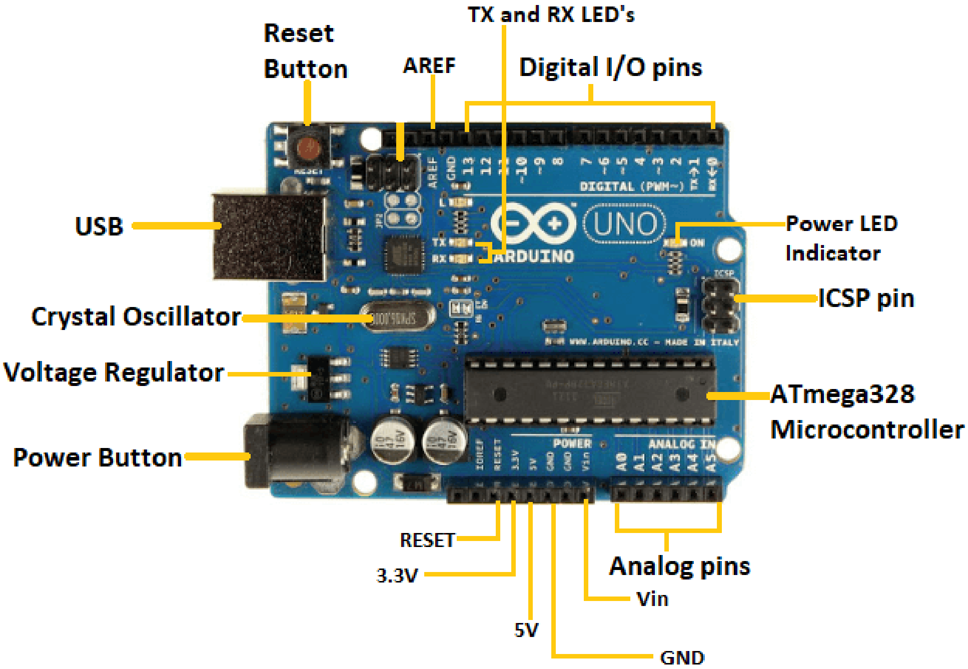

Fig no.18 Arduino Uno Parts

2. IR SENSOR

A sensor that emits infrared light to detect objects in the environment is a type of electrical equipment. The location of a line follower in relation to the robot position is determined using infrared ray sensors. The most common type of sensor utilized in the creation of a line follower robot is an infrared sensor (IR) for line sensing operations. Image shown in Fig no.6.

3. L293D

One of the simplest and chip-based methods for controlling DC motors is L298N. DC motors' speed and direction of rotation are controlled by a two-channel motor driver.

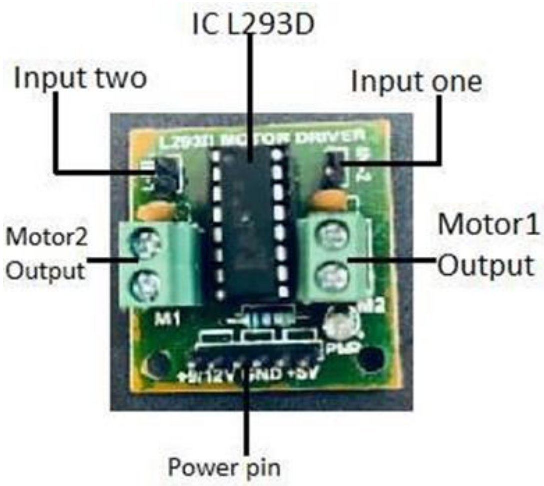

Fig no.19 L293D

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A high-power motor driver module, the L298N Motor Driver. It's employed to power DC and stepper motors. This motor driver is made up of an integrated circuit with an L298N motor driver IC, a 78M05 5V voltage regulator, resistors, capacitor, power LED, and a 5V jumper.

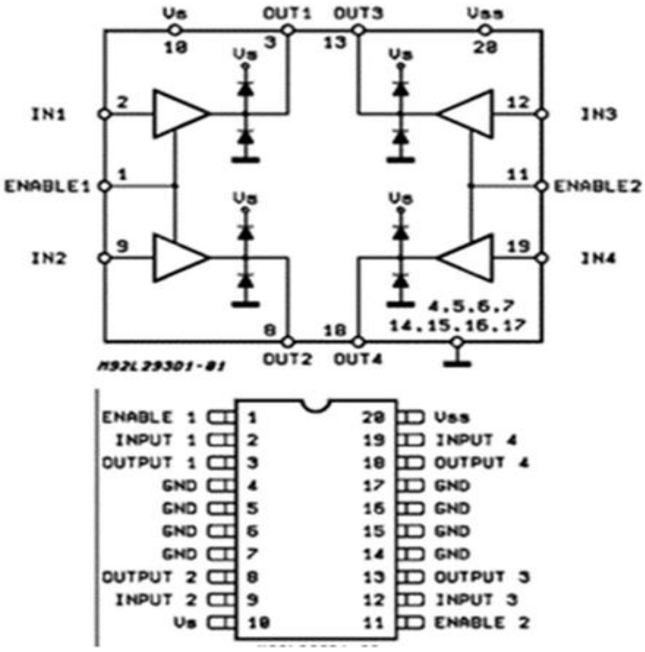

Fig no.20 L293D Pin Diagram(source: www.google/images)

4. ULTRASONIC SENSORS

Ultrasonic sensors are electronic devices that use the emission of ultrasonic sound waves to determine a target's distance before converting those waves into electrical signals. The speed of travelling ultrasonic waves is greater than the speed of audible sound.

The idea behind how ultrasonic sensors operate is that they produce waves with a higher frequency than humans can hear. The sensor then estimates how far away the item is when it is in front of it after waiting for the wave to be reflected. Image presented in Fig. 10.

5. MOTOR

The term "BO Motor" refers to battery-operated motors. These motors are frequently employed in hobby-grade applications when a tiny DC motor is needed as a straightforward actuator.

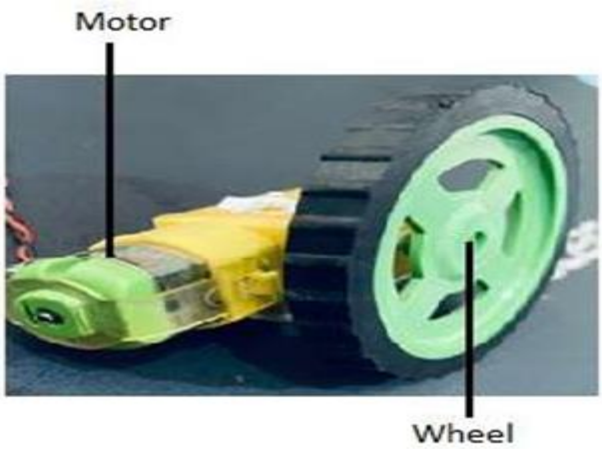

Fig no.21 Motor and Wheel

Good torque and rpm are available with BO series linear motors at lower operating voltages. There are three different types of BO motors: single shaft, dual shaft, and DC plastic gear BO. These motors only draw small current.

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6. SERVO MOTORS

Servo motors, or "servos" as they are sometimes referred to, are electrical gadgets and rotary or linear actuators that precisely spin and push elements of a machine. Servos are often utilized for particular velocity, acceleration, and angular or linear position.

Fig no.22 Servo Motor

7. POWER SUPPLY

Rechargeable batteries include lithium-ion batteries. It is frequently utilized in portable equipment including electric cars, computers, gadgets, and mobile phones.

Fig no.23 Lithium-ion Battery

8. HC-05 BLUETOOTH MODULE

An accessible Bluetooth SPP (Serial Port Protocol) module, the HC-05 is intended for setting up transparent wireless serial connections.

A serial port with a comprehensive 2.4GHz radio transceiver and baseband, the Bluetooth module is fully certified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation. It makes use of an AFH (Adaptive Frequency Hopping Feature)-equipped CSR Blue core 04-External single chip Bluetooth system. Its footprint is just 12.7 mm × 27 mm. I hope it will make the entire design/development cycle simpler.

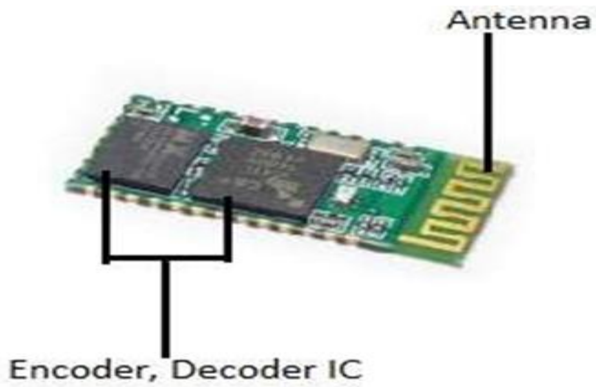

Fig no.24 Bluetooth Module

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SOFTWARE REQUIRED

1. ARDUINO IDE

The text editor, notification area, text content panel, toolbar with buttons for writing code, menus, and odd localization are all included in the Arduino Compiler or Arduino Software (IDE). The Arduino compiler is used to generate packages and to comfortably use the hardware sensor. It I open- source software and a platform on which the electronic equipment is mainly based on the complete and is fully fluent to the user hardware and software utilities. This compiler read input from the sensors, and it activates other sensors connected to the main sensor. The Language we use to write the program is Embedded C, a version of the C programming language.

2. NEWPING LIBRARY

a library that provides functionality for using ultrasonic sensors. I wasn't happy with the ultrasonic sensor's subpar performance when I initially got it. I quickly came to the conclusion that the problem wasn't with the sensor itself, but rather with the ping and ultrasound libraries that were readily available. With the help of the New-Ping library, Arduino users may use ultrasonic sensors to detect distances.

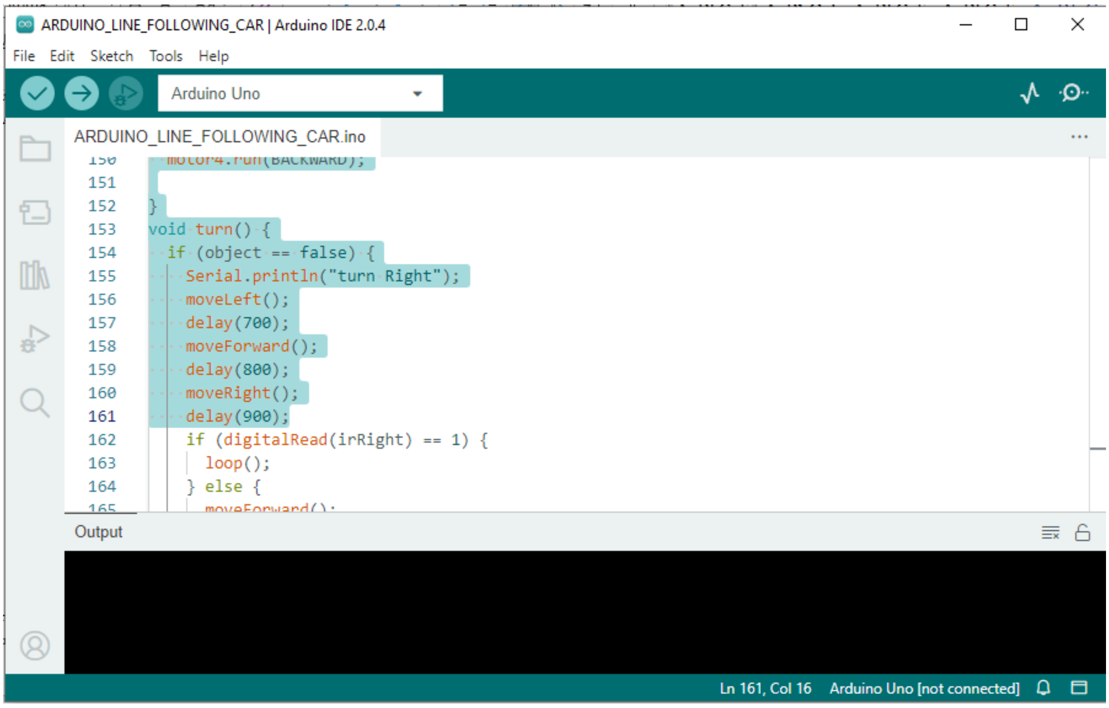

Fig no.25 Arduino IDE Software

3. EAGLE

Printed circuit board (PCB) designers may easily link schematic designs, component placement, PCB routing, and extensive library material using the electronic design automation (EDA) programmer EAGLE.

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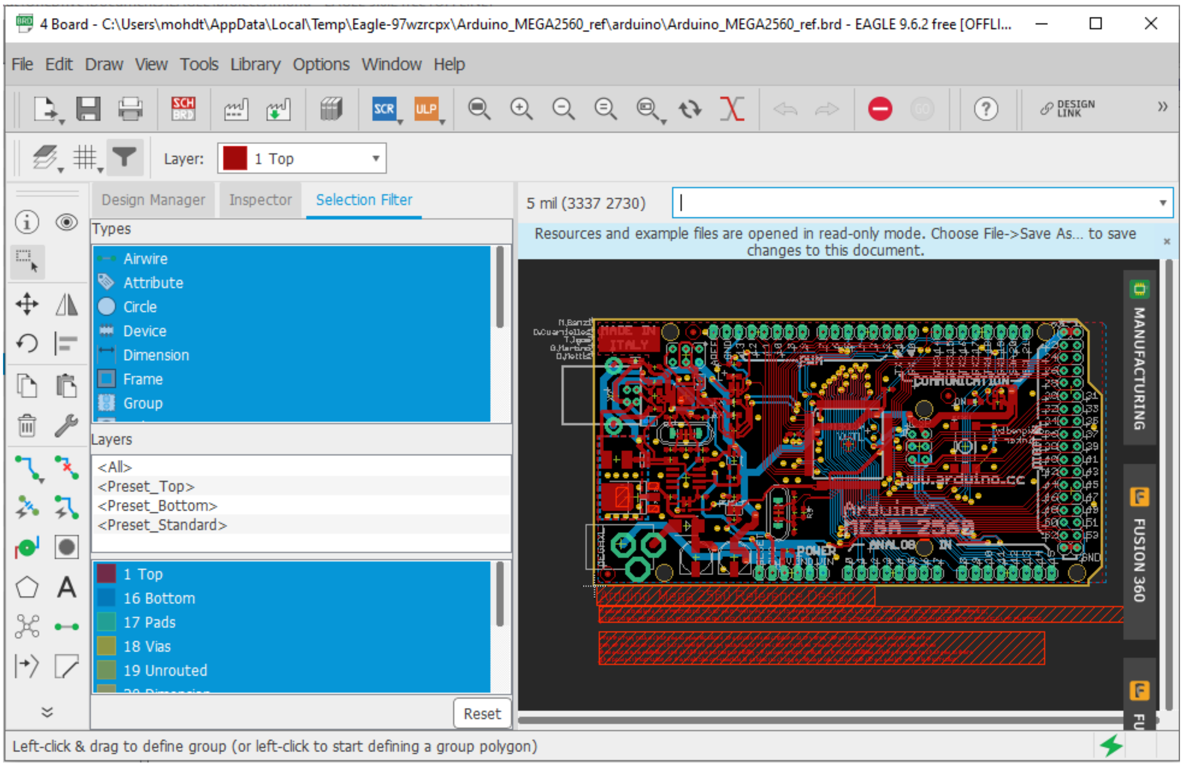


Fig no.26 Eagle Software preview

VII. IMPLEMENTATION AND RESULTS

Robot continuously checks its path for obstructions as it moves down the black line in accordance with the line follower module's instructions. When an obstruction is found, the robot's control is transferred to the obstacle-avoiding module. Following the barrier to be avoided, it returned control to the line follower module. Code uses a variety of functions to simplify and improve robot precision.

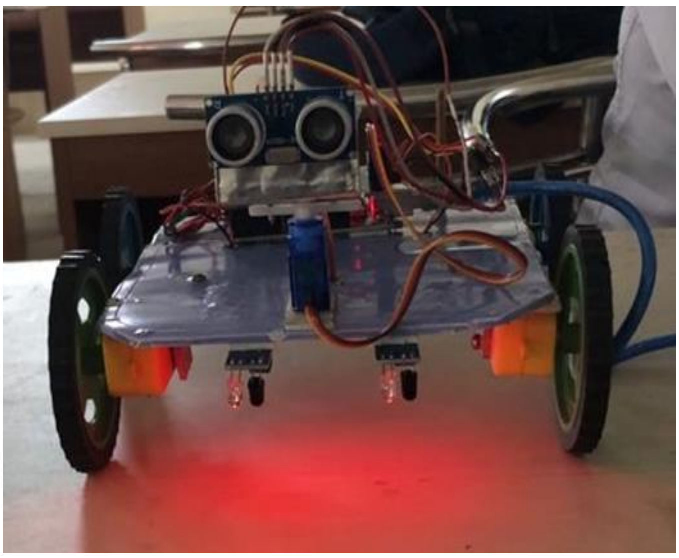


Fig no. 27A: Proposed model

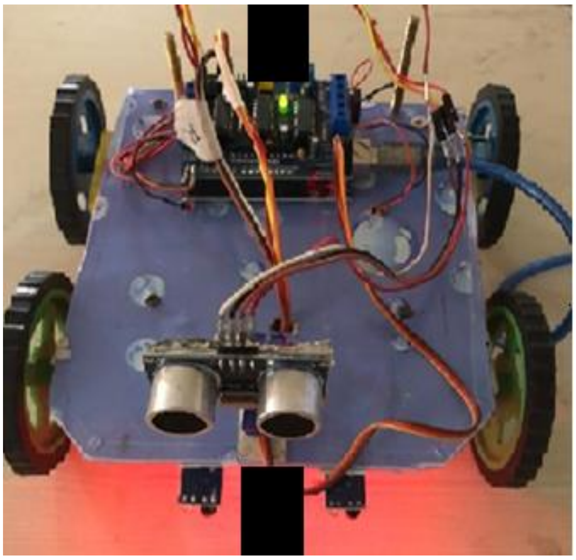


Fig no. 27B: Working model

The specimen's results are shown in the figures below. By identifying impediments and following the course, it was functioning properly.

For better understanding the working of this robot consider following cases:

CASE 1: Straight path

Table no. 1: Show reading of Case 1

Sr no.	Distance covered	Time required
1.	1.2m	16sec.
2.	2.4m	22sec.
2.	3.6m	31sec.

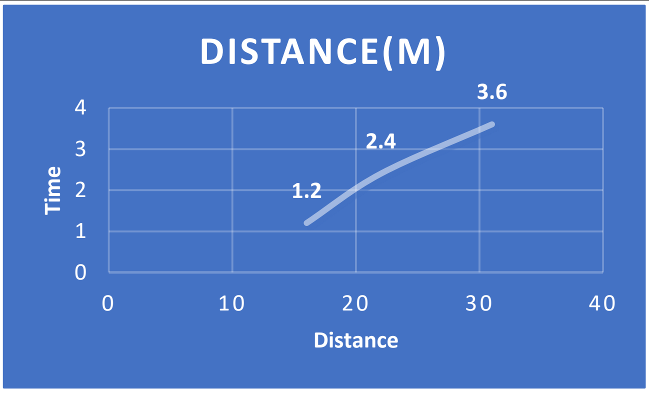
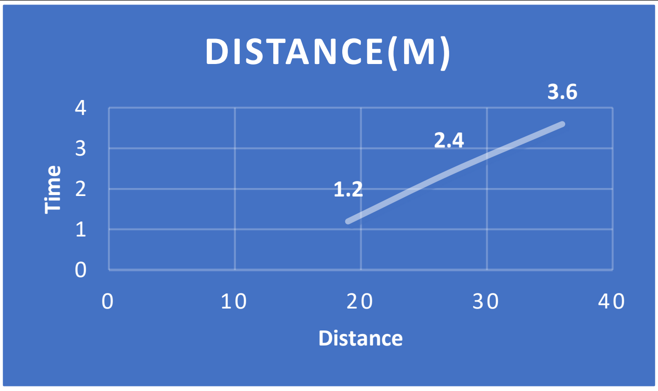


Fig no. 28 Test results

CASE 2: Curved path

Table no. 2 Show reading of Case 2

Sr no.	Distance covered	Time required
1.	1.2m	19sec
2.	2.4m	27sec
3.	3.6m	36sec



VIII. CONCLUSION

In comparison to current line-following and obstacle-avoidance robots, the suggested robot performs various duties. We were able to reduce the number of ultrasonic sensors from three to one, spin the robot's head to cover all three directions, and identify the robot's direction of gaze by looking at its head by adding a servo motor. We can detect obstacles at every angle surrounding the robot and determine their locations by making a few adjustments to the robot's code. It can detect impediments and take the appropriate action by using a camera in place of the ultrasonic sensor. The robot may be utilized for a variety of tasks by implementing certain logical commands. By adding more IR sensors, the robot in the line after you can become more exact.

This robot may be employed in businesses, medical facilities, and even by the military. Conveyor belts can be replaced by this robot.

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