ISSN 2347 - 3983
Volume 11. No.11, November 2023
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter0311112023.pdf
https://doi.org/10.30534/ijeter/2023/0311112023

Line Follower with Obstacle Avoiding Robot

A. Sarada[1], Bhukya Saritha[2], V V L Kamakshi Likhitha[3], Jupaka Himavarshini[4], Mandala Akshethra[5]

[1] G. Narayanamma Institute of Technology and Science (for women), India, saradaaavula.ece@gnits.in
[2] G. Narayanamma Institute of Technology and Science (for women), India, 20251A0494@gnits.in
[3] G. Narayanamma Institute of Technology and Science (for women), India, 20251A04B9@gnits.in
[4] G. Narayanamma Institute of Technology and Science (for women), India, 20251A04A1@gnits.in
[5] G. Narayanamma Institute of Technology and Science (for women), India, 21255A0412@gnits.in

Received Date: September 30, 2023 Accepted Date: October 22, 2023 Published Date : November 07, 2023

ABSTRACT

An intelligent robot called a "line follower" finds and follows a visible line that is embedded in the floor. The predetermined route can be seen as a black line on a white background with sharply contrasted colours. It can recognize the existence of an obstruction and select a different route to its destination. The robot that detects a line and tries to move in the direction of the target can be programmed to follow instructions. Different sensors can be used to detect the line. The robot can identify the path it needs to take using infrared sensors. The ultrasonic sensor is a device that can detect the obstacle by measuring the distance using sound waves and avoiding collision.

Key words: Arduino, IR Sensor, Motor Driver, Servo Motor, Ultrasonic Sensor

1. INTRODUCTION

A line follower robot's main goal is to go following a clearly designated or visibly different line on the ground or floor. Physical lines, like a black line on a white surface or the opposite, can represent this line. To identify the line and make the appropriate modifications to its movement to stay on course, the robot needs sensors normally mounted on the front of the robot.

In addition to the line following, obstacle avoidance is another crucial feature incorporated into the robot. It allows the robot to detect obstacles or objects in its path and take appropriate actions to avoid collisions. Obstacle detection can be achieved using various sensors, such as ultrasonic and infrared sensors.
The combination of line following and obstacle avoidance enables the robot to navigate through complex paths, follow a line with curves and intersections, and avoid obstacles along the way.

To implement a line follower with obstacle-avoiding capabilities, the robot typically consists of a programmable board as its brain, sensors for line detection and obstacle detection, motors or wheels for movement, and drive the motors accordingly. Building a line follower with an obstacle-avoiding robot requires a combination of hardware and software skills, including electronics, programming, and sensor integration. It offers a practical and interactive way to learn about robotics, sensor technology, and autonomous navigation systems.

2. PRELIMINARIES AND RELATED WORKS

2.1. Line Following

2.1.1. Infrared Sensors: Infrared (IR) sensors are widely employed in line follower robots due to their simplicity, reliability, and cost-effectiveness. These sensors emit infrared light and measure its reflection to detect the presence or absence of a line. They consist of an IR emitter (usually an infrared LED) and an IR receiver (photodiode or phototransistor).

A. Working Principle: The IR emitter sends out infrared light, and the IR receiver measures how much of it is reflected off the surface[1]. When the sensor is positioned over a line, the reflected light intensity is significantly different from when positioned over a non-line area (floor or ground). The sensor measures this difference and provides an output signal based on the detected line.

B. Placement: Infrared sensors are usually mounted on the bottom of the robot, facing the surface[5]. Multiple sensors are commonly used to provide better line detection accuracy and enable tracking of wider lines or multiple lines simultaneously.

2.1.2. Ultrasonic Sensors: Ultrasonic sensors are another popular choice for line follower robots, particularly when combined with obstacle-avoidance capabilities. These sensors may be used to identify lines as well as objects using sound waves.

A. Working Principle: Ultrasonic sensors send out high-frequency sound waves that are normally above the range of human hearing, and they then time how long it takes for those waves to return after striking a surface or an item[1]. The sensor can identify the presence or absence of a line by examining the time delay.

B. Placement: Ultrasonic sensors are usually positioned at the front or sides of the robot, facing the surface or the area to be detected[5]. By angling the sensors, the robot can also detect the distance to obstacles and avoid collisions.

2.2. Obstacle Avoidance

2.2.1. IR Sensors: IR sensors use infrared light to transmit and receive it to detect the presence of barriers. In-line follower robots are frequently utilized for close-range obstacle detection. The sensor can gauge an object's closeness by analyzing the infrared light's intensity when it is reflected. IR sensors are effective in detecting objects within their limited range, typically up to a few meters. They are useful for detecting obstacles such as walls, furniture, or other stationary objects.

2.2.2. Ultrasonic Sensors: Ultrasonic sensors use sound waves to detect obstacles and measure distances[3]. They produce ultrasonic waves and the time how long it takes for the waves to return after colliding with an object. Ultrasonic sensors can provide distance measurements and are suitable for both short and medium-range obstacle detection.

2.3. Components

2.3.1. IR Sensor: The infrared (IR) sensors are made up of infrared (IR) photodiodes and LEDs. Infrared LEDs are referred to as photo emitters and photodiodes as receivers[4], [5]. The surface is hit by the IR light the LED emits, which is then reflected to the photodiode. The output voltage from the photodiode is then proportional to the surface reflectance, which is high for a light surface and low for a dark surface[5]. Dark objects reflect less IR light, while light objects reflect more IR light. Figure 1 shows the IR Sensor and its label.

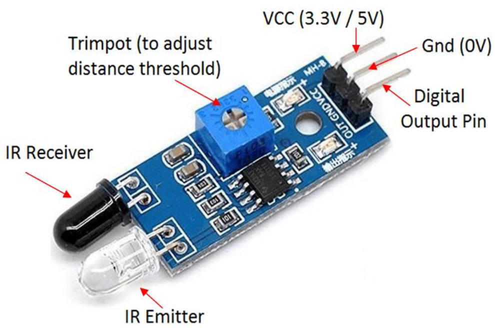

Figure 1: IR Sensor

2.3.2. HCSR04 Ultrasonic Sensor: An ultrasonic sensor comprises a transmitter (emits ultrasonic waves), a receiver (captures reflected waves), and a time-of-flight measurement circuit (calculates distance based on wave travel time). A gadget called an ultrasonic sensor uses sound waves to estimate the distance to an item. A sound wave at a specific frequency will be sent out, and the distance will be measured by listening to the sound wave as it returns. Figure 2 shows the HCSR04 Ultrasonic Sensor and its label.

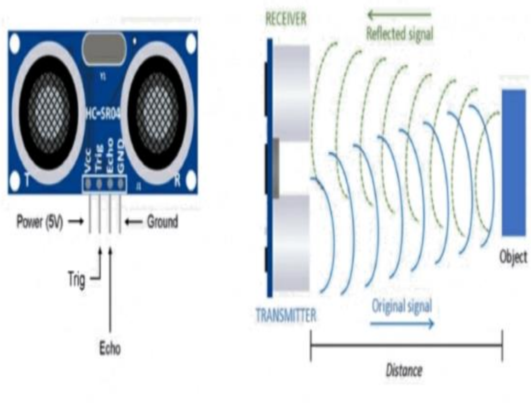

Figure 2: HCSR04 Ultrasonic Sensor

2.3.3. Arduino Uno: Arduino Uno includes a microcontroller (processes code and controls components), input/output pins (connect sensors and actuators), and analog/digital converters (convert signals between analog and digital domains). Based on the datasheet file at http://www.atmel.com/dyn/resources/prod_documents/doc8161.pdf the Arduino Uno is a microcontroller board. Figure 3 shows the Arduino Uno and its label.

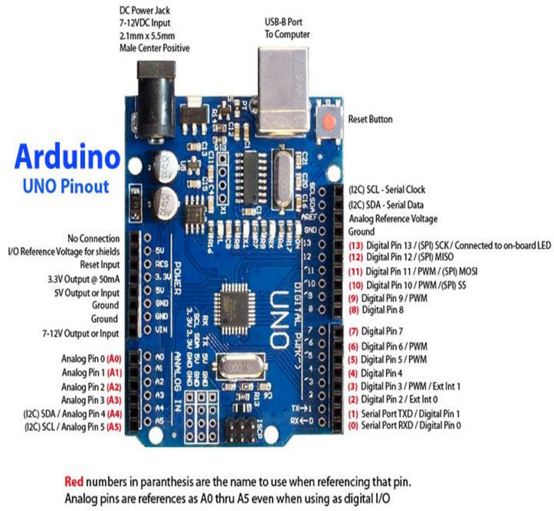

Figure 3: Arduino Uno

2.3.4. SG90 Servo Motor: The SG90 servo motor comprises a DC motor (generates rotational motion), gear train (amplifies motion), position feedback potentiometer (provides position feedback), and control circuitry (controls motor movement based on input signals)[6], [10]. Figure 4 shows the SG90 Servo Motor and its label.

Figure 4: SG90 Servo Motor

2.3.5. L298 Motor Driver: The L298 motor driver includes an H-bridge (controls the motor direction and speed), [9]input pins (receive control signals), output pins (connect to the motor), and current sensing/protection circuitry (monitors and protects against overcurrent or short circuits). This motor driver integrated circuit can control two motors at once[2]. The arrangement of motors is known as H-Bridge. An electronic circuit called an "H-Bridge-It" allows a voltage to be applied across a load in either way[6], [8]. It enables complete control of a conventional electric DC motor by a circuit. In other words, an H-bridge enables electronic control of the motor's forward, reverse, brake, and coast functions via a microcontroller, logic chip, or remote control[7], [11]. Figure 5 shows the L298 Motor Driver and its label.

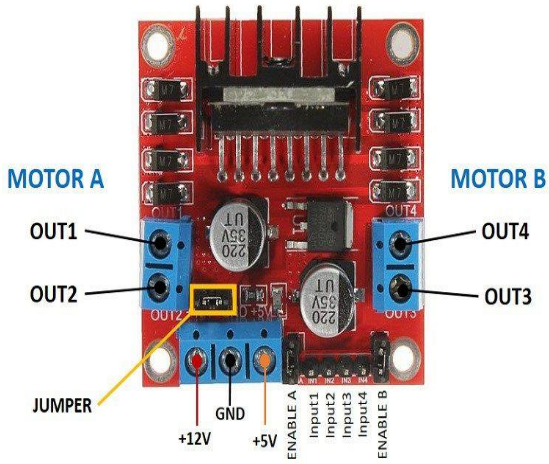

Figure 5: L298 Motor Driver

2.3.6. Jumper Wires: Jumper wires are simply lengths of wire with connector pins at either end, enabling the non-soldering connection of two sites. Jumper wires are widely used with breadboards and other prototype tools to making it simple to change a circuit as needed. Figure 6 shows the Jumper wires.

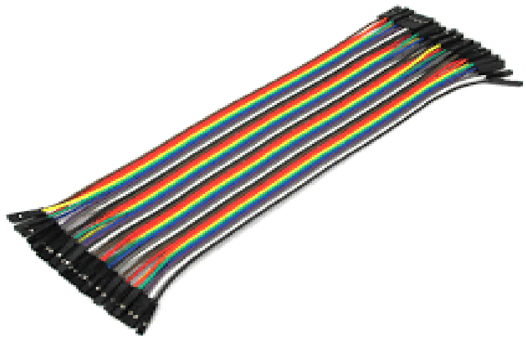

Figure 6: Jumper Wires

3. LITERATURE SURVEY

[1] Pakdaman, M.Sanaatiyan, M.M., "Design and Implementation of Line Follower Robot", Second International Conference on Computer and Electrical Engineering TCCEE '09, vol.2, pp.585-590, Dec. 2009.

[2] Román Osorio, "Intelligent Line Follower Mini-Robot System", International Journal of Computers, Communications & Control Vol. I, No.2, pp.73-83, 2006.

[3]https://www.researchgate.net/publication/327814718_PROJECT_EPORT_LINE_FOLLOWING_ROBOT

4. PROPOSED WORK

Obstacle avoidance is critical to designing an efficient and reliable line-follower robot. In a line follower system, the primary objective is for the robot to accurately follow a predefined path, typically marked by a contrasting line. However, in real-world scenarios, there may be unexpected obstacles that the robot needs to detect and navigate around to ensure uninterrupted operation. This is where obstacle avoidance techniques come into play.

The goal of obstacle avoidance in a line follower robot is to detect obstacles in its path and take appropriate actions to avoid them while still maintaining its primary objective of following the line.

Sensor-based Approach: In this approach, the robot is equipped with various sensors, such as proximity sensors or ultrasonic sensors, that can detect obstacles in its vicinity. These sensors supply the robot with distance data, enabling it to assess the existence and vicinity of obstacles[2], [3]. Based on this knowledge, the robot can modify its course to pass over the obstacles without deviating from the line.

In implementing obstacle avoidance for a line follower, it is crucial to strike a balance between avoiding obstacles and staying on the desired path. The robot should be able to detect and respond to obstacles promptly without deviating too far from the line it is following. Furthermore, robustness and reliability are essential considerations to ensure the robot's effectiveness in various environments and under different obstacle scenarios.

It's important to note that the specific implementation details and algorithms for obstacle avoidance in a line follower may vary depending on the hardware and software platform being used. Designing a successful obstacle avoidance system often requires iterative development, testing, and fine-tuning to achieve the desired performance. By incorporating obstacle avoidance techniques into a line follower robot, you can enhance its autonomy, safety, and reliability, enabling it to navigate complex environments while staying on track.

5. CONNECTIONS

Table 1: Connection Between Ultrasonic Sensor and Arduino

Ultrasonic Sensor	Arduino
GND	GND
ECHO	A3
TRIG	A5
VCC	VCC

Table 2: Connection Between Motor Driver and Arduino

Motor Driver	Arduino
N1	10
IN2	9
IN3	6
IN4	5
VCC/12V	Vin/5V
GND	GND
5V	5V

Table 3: Connection Between IR Sensor and Arduino

IR Sensor	Arduino
Sensor 1	
VCC	VCC
GND	GND
OUT	A0
Sensor 2	
VCC	VCC
GND	GND
OUT	A1

Table 1 shows the connection between the Ultrasonic sensor and Arduino. Table 2 shows the connection between the Motor Driver and Arduino. Table 3 shows the connection between IR Sensor and Arduino[2].

6. BLOCK DIAGRAM

Figure 7 shows the block diagram which gives the connection to the components.

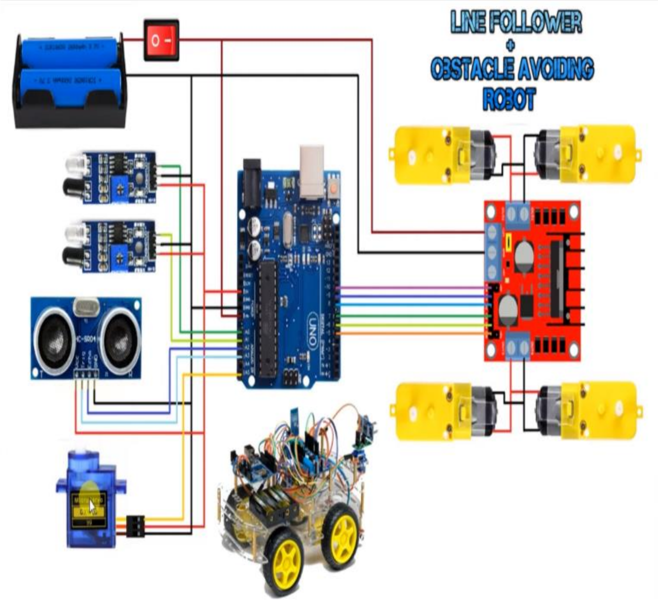

Figure 7: Block Diagram

7. RESULTS AND DISCUSSION

Here are some of the challenges that I faced during the project:

- The first challenge was getting the robot to follow the line accurately. I had to adjust the sensitivity of the infrared sensors and the speed of the motors until I found a combination that worked well.

- The second challenge was getting the robot to avoid obstacles. I had to adjust the sensitivity of the ultrasonic sensor and the speed of the motors until I found a combination that allowed the robot to safely avoid obstacles without crashing.
- The third challenge was making the robot move smoothly. I had to adjust the PID values of the motors until I found a combination that allowed the robot to move smoothly and accurately.

These difficulties were overcome by me through research, experimentation, and perseverance. Figure 8 shows the Line Following Robot, where black line is follows the robot on the white surface. I gained a lot of knowledge from working on this project, and I do not doubt that I will be able to use it in the future to build even more intricate and advanced robots. Figure 9 shows the Front view of the robot.

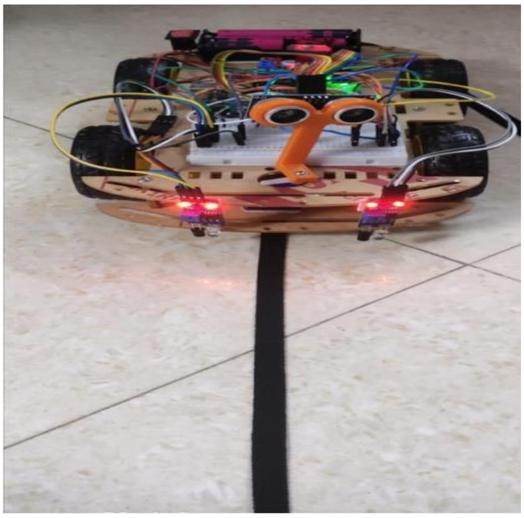

Figure 8: Line Following robot

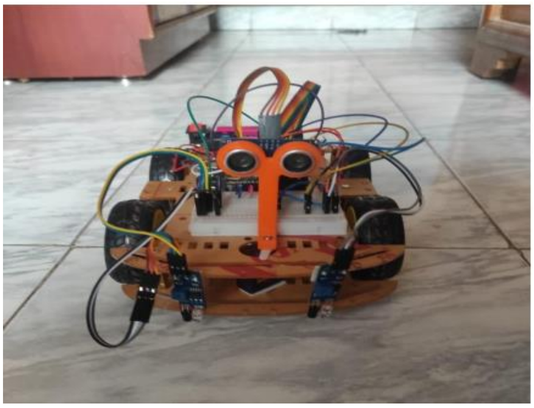

Figure 9: Front view of the robot

The endeavor to develop a line-following robot that can avoid obstacles was successful. The robot proved successful in avoiding obstacles and following a black line on a white surface. An Arduino Uno microcontroller, two infrared sensors, and an ultrasonic sensor were used to create the robot. The ultrasonic sensor was used to identify obstructions, while the infrared sensors were utilized to identify the black line. The robot was moved using an Arduino Uno microcontroller.

A black line on a white surface could be accurately followed by the robot. Even when the line was bent or there were other challenges in its route, it was able to maintain its position. The robot was also quite successful at dodging obstacles. It could recognize obstructions in its path and move evasively to avoid them. Figure 10 shows the Obstacle Avoiding Robot.

Figure 10: Obstacle Avoiding Robot

The successful implementation of obstacle avoidance in a line follower robot requires a careful balance between avoiding obstacles and staying on track. The robot should be able to swiftly detect and respond to obstacles without deviating too far from the intended path. By continuously improving algorithms, sensors, and control systems, researchers and engineers can enhance the robot's performance, adaptability, and robustness, enabling it to navigate complex environments with agility and accuracy. With further advancements in artificial intelligence and robotics, we can anticipate even more sophisticated line-follower robots capable of handling intricate obstacles and performing intricate tasks autonomously.

8. CONCLUSION

By implementing sensor-based systems the robot can detect obstacles in its path and make appropriate decisions to navigate around them while still adhering to the desired line. The robot's adaptability is increased and its potential uses are expanded thanks to this integration. The initiative to build a line-following robot with obstacle avoidance is an excellent illustration of how basic technologies may be leveraged to build a functional and adaptable robot.

REFERENCES

1. https://www.researchgate.net/publication/351942942
2. https://www.hackster.io/embeddedlab786/line-follower-with-obstacle-avoiding-robot-9ee707
3. V. Saini, Y. Thakur, N. Malik, and S. N. M, "Line Follower Robot with Obstacle Avoiding Module," 2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), Greater Noida, India, 2021, pp. 789-793, doi: 10.1109/ICAC3N53548.2021.9725364.
4. https://fdocuments.in/document/smart-and-intelligent-linefollower-robot-with-obstacle-actors-line-follower.html
5. Pakdaman, M, Sanaatiyan, M.M., “Design and Implementation of Line Follower Robot”, Proceedings of IEEE conference, pp 2-4, Dec. 2009.
6. Ikalogic.com, “Robot Driving Mechanism”, Retrieved on November 18, 2010 From the World Wide Web: http://www.ikalogic.com/tut_mech_1.php
7. Icreator.wordpress.com, “Differential Driving Mechanism”, Retrieved on November 10, 2010, From the World Wide Web: http://icreator.wordpress.com/
8. Vibhor Gupta, "Working and Analysis of the H – Bridge Motor Driver Circuit Designed for Wheeled Mobile Robots", IEEE, 2010.
9. Ikalogic.com, “Robot Driving Mechanism”, Retrieved on November 18, 2010 From the World Wide Web: http://www.ikalogic.com/h_bridge_old.php
10. Luckylarry.co.uk, “DC Motor & H-Bridge Connections”, Retrieved on November 18, 2010 From the World Wide Web: http://luckylarry.co.uk/arduino-projects/control-a-dc motor-with-arduino-and-l293d-chip/
11. Claudio Miklo, “DC Motor & H-Bridge Connections”, Retrieved on November 18, 2010 From the World Wide Web: http://www.miklos.blog.br/2009/11/controlar-motores dc-com-l293d.htm