“Line Following Robot with Obstacle Avoidance”

Submitted as Second Year Mini Project 1B

by

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CERTIFICATE

This is to certify that the project entitled **"Line Following Robot with Obstacle Avoidance"** is a bonafide work of **"Vedant Jadhav (19), Ameya Roplekar (40), Nachiket Suryawanshi (49)** and **Sanket Zope (54)"** submitted to the V.E.S. Institute of Technology as a Second Year Mini Project 1B during Academic year 2021-22.

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Project Report Approval

This project report entitled **“Line Following Robot with Obstacle Avoidance”** by **Vedant Jadhav (19), Ameya Roplekar (40), Nachiket Suryawanshi (49) and Sanket Zope (54) is approved as Second Year Mini Project 1B** during academic year 2021-22

Examiners

1.

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INDEX

CHAPTER 1
INTRODUCTION

1.1 Problem Statement

The main aim of any robot is to reduce human effort. In any work environment proper monitoring is always needed for better results. This smart and intelligent line follower robot can be used in industries for carrying goods from one place to another. The main reason why this robot can be employed for transportation of goods is its fit and forget ability, which means that once the robot is placed on the desired path the working of the robot is totally automatic, there is no need for controlling the robot manually. This is what makes the line follower robot more efficient and useful when compared to other conventional robots. A traditional obstacle avoiding robots cannot help in transportation of goods because there is no particular path for the robot. It will move randomly by avoiding the obstacles and will not reach the required decision. Considering this factor line follower robot has more useful applications. This improves the working of the line follower robot, because in any work environment obstacles are common. This intelligent robot can also be installed for health care management in hospitals, which decreases the human effort in monitoring patients and delivering things or medicines.

CHAPTER 2
LITERATURE REVIEW

2.1 "M. Sri Venkata Sai Surya, K. Bhogeshwar Reddy, K. Pavan Kalyan and S. Senthil Murugan, "Smart and Intelligent Line Follower Robot with Obstacle Detection", International Journal of Research and Scientific Innovation, vol. V, pp. 1-6, 2018."

Line follower is an intelligent robot which detects a visual line embedded on the floor and follows it. The path is predefined and can be either visible like a black line on a white surface with a high contrast colour or the path can be a complex such as magnetic markers or laser guide markers. In order to detect these lines various sensors can be employed. Generally, infrared Sensors are used to detect the line which the robot has to follow. The robot movement is automatic and can be used for long distance application. Line follower can be modified by giving obstacle detection capability to it. 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 ultrasonic sensors, the line follower can detect an obstacle and can stop till the obstacle is removed.

2.2 "Aamir Attar, Aadil Ansari, Abhishek Desai, Shahid Khan, Dipashri Sonawale, "Line Follower and Obstacle Avoidance robot using Arduino", International Journal of Advanced Computational Engineering and Networking, vol. 5, pp. 18-21, 2017"

This paper is designed to build a line follower and obstacle avoidance robot using IR sensor and ultrasonic sensor. The IR sensor is meant to trace a particular line and ultrasonic sensors are meant to detect obstacles which it encounters. ROBOT has sufficient intelligence to cover the maximum area of space provided. It will move in a particular direction specified by the user and avoids the obstacle which is coming in its path. Autonomous Intelligent Robots are robots that can perform desired tasks in unstructured environments without continuous human guidance.

2.3 "Abhijit Pathak, Refat Khan Pathan, Amaz Uddin Tutul, Nishat Tahsin Tousi, Afsari Sultana Rubaba and Nahida Yeasmin Bithi, "Line Follower Robot for Industrial Manufacturing Process", International Journal of Engineering Inventions, vol. 6, pp.10-17, 2017."

Line follower robot is one kind of autonomous robot which follows a line until that line exists. Generally, the line is drawn on the floor. It can be either black or white. The line can also be normal visible colour or invisible magnetic field or electric field. The robot follows the line by using Infra-Red Ray (IR) sensors. There are five IR sensors which makes it an IR sensor array. These sensors read the line and send that reading to Arduino and then control the robot movement. In this paper, the authors will explain about the robot design, implementation, coding, testing, problems they faced and their solutions.

2.4 “Colak, I., Yildirim, D.,"Evolving a Line Following Robot to use in shopping centers for entertainment”, Industrial Electronics, 2009. IECON '09. 35th Annual Conference of IEEE, pp.3803 - 3807, 2009.

In this work the design of a Line Following Robot which is commonly used to carry children through shopping malls and entertainment places is discussed as a new commercial product in this field. The robot has five different speed levels, and is able to follow a 4.8 cm wide black line carrying nominally 400 kg load. The robot can be operated in two control modes; Line Following Mode and Service Mode.

2.5 “Surya prakash.M, Ajay Vignesh.K, Shyamsunthar.J, Raman.K, Senthil Raju.J, and Raju.N, "Computer Vision Assisted Line Following Robot", International Conference on Modeling, Optimization and Computing, 2012.

In this paper, we propose a method for a line follower robot based on the instantaneous computation of the radius of curvature of this line, using infrared line sensors. The number and layout of its sensors, as well as the method chosen, play an important role in the robot's response to the line, with the desired accuracy and speed. In addition, the robot must be equipped with an anti-collision system, using an ultrasonic distance sensor, to detect and avoid obstacles in several situations, especially at line crossovers, when other robots share a common complex line.

CHAPTER 3
BLOCK DIAGRAM & WORKING

3.1 Circuit Diagram

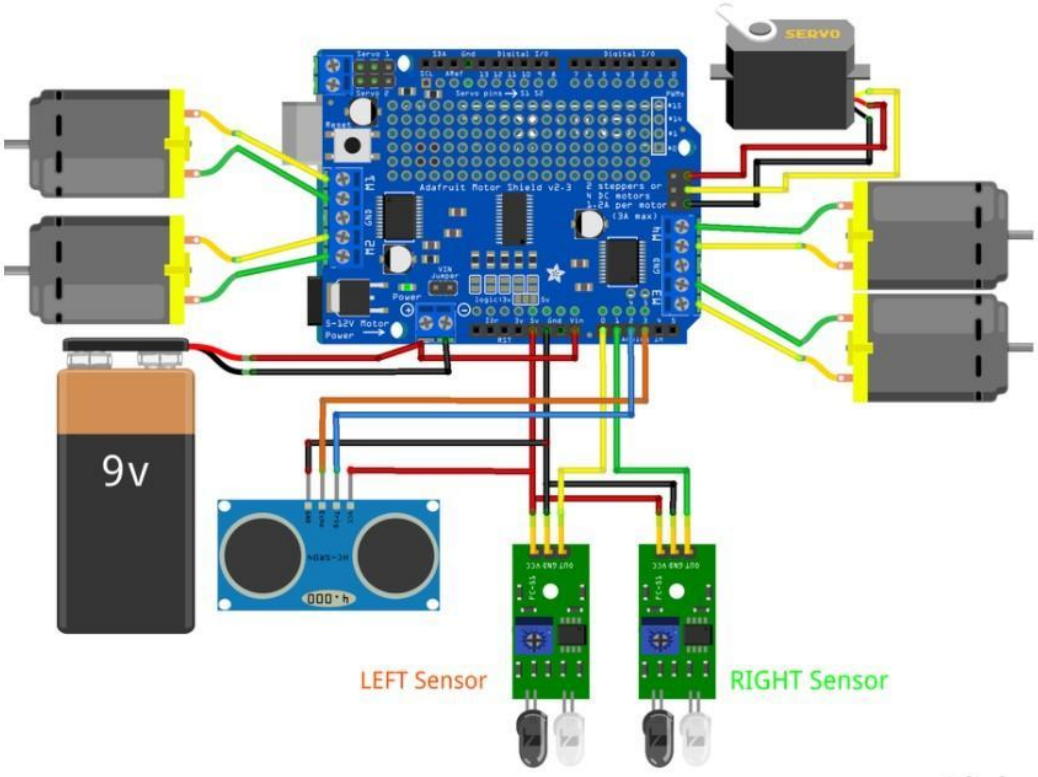


Fig 3.1 Circuit Diagram

3.2 Working

In this project, we have designed an Arduino based Line Follower Robot With Obstacle Avoidance. The working of the project is pretty simple: detect the black line on the surface and move along that line and if any obstacle present in that line moves around it and continues to follow a line. The detailed working is explained here.

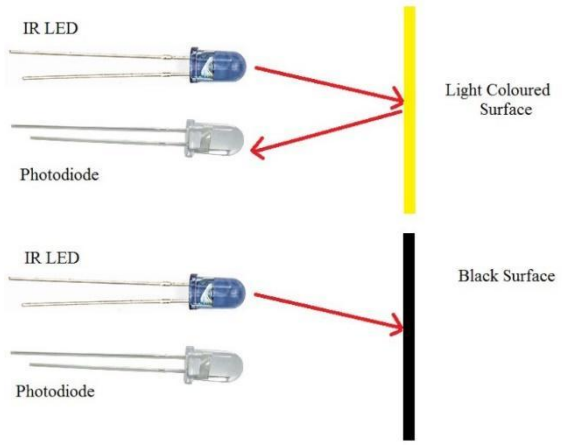


Fig 3.2.1 IR Sensor Working

The following image shows the working of a typical IR Sensor (IR LED – Photodiode pair) in front of a light-coloured surface and a black surface. As the reflectance of the light-coloured surface is high, the infrared light emitted by IR LED will be maximum reflected and will be detected by the Photodiode. In the case of black surface, which has a low reflectance, the light gets completely absorbed by the black surface and doesn't reach the photodiode.

Using the same principle, we will set up the IR Sensors on the Line Follower Robot such that the two IR Sensors are on either side of the black line on the floor. When the robot moves forward, both the sensors wait for the line to be detected. For example, if the IR Sensor 1 detects the black line, it means that there is a right curve (or turn) ahead. Arduino UNO detects this change and sends a signal to the motor driver accordingly. In order to turn right, the motor on the right side of the robot is slowed down using PWM, while the motor on the left side is run at normal speed.

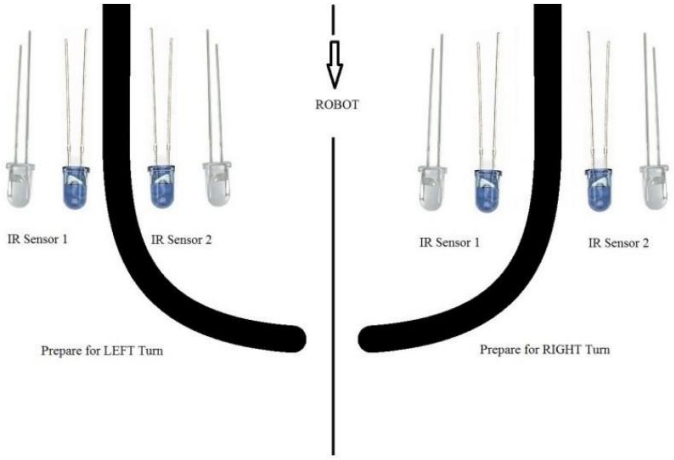


Fig 3.2.2 IR sensor Working

Similarly, when the IR Sensor 2 detects the black line first, it means that there is a left curve ahead and the robot has to turn left. For the robot to turn left, the motor on the left side of the robot is slowed down (or can be stopped completely or can be rotated in

opposite direction) and the motor

on the right side is run at normal speed. Arduino UNO continuously monitors the data from both the sensors and turns the robot as per the line detected by them.

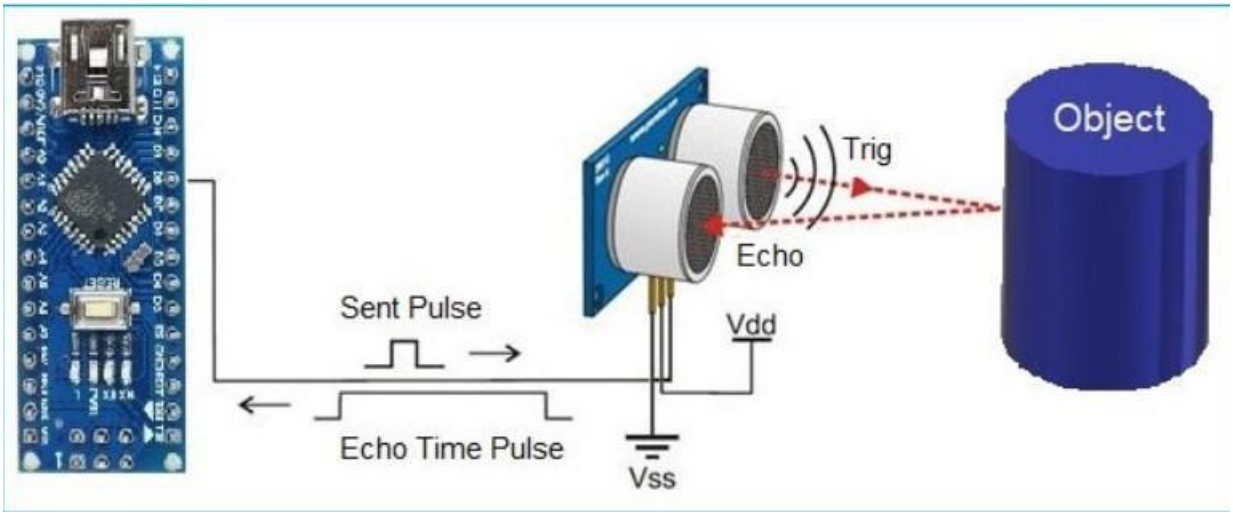


Fig 3.2.3 Ultrasonic sensor Working

The sonar system is used in HC-SR04 ultrasonic sensors to determine distance to an object like bats do. 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 the short and high frequency signal. If they detect any object, then they reflect back the echo signal which is taken as input to the sensor through the Echo pin. Firstly, users initialize Trigger and Echo pins as low and push the robot in forward direction. When an obstacle is detected Echo pin will give input as high to board.

Pulse In function is used for calculating the time of distance from the obstacle. Every time the function waits for the pin to go high and starts timing, then timing will be stopped when the pin goes low. It returns the pulse length in microseconds or when complete pulse was not received within the timeout it returns. The timing has been determined means it gives length of the pulse and will show errors in shorter pulses. Pulses from 10microseconds to 3 minutes in length are taken into consideration. After determining the time, it converts into a distance. If the distance of the object 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 will turn in backward direction and then can go in left or right direction.

CHAPTER 4
HARDWARE & SOFTWARE OVERVIEW

4.1 Hardware:

1. **<u>Arduino UNO</u>**: -

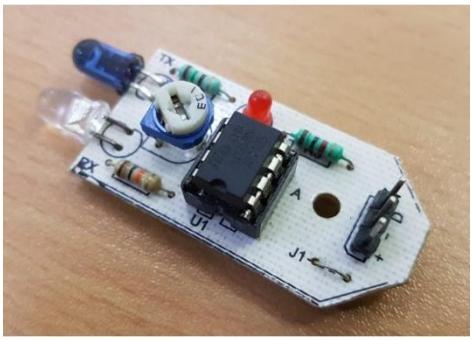
Specifications:

- Processor: 16 MHz ATmega328
- Flash memory: 32 KB
- Ram: 2kb
- Operating Voltage: 5V
- Input Voltage: 7-12 V
- Number of analog inputs: 6
- Number of digital I/O: 14 (6 of them pwm)

4.1 Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board and an IDE that runs on your computer, used to write and upload computer code to the physical board.

2. **<u>IR Sensor Module: -</u>**



4.2 IR Sensor

IR sensor is an electronic device that emits light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detect the motion. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiodes are sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

3. Motor Driver L298n: -

4.3 Motor Driver

We can control two DC motors with a single L293D IC. The L293D works on the concept of a typical H-bridge, a circuit which allows the high voltage to be flown in either direction. In a single L293D IC there are two H-bridge circuits which can rotate two DC motors independently. The module consists of two pairs of pins for connecting the two motors, a Vcc to supply external 5 Volts electricity to drive the motors, a GND for negative terminal. The motor driver consists of 4 pins p1, p2, p3 & p4 (which is input to this module & output from Arduino).

4. Ultrasonic Sensor:

4.4 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target). In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver.

5. Servo Motor: -

4.5 Servo Motor

A servo motor is an electromechanical device that produces torque and velocity based on the supplied current and voltage. A servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop. The feedback device supplies information such as current, velocity, or position to the servo controller, which adjusts the motor action depending on the commanded parameters.

6. Jumper Wires: -

4.6 Jumper Wires

A jump wire (also known as jumper wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

7. Motors: -

4.7 Motors

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

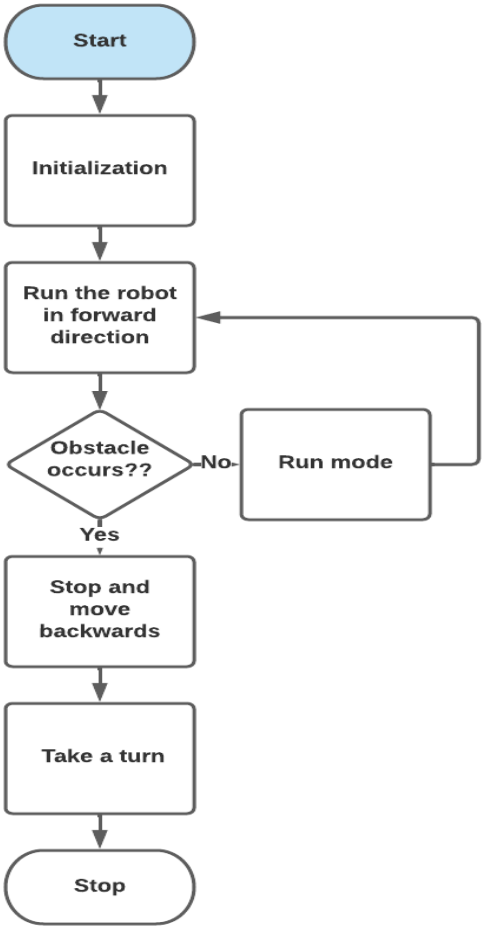
4.2 Software:

1. Arduino IDE:

4.2.1 Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

2. Flowchart:



4.2.2 Flowchart

3. Algorithm:

1. Start
2. Read left and right IR sensor value.
3. If the left and right IR sensor is on black surface Move forward (rotate all motors with same speed).
4. Go to step 2
5. If the left IR sensor is on white line and right is on black then Turn Left.
6. Go to step 2
7. If the right IR sensor is on white line and left is on black then Turn Right.
8. Go to step 2
9. If both the IR sensors are on the white line, it counts the crosses.
10. If any object is detected by an ultrasonic sensor, it stops and moves backwards till the previous cross.
11. To avoid the object and to move forward it takes a left turn and continues its path.

CHAPTER 5
RESULT AND CONCLUSION

6.1 Result

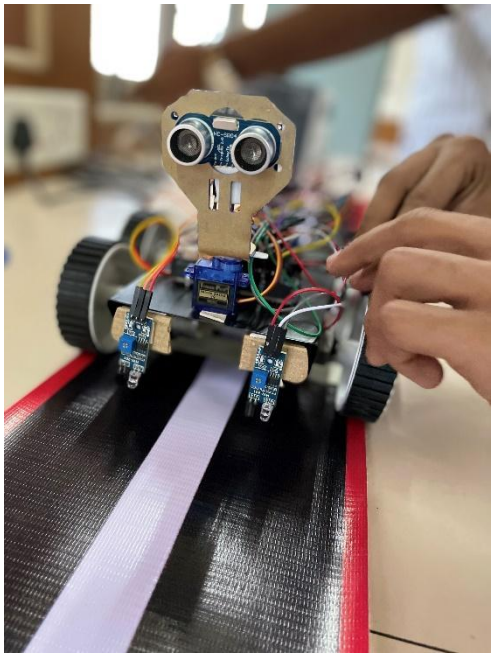


Fig 6.1 Final Working Model Fig 6.2

An obstacle avoiding line following robot is designed, developed and implemented that does not need any remote controller etc. This will run automatically following a given line using an Arduino microcontroller. This line follower robot is low cost but very effective for various purposes.

6.1 Conclusion

Our objective is to design a line follower and obstacle avoid robot designed for autonomous navigation along a white line on a black ground, using the concept of IR sensors. The robot can be given the location of the final destination and it accordingly chooses the path. It also avoids and chooses a new path if it is encountered by an obstacle in its path. Since the robot can be controlled by the user freely, it is more efficient. The ability to detect and avoid any obstacles makes it more suitable for a human friendly environment. The robot can be controlled using a WIFI module but in this technique, power consumption is more, so the battery will drain out quickly. Apart from these limitations, the smart, intelligent, and autonomous line follower robot can be used for very long-distance applications with a predefined path.

CHAPTER 7
REFERENCES

7.1 References

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