LINE FOLLOWER AND OBSTACLE DETECTOR ROBOT

INTRODUCTION

An obstacle-detecting line follower robot is an autonomous robot that uses sensors to detect obstacles in its path while following a predefined line. The robot typically moves along a line drawn on the surface, such as a black line on a white surface and vice versa, and uses sensors such as infrared sensors or ultrasonic sensors to detect obstacles in its path.

The main aim of an obstacle-detecting line follower robot is to navigate along a designated path while avoiding obstacles that may appear on the way. This type of robot is commonly used in indoor navigation, automobiles, industrial automation, etc.

The obstacle-detecting line follower robot consists of a microprocessor and microcontroller asits brain, sensors to detect paths and obstacles, motors or wheels for movement, and a battery forpower supply. The microcontroller processes the sensor data, makes decisions based on predefined algorithms, and controls the motors and wheels to achieve desired movement and obstacle avoidance behavior.

With an increasing demand for intelligent systems and automation, obstacle detector line follower robots have become popular in the field of robotics, offering versatile and practical solutions for navigating environments with both lines and obstacles.

Project objective

The field of robotics is fast-paced and ever-growing to the point that many machines are developing every day in industries. Our project is inspired by the advent of robotics and uses line following done by the robot with the use of infrared sensors and object detection using ultrasonic sensors. If any object is placed on the path then a normal line follower will try to push the obstacle and hence it gets damaged. By using an ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robot can perform a lot of tasks in industries, like material handling. These robots can be used as automated equipment carriers in industries replacing traditional conveyor belts.

METHODOLOGY

The methodology for designing and building a Line following obstacle detector can be broken down into the following steps:

Research and Planning:

Conduct research on the different types of Line following obstacle detectors available and analyze their various characteristics after finalizing the characteristics we require in our model we determine the requirements of the project and plan the design accordingly.

Design:

Create a design of the Line following obstacle detectors using proteus software. The design should include the dimensions of the container, the motors, the sensor, and the hardware system.

Prototype Development: Build a prototype of the Line following obstacle detectors to test the design and functionality. The prototype should be built using materials that are durable and suitable for use with obstacles, but before having a prototype on hardware we have to build a prototype on Proteus Software.

Testing: Test the prototype by loading the code from Arduino and monitoring its performance. Observe how it responds to changes in speed, the ultrasonic motor's efficiency, and the system's ability to detect obstacles.

Refining: Based on the test results, refine the code of the Line following obstacle detectors and make any necessary adjustments to improve its performance.

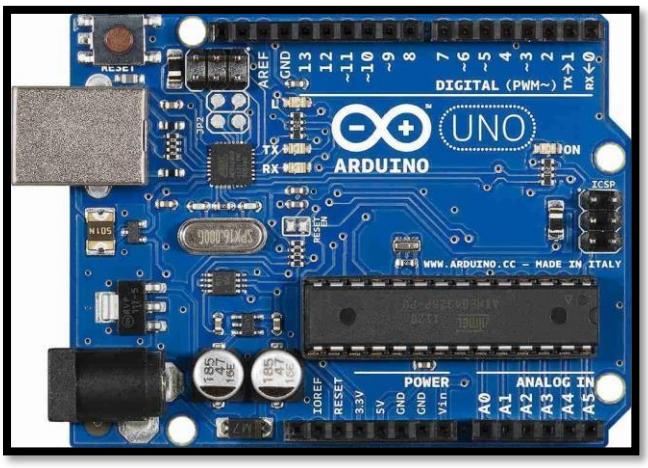
Manufacturing: Once the design has been refined, manufacture the final product using materials that are suitable for use with obstacles.

COMPONENTS USED

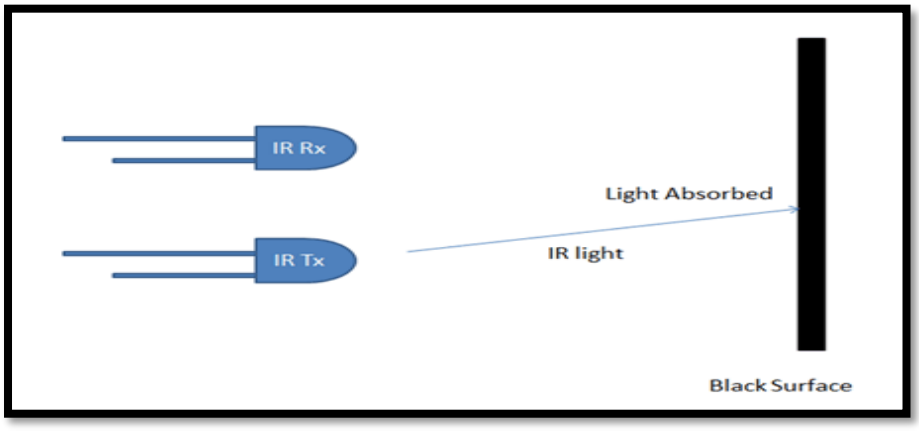
4.1 Arduino UNO

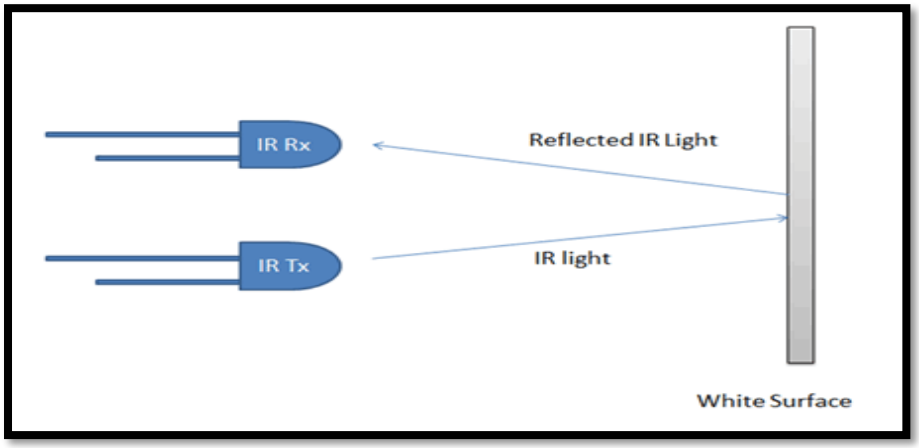
Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board

can be interfaced with other Arduino boards, Arduino shields, and Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output.



4.2 IR SENSOR





- The Infrared (IR) sensors consist of Infrared (IR) LED and Infrared (IR) photodiodes.
- One pin on either side of the motor will be HIGH and the other pin will be LOW. Then the robot will make a turn depending on the HIGH and LOW of the pin.
- When both the sensors are on a white surface then the robot moves forward and when both the sensors are on a black surface then the robot stops. In this case, both the sensors will detect the black line but the position where the sensors are located decides whether the robot will stop or will move forward.
- When the left sensor detects the black line andthe right sensor is not able to detect the black line then the robot has to turn left. Whenthe right sensor detects the black line and the left sensor is not able to detect the black line then the robot has to turn right. In any case, if there is a black line then the rotor has to stop.

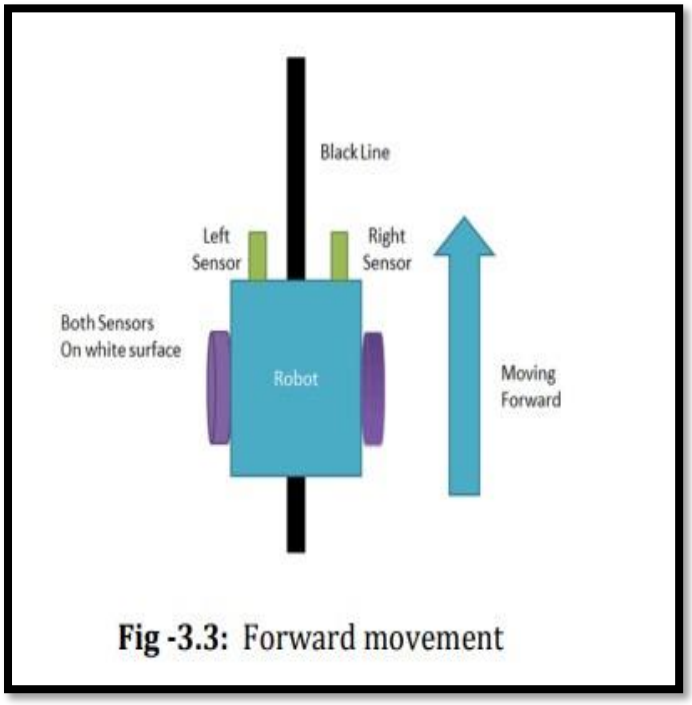


Fig -3.3: Forward movement

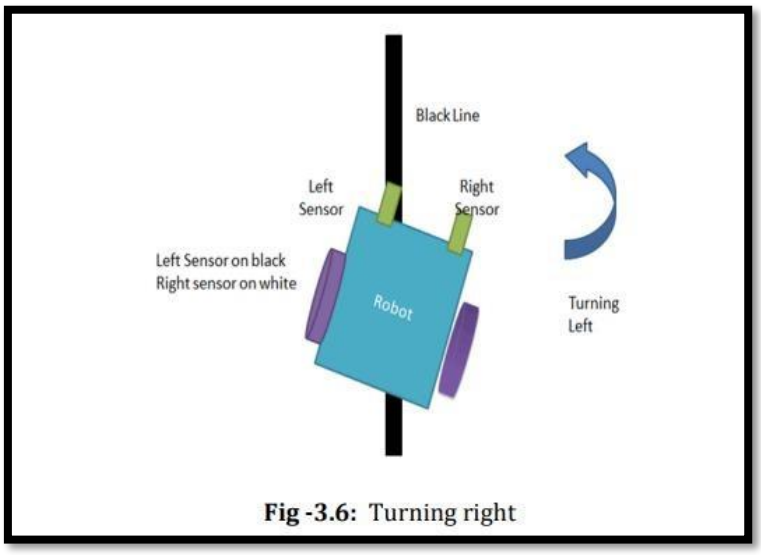


Fig -3.6: Turning right

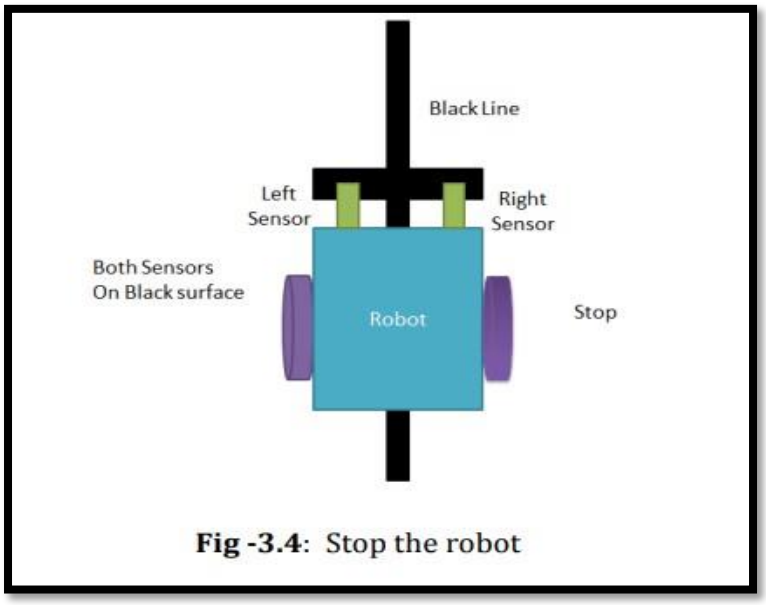


Fig -3.4: Stop the robot

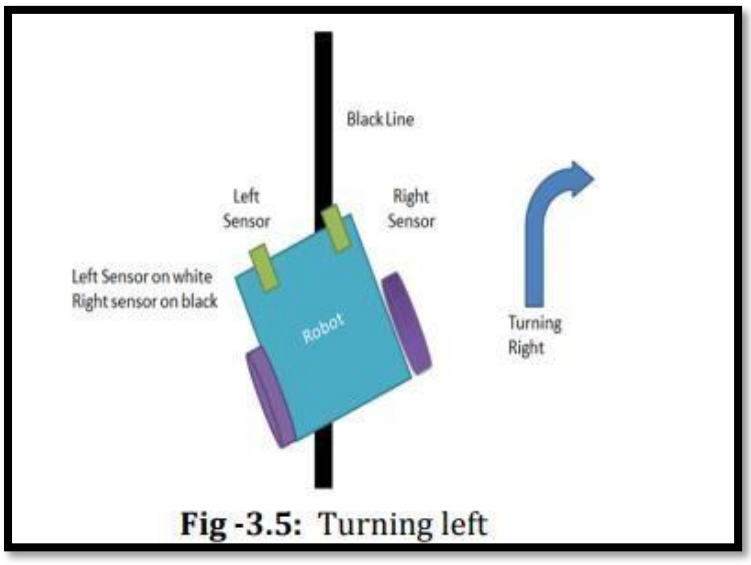
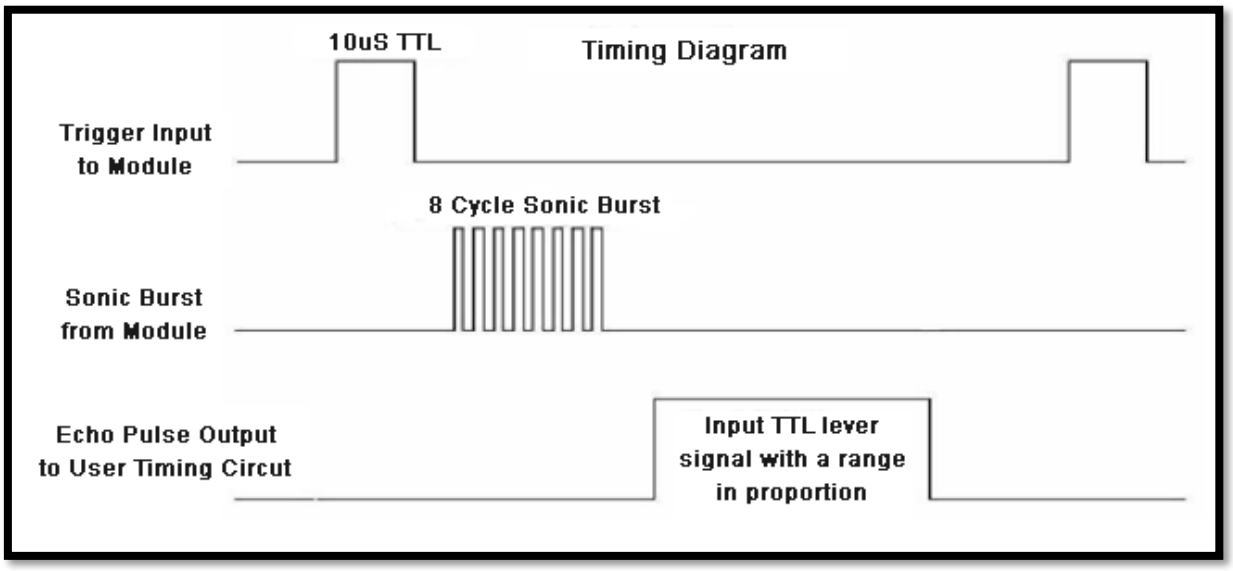


Fig -3.5: Turning left

4.3 ULTRASONIC SENSOR

The sonar system is used in HC-SR04 ultrasonic sensor to determine the distance to an object. It offers excellent non-contact range detection from about 2 cm to 400 cm or 1feet to 13 feet. Its operation is not affected by sunlight or black material. The ultrasonic sensor emits short and high-frequency signals. If they detect any object, then they reflect an echo signal which is taken as input to the sensor through the Echo pin. Firstly, the user initializes the Trigger and Echo pin aslow and pushes the robot in the forward direction. When an obstacle is detected Echo pin willgive input as high to the microcontroller. The pulse In function is used for calculating the time of distance from the obstacle. Pulses from 10 microseconds to 3 minutes in length are taken into consideration. After determining the time, it converts into a distance. If the distance of theobject is moderate then the speed of the robot gets reduced and will take a left turn, if an obstacle is present on the left side then it will take a right turn. If the distance of the object is short then the speed of the robot gets reduced and it can then go in either the left or right direction.

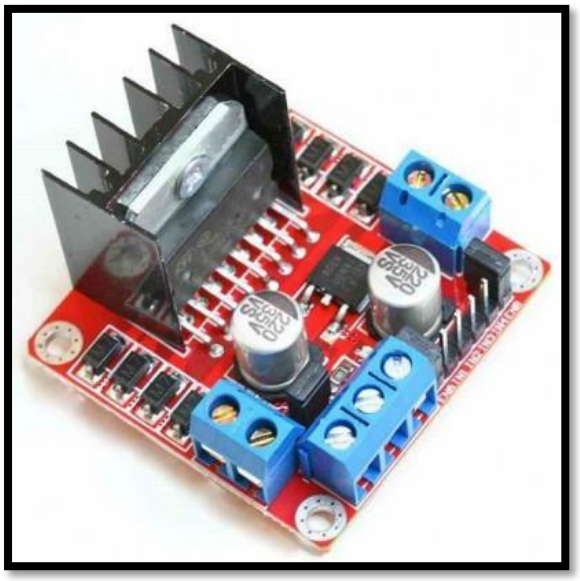


This robot was built with an Arduino development board on which the microcontroller is placed. The Arduino board is connected to DC Motor through the Motor driver board (pin4, pin5, pin6, pin7) which provides power to the actuators. Actuators are used to move robots in Forward, Backward, Left, and Right directions. The movement of the robot will be stopped whenever there is an obstacle present on its path which can be detected by ultrasonic sensors. Ultrasonic sensors give time in length to the microcontroller as an input for further actions.

4.4 MOTOR DRIVER L293D

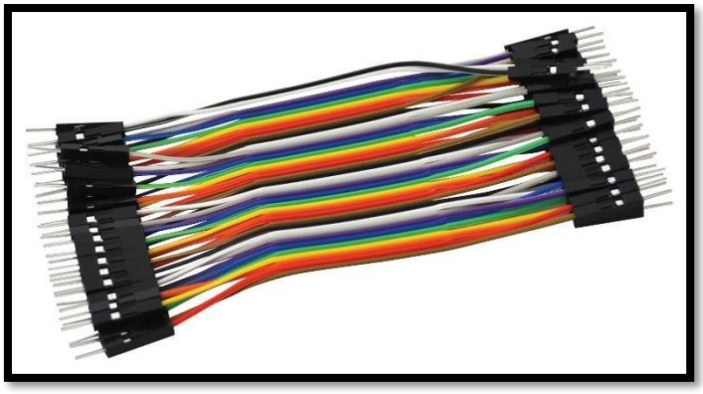
L293D Motor Driver Module is a medium-power motor driver perfect for driving DC Motors and Stepper Motors. It uses the popular L293 motor driver IC. It can drive 4 DC motors on and off, or drive 2 DC motors with directional and speed control.

The driver greatly simplifies and increases the ease with which you may control motors, relays, etc from micro-controllers. It can drive motors up to 12V with a total DC of up to 600mA.



4.5 JUMPER WIRES

Jumper wires are simply wires with connector pins at each end that can be used to connect two places without soldering. Jumper wires are commonly used with breadboards and other prototyping tools to allow for quick circuit changes as needed. Male-to-male, male-to-female, and female-to-female jumper wires are the most common. The distinction between them lies in the wire's terminating point. Male ends have a protruding pin and can plug into anything, but female ends do not and must be plugged into. Male-to-male jumper wires are the most prevalent and will most likely be used the most. A male-to-male wire is required for connecting two ports on a breadboard.



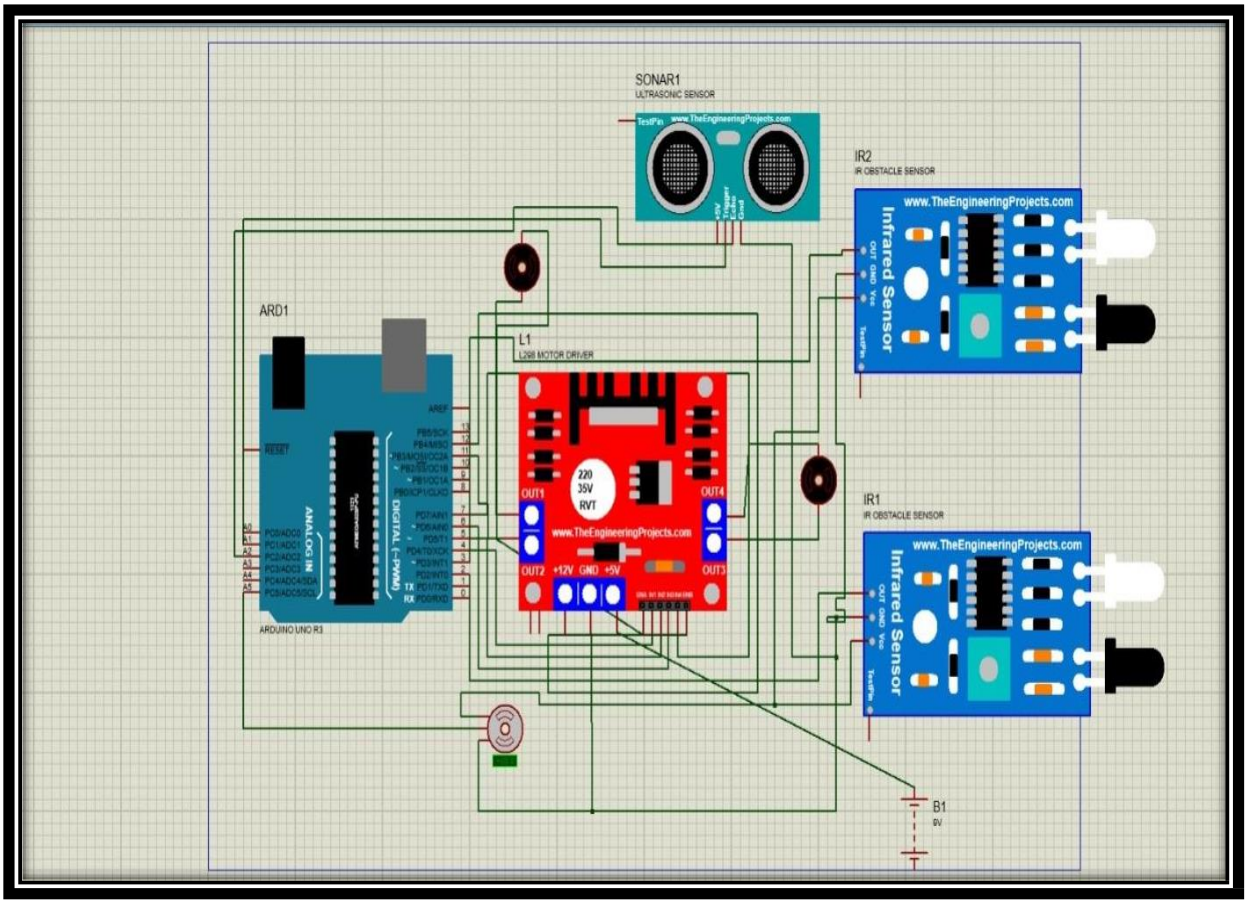
4.6 SERVO MOTOR

A **servo motor** is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor that runs through a **servo mechanism**. If the motor is powered by a DC power supply then it is called a DC servo motor, and if it is an AC-powered motor then it is called an AC servo motor. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages.

4.7 DC MOTOR

A magnetic field arises in the air gap when the field coil of the DC motor is energized. The created magnetic field is in the direction of the radii of the armature. The magnetic field enters the armature from the North pole side of the field coil and "exits" the armature from the field coil's South pole side. The conductors located on the other pole are subjected to a force of the same intensity but in the opposite direction. These two opposing forces create a torque that causes the motor armature to rotate.

CIRCUIT DIAGRAM



CIRCUIT DIAGRAM OF OBSTACLE DETECTOR AND LINE FOLLOWER ROBOT

WORKING

COMPONENTS REQUIRED FOR THE PROJECT:-

- Arduino UNO
- Motor driver
- Ultrasonic sensor
- IR sensor
- Servo motor
- 9v battery
- Chassis
- Jumper wires

SOFTWARE USED IN THE PROJECT:-

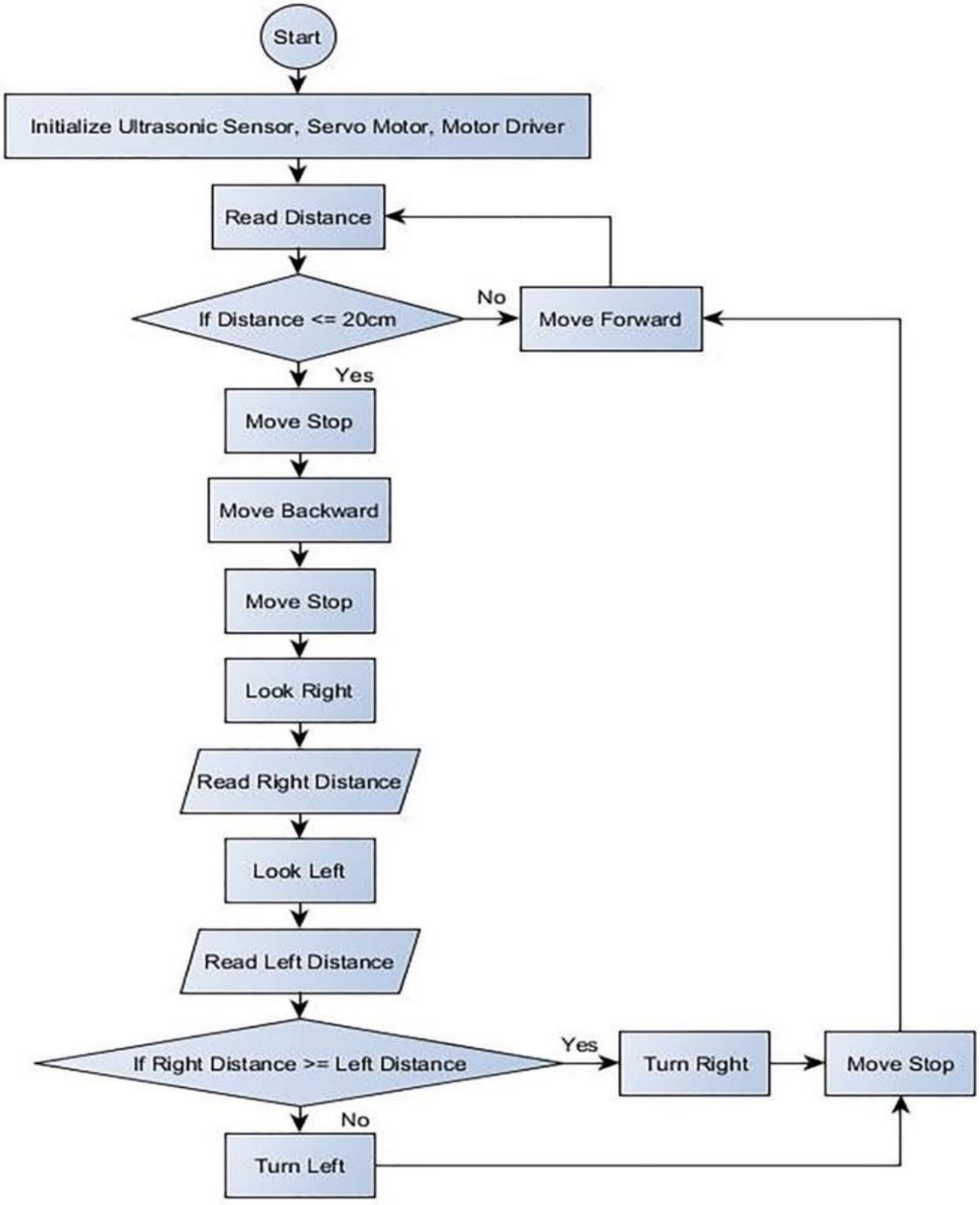
- Arduino IDE

For construction, firstly the Arduino needs to be programmed on its software and then the schematic model should be made on Proteus for the smooth working of the project. Once, these basicrequirements are fulfilled then we need to install Arduino code to the proteus layout and checkthe working of the project.

PINS:-

L289 PINS:-	IR SENSOR:-
enA(ENABLE1) - PIN 11	L_S - PIN 3
enA(ENABLE2) - PIN 12	
in1(MOTOR1) - PIN 4	R_S - PIN 2
in2(MOTOR1) - PIN 5	
in3(MOTOR2) - PIN 6	
in4(MOTOR2) -PIN 7	

ULTRASONIC SENSOR:- ECHO - PIN A2 TRIGGER - PIN A1	SERVO MOTOR:- PIN – A5


Start
Initialize Ultrasonic Sensor, Servo Motor, Motor Driver
Read Distance
If Distance <= 20cm
No
Move Forward
Yes
Move Stop
Move Backward
Move Stop
Look Right
Read Right Distance
Look Left
Read Left Distance
If Right Distance >= Left Distance
Yes
Turn Right
Move Stop
No
Turn Left

WORKING ALGORITHM:

- START
- INITIALIZE ROBOT
- CHECK LINE SENSOR INPUT
- IF LINE DETECTED
- FOLLOW LINE
- ELSE IF OBSTACLE DETECTED BY ULTRASONIC SENSOR
- STOP ROBOT
- DETECT DISTANCE
- TURN AROUND
- RETRY LINE FOLLOWING
- END

Explanation of the flowchart:

- The robot is initialized and ready to begin functioning.
- The line sensor input is checked to determine if the robot is currently on the line or has veered off course.
- If the line is detected, the robot will continue following the line until an obstacle is detected by the ultrasonic sensor.
- If an obstacle is detected, the robot will stop moving.
- The robot will then turn around and attempt to navigate around the obstacle.
- The IR sensor will detect the distance of the obstacle.
- The robot will then turn around and attempt to return to the line and resume line following.
- The flowchart ends when the robot has completed its task or is shut down.

The logics used in this flowchart are:

- Line Following Logic: The robot follows the line by detecting the contrast between the line and the surface using the line sensor.
- Obstacle Detection Logic: The robot uses the ultrasonic sensor to detect obstacles in its path and stops when one is detected.
- Obstacle Avoidance Logic: The robot uses the IR sensor to detect the distance of the

obstacle and determine its type (wall or object). If it's a wall, the robot avoids it using the ultrasonic sensor.

- Turning Logic: The robot turns around to navigate around the obstacle or to return to the line .
- Retry Logic: The robot retries line following after turning around and resuming its original direction.

ADVANTAGES:

- **OBSTACLE AVOIDANCE:** An obstacle detector allows the robot to sense and avoid obstacles in its path, which helps prevent collisions and damage to the robot or itssurroundings.
- **INCREASED SAFETY:** By detecting obstacles in real-time, the robot can take appropriate action to avoid them, thus minimizing the risk of accidents and ensuring the safety of users or by standards. This is especially important in scenarios where the robot operates near human a delicate object.
- **ENHANCED AUTONOMY:** An obstacle detector can enable the robot to operate autonomously without constant human intervention. The robot can make decisions on its own to navigate around obstacles and continue its intended path, allowing for efficient and uninterrupted operations.
- **IMPROVED EFFICIENCY:** Obstacle detection can help the robot optimize its path and avoid unnecessary detours, resulting in more efficient and faster navigations.
- **FLEXIBILITY IN NAVIGATION:** With obstacle detection, the robot can adapt to a changing environment and dynamically avoid obstacles, allowing in complex and dynamic environments.

LIMITATIONS:

- **LIMITED DETECTION RANGE:** The obstacle detection range robot is limited by the range of the sensor used. Depending on the type and quality of the sensor used, the robot may not be able to detect obstacles beyond a certain distance.
- **ENVIRONMENTAL INTERFERENCE:** The accuracy of obstacle detection can be affected by various environmental factors such as lightning conditions, shadows, and reflections. These factors interfere with the sensor's ability to detect obstacles accurately,leading to false readings or inaccurate obstacle avoidance.
- **LINE DEPENDENCY:** Obstacle-detecting line follower robots rely on following a pre-defined path or line to navigate through the environment. This means that the robot may not be able to navigate through the area without a visible line, making it unsuitable for certain applications or environments.

- **COMPLEX ENVIRONMENT:** In highly dynamic and complex environments, such as outdoor environments with varying an obstacle, the robot's ability to navigate and avoid obstacles can be limited.
- **MAINTENANCE AND UPKEEP:** These robots require regular maintenance and calibration to ensure accuracy in obstacle detection and avoidance. The sensor needs tobe cleaned and checked periodically, and the software need to be updated to ensure proper functionality.

Conclusion

This project developed an obstacle-avoiding robot to detect and avoid obstacles in its path. The robot is built on the Arduino platform for data processing and its software counterpart helped to communicate with the robot to send parameters for guiding movement. For obstacle detection, ultrasonic distance sensors were used that provided a wider field of detection. The robot is fully autonomous and after the initial loading of the code, it requires no user intervention during its operation. When placed in an unknown environment with obstacles, it moved while avoiding all obstacles with considerable accuracy. In order to optimize the movement of the robot, we have many considerations for improvement. However, most of these ideas will cost more money and time as well.

Done by-Urvashi