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Line Follower Robot with Obstacle Detection and Evasion

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ABSTRACT: “Line follower is a smart autonomous robot that detects or follows a visible line embedded in the ground. The trail is predetermined and can be selected with a high contrast color or with a black line visible on the trail surface. Infrared sensors are used to detect these lines. Typically speaking, the area unit of the infrared sensors is used to locate the path that the robot has to follow. The robot movement is automatic and can be used for applications of long distances. It is the fundamental line follower robot’s function. The device proposed for commercial, medical, rescue and military operations are extremely useful. In particular, these past constraints are no longer necessary with recent technological advances in computing. The production of tracking systems can now be made more capable of reliably estimating the target location behind the obstacle. The benefit of these technologies consists in the possibility of using an ultrasonic method for measurement without direct contact with a target. Different models and systems for indoor and outdoor object detection have been described in the literature. Using optical, heat base, infrared and ultrasonic approaches, object localization techniques were introduced. Indoor positioning systems monitor and locate objects and enclose environments inside buildings. Wireless methods, optical tracking, and ultrasonic techniques are used for object position detection systems. The goal of this study is to develop a monitoring system that follows certain paths and can detect objects and edges using ultrasonic frequencies. If some object is put, a regular line follower will try to move and smash the obstacle. This prototype of line follower robot tries to push the limit little to overcome this issue. It has been built in a way that any obstacle in front of it can be identified. It will stop and will not pass until the barrier remains. Also, it is able to identify every front edge and comply similarly. In industries, such as material handling, this type of robot performs many tasks.

KEYWORDS: Line Follower; Obstacle Detection and Evasion ;Ultrasonic Sonar Sensor; IR Sensor.

I.INTRODUCTION

Robotic systems have gained immense popularity in various domains owing to their versatility and efficiency. Among these, line-following robots represent a fascinating intersection of robotics, automation, and artificial intelligence. Designed to navigate along a predefined path, these robots utilize sensors to detect and follow lines on the ground, making them ideal for applications such as warehouse automation, transportation systems, and even educational platforms. In this paper, we present a comprehensive overview of a line-following robot equipped with obstacle detection and evasion capabilities. Combining the principles of line following with obstacle avoidance enhances the robot's adaptability and safety in dynamic environments, making it suitable for real-world applications where unexpected obstacles may arise.

Line Following

Line following is a fundamental concept in robotics, wherein a robot is programmed to track and follow a designated path marked by contrasting colors or patterns on the ground. Typically, line-following robots employ infrared sensors or cameras to detect these lines and adjust their movements accordingly. By interpreting sensor data, the robot can maintain its position relative to the line, ensuring precise navigation along the desired route.

Obstacle Detection and Evasion

While line following enables efficient navigation along a predefined path, the presence of obstacles poses a significant challenge to the robot's autonomy and safety. Therefore, integrating obstacle detection and evasion capabilities

becomes imperative to enhance the robot's robustness in dynamic environments. Various sensor technologies, including ultrasonic sensors, LiDAR, and computer vision systems, can be employed to detect obstacles in the robot's vicinity. Upon detecting an obstacle, the robot must formulate an appropriate evasion strategy to circumvent the obstruction while staying on course with the designated path.

II. LITERATURE SURVEY

This line following robot, which is a part of agv (automated guided vehicle), an autonomous robot in a simple term, can detect black or white lines to follow them. Students have been developing this kind of robots for a while. But the basic concept has always been the same [1]. These robots determine the black or white line using infrared rays. And makes its path following that line. As the robot works fully autonomously engineers have tried to bump up its abilities to make it more reliable for practical usage in various sectors. Making it capable of avoiding obstacles [2]. This line following robot, which is a part of agv (automated guided vehicle), the autonomous robot in a simple term, can detect black or white lines to follow them. But research has been done to make them capable of following any color [3]. light sensors based on led or ldr and rfid based verification systems have been used to upgrade the line follower robot to that level. How a line following robot runs is based on the sensor value it gets from the sensors. The correct sensor value leads to the correct result. That's why it's important to have an accurate idea of those sensor data and so on. That is what the researchers have done. They not only built their line follower robot prototype but also went through those data. Based on which the robot takes its decisions [4]. Line follower robot competition held commonly to encourage students more about it [5]. Path planning is the most crucial part of the line follower robot. As it is autonomous, it has to make the decision based on the path. Most robots can follow a straight or round-shaped path. However, vital part is to let it take its decision when there is more than one path to go and they are of different Shapes obviously [6].

III. RELATED WORK

The related work for a line follower robot with obstacle detection and evasion typically involves research and projects in the field of robotics, computer vision, and artificial intelligence. Here are some common themes and approaches you might find in related work: Line Following Algorithms^[1]: Explore different algorithms for line following, such as PID control, fuzzy logic, or neural networks. Researchers often compare the performance of these algorithms in terms of speed, accuracy, and robustness to changes in lighting conditions or track patterns. Obstacle Detection Techniques^[2]: Investigate various methods for detecting obstacles in the robot's path, including ultrasonic sensors, infrared sensors, LiDAR, or computer vision techniques like object detection with cameras. Researchers may assess the effectiveness of these techniques in different environments and with various types of obstacles. Obstacle Avoidance Strategies^[3]: Study strategies for navigating around obstacles once they are detected. This could involve path planning algorithms like A* or Dijkstra's algorithm, reactive approaches like potential fields, or machine learning techniques for learning obstacle avoidance behaviors. Integration of Line Following and Obstacle Avoidance^[4]: Examine how line following and obstacle avoidance can be combined seamlessly in a single system. Researchers might propose architectures or frameworks for integrating these functionalities, ensuring smooth transitions between line-following mode and obstacle-avoidance mode. Hardware Implementations^[5]: Discuss the hardware components used in building the robot, including motors, sensors, microcontrollers, and power systems. Researchers may evaluate different hardware configurations for their cost, reliability, and performance. Real-World Applications^[6]: Explore practical applications of line follower robots with obstacle detection and evasion, such as in warehouse automation, agriculture, or search and rescue missions. Researchers may conduct experiments or simulations to demonstrate the effectiveness of their approach in real-world scenarios.

METHODOLOGY

1. Read the ultrasonic sensor to get the distance in front of the robot.
2. Print the distance value to the serial monitor.
3. Check if both the right and left line sensors detect white color:
 - a. If true:
 - If true, call the forward function.
 - If false, call the Check_side() function.
4. If the right sensor detects black and the left sensor detects white:
 - a. Call the turnRight() function.
5. If the right sensor detects white and the left sensor detects black:
 - a. Call the turnLeft() function.

6. Add a delay of 10 milliseconds.

IV. BLOCK DIAGRAM AND WORKING

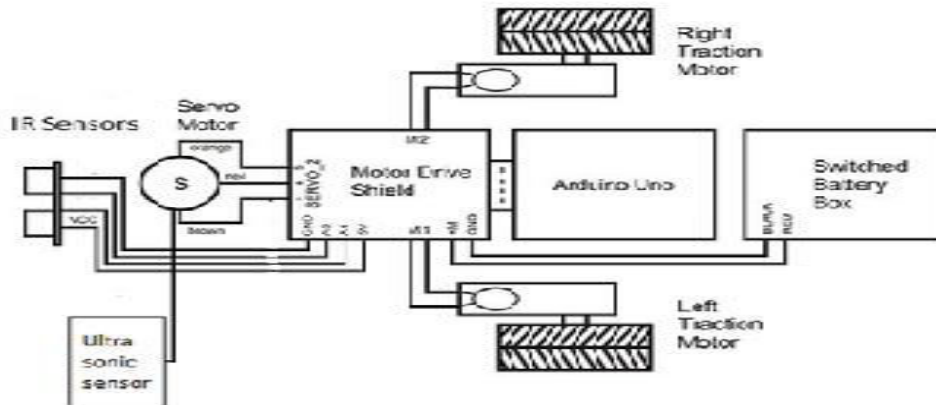


Fig (a): Block Diagram

The working of a line follower robot involves several key steps. Here is a general overview of how a line follower robot operates:

In this it shows the decision making process of the robot. First of all, the robot will not start the movement after turning on the power. The first thing it will do is to search for a black line. If the robot finds the black line, then it will move forward. When it's way to moving forward by following the black line it will search for obstacle and evasion takes place in its path in every moment. It will smoothly move forward whenever the black line is available and if there is no obstacle. If the black line is not available, it will stop. When black line is available but the robot faces any obstacle, then it will immediately take diversion and follows its original path. If the black line is available and the obstacle is removed with , then the robot will continue to move forward again. Finally, if there is no further path robot comes back at certain distance and stops then buzzer alarm signal is sent, then the robot will completely stop and again if robot resets it again tracks its position.

V. COMPONENTS



Fig(a) IR Sensor



Fig (b): Motor Driver L298N



Fig (c): Servo Motor



Fig(d): BO Motors



Fig (e):Battery



Fig (f): Ultrasonic Sensor



Fig (g): Buzzer

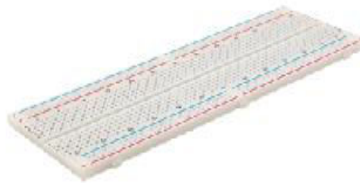


Fig (h): Bread Board

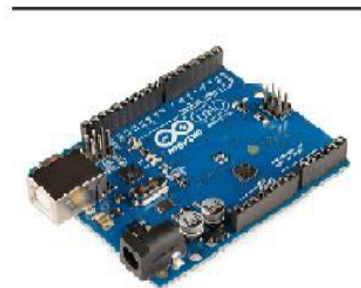


Fig (I): Arduino UNO

VI.EXPERIMENTAL RESULTS

A LINE FOLLOWER ROBOT EQUIPPED WITH OBSTACLE DETECTION AND EVASION CAPABILITIES IS A VERSATILE AND EFFICIENT DEVICE. IT COMBINES THE PRECISION OF LINE-FOLLOWING ALGORITHMS WITH THE ABILITY TO DETECT OBSTACLES IN ITS PATH. WHEN AN OBSTACLE IS DETECTED, THE ROBOT EMPLOYS EVASION STRATEGIES SUCH AS MANEUVERING AROUND THE OBSTACLE OR FINDING AN ALTERNATIVE ROUTE TO CONTINUE FOLLOWING THE LINE. THIS ENHANCES ITS ADAPTABILITY AND MAKES IT SUITABLE FOR NAVIGATING COMPLEX ENVIRONMENTS WITH EASE, MAKING IT A VALUABLE TOOL IN VARIOUS APPLICATIONS, INCLUDING INDUSTRIAL AUTOMATION, LOGISTICS, AND ROBOTICS COMPETITIONS.



Fig (j): Line Follower Robot

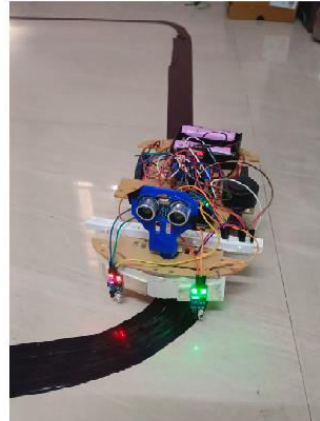


Fig (k): Path Detection of Line Follower Robot

Fig (j), shows the line follower robot is an autonomous robot design with various microcontroller units such as Arduino UNO, IR Sensors, Ultrasonic Sensors, DC Motors, Motor Shield, Battery, Bread Board, Buzzer. Fig (k), shows the path detection typically marked on floor or a surface in a specified path. Therefore, this robot follows and detects the path with the help of IR sensor and detects the objects with the help of ultrasonic sensor.

VII. 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.

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