Obstacle Detection and Avoiding Robot using Arduino and Ultrasonic Sensor

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Abstract - self-governing system that can identify and steer clear of impediments in real time is known as an obstacle-avoiding robot. Actuators are used for movement, a microcontroller is used for data processing, and sensors like ultrasonic or infrared modules are used to sense its environment. These machines are widely employed in a variety of fields, including healthcare, exploration, industrial automation, and service robotics. The main objective is to guarantee effective, collision-free navigation, improving operational dependability and safety. The intelligence and flexibility of obstacle-avoiding robots are being enhanced by developments in artificial intelligence and sensor technology, which makes it possible to employ them in settings that are becoming more dynamic and complicated.

Keywords— obstacle, microcontroller, ultrasonic sensor , Arduino, encoder

I. INTRODUCTION

A.Introduction to obstacle avoiding robot.

Identification and avoidance of obstacles Autonomous devices known as robots are made to move through their environment without running into barriers. These robots are crucial in a variety of applications where safe and effective mobility is needed, such as automation, logistics, and home help.

The central control unit of this project is an Arduino microcontroller, and impediments are detected using ultrasonic sensors. High-frequency sound waves are emitted by ultrasonic sensors, which then time how long it takes for the echoes to return after striking an item. This time is calculated to find the distance to the obstacle.

In order to ensure that the robot stays safe and avoids obstacles, the Arduino analyzes the sensor data and applies pre-programmed instructions to control its motions. The practical application of sensor-based navigation is demonstrated by this project.

II. LITERATURE SURVEY

Microcontroller based robot: Sensor fusion is the process of integrating the data into a form that may be used to make navigational decisions. The navigation system developed for a mobile robot working in a warehouse is described in this study with an emphasis on the sensory system in use. Perception and dead reckoning are combined in a hybrid navigation system that provides good functioning. A mobile robot's navigation while dodging obstacles is managed by a microcontroller system. The operation algorithms for a system of 24 ultrasonic sensors were described.

IR based Robot: In order to achieve long-term robotic activity without human involvement, this paper proposes a way for autonomous navigation of a mobile robot, an idea that can be expanded upon. An IR receiver is attached to an 8051 microcontroller robot, and an IR transmitter is made out of an IR LED and a NE 555 timer (a standard remote). Over the course of 50 trials, the system was modified and enhanced to withstand environmental obstacles and incorporate obstacle avoidance, finally leading to a navigation success rate of 93%.

*Ultrasonic sensor robot:*The Arduino Uno microcontroller, a Wi-Fi module, and an Arduino motor shield driver—which regulates the robot using geared dc motors—are used in the system's implementation. The technology performed well in a range of illumination scenarios. Results from experiments with different obstacle positions demonstrate the robot's ability to avoid obstacles and its respectable performance in our lab. Because it only requires one distance detecting element, the sensing element system is incredibly inexpensive, and the robot is also prepared to recognize victims before it

III. EXISTING WORKS

1. *Control Based on Microcontrollers*: A microprocessor, usually an Arduino board like the Arduino Uno or Mega, is at the heart of the obstacle-avoiding robot. As the system's brain, the microcontroller processes sensor data and communicates control signals to the motors. It uses an algorithm that has been developed to decide how the robot should respond to impediments, such as stopping, turning, or changing course.

2. *Integration of Sensors*: In order to detect obstacles, sensors are essential. Ultrasonic sensors, like the HC-SR04, are often used sensors that employ sound waves and their reflections to determine the distance between the robot and obstacles. The robot also uses proximity and infrared (IR) sensors to identify items in its route. LiDAR or depth cameras are examples of advanced technology that can provide accurate.

3. *Motor Regulating*: DC motors or servo motors are used by the robot to move and steer. To enable smooth and controlled operation, motor driver modules such as L298N or L293D are used to manage the power provided to the motors. To change the robot's speed or direction, the microcontroller uses sensor inputs to send signals to the motor drivers.

4. The Algorithm for Obstacle Avoidance: The Arduino IDE is used to program an obstacle avoidance algorithm that is executed by the microcontroller. primitive reasoning, like "if distance < threshold, turn left or right," may be used for primitive robots. To anticipate and avoid obstacles more effectively, sophisticated systems can employ machine learning models or path-planning algorithms.

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A. Limitations of Existing Systems

Although useful for simple tasks, the techniques employed in obstacle-avoiding robots have a number of drawbacks. Complex algorithms cannot be handled by microcontroller-based control due to its limited computational capacity and multitasking capabilities. Multiple sensors are necessary for complete coverage because of the accuracy problems, short range, and narrow detection fields of sensors like ultrasonic and infrared. Basic obstacle avoidance algorithms are useless in dynamic contexts because to their reliance on simple logic, while motor control may experience inefficiencies, excessive battery consumption, and imprecise feedback. Another difficulty is power management, as performance is impacted by uneven voltage regulation and short battery life. Maintenance issues, environment dependence, and instability

are some of the limits of mechanical design. Bluetooth and Wi-Fi communication modules are susceptible to latency, interference, and security threats.

A. Proposed System

An Arduino microcontroller and an HC-SR04 ultrasonic sensor are used in the suggested approach for obstacle identification and avoidance in order to create an economical and effective robotic system. By measuring the time it takes for the ultrasonic waves to reflect back, the ultrasonic sensor determines the distance between the robot and any obstruction. After processing this distance data, the Arduino decides if the obstruction is within a predetermined threshold, such as 15 cm. The robot advances if it detects no obstacles. However, the robot halts, determines a new course, and turns left or right before rechecking the path and continuing onward motion if a barrier is inside the threshold. The system uses a motor and is powered by a rechargeable battery.

IV. HARDWARE

Arduino Uno: The ATmega328P is the foundation of the Arduino Uno microcontroller board. By reading data from sensors (such as the ultrasonic sensor) and managing outputs like motors, it acts as the central processing unit. The Arduino IDE can be used to program it to carry out the obstacle avoidance logic.

Ultrasonic Sensor (HC-SR04): This sensor uses ultrasonic technology to identify obstacles. The robot can determine the distance to objects in its path by sending out ultrasonic waves and timing how long it takes for the waves to return after hitting an obstruction.

Breadboard: Without soldering, circuits can be constructed and tested using a breadboard. It enables you to rapidly prototype the wiring of parts like motor drivers, sensors, and Arduino.

Electrical connections between sections of the circuit, such as the Arduino, motor driver, ultrasonic sensor, and others, are made via connecting wires. Usually available in a range of lengths, these wires are either directly linked to the components or placed into the breadboard.

Motor Driver (L293D): This well-known integrated circuit (IC) enables the Arduino to regulate the speed and direction of DC motors. By supplying the required current and voltage to run the motors, it serves as an interface between the high-power motors and the low-power Arduino.

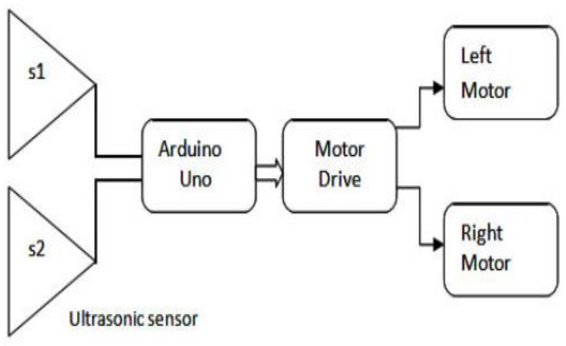
DC Motor: The robot is moved by use of DC motors. Depending on the signals from the motor driver, these motors transform electrical energy into mechanical motion, enabling the robot to move forward, backward, or turn.

Arduino to USB Cable: This cable allows the Arduino Uno to be connected to a computer for serial communication and programming. In addition to carrying data from the Arduino IDE to the Arduino board, this wire can be used to power the board while it is being developed.

Battery Pack: The power required to operate the motors and Arduino is supplied by a battery pack. To guarantee the robot runs on its own, a Li-ion or Li-poly rechargeable battery pack is typically utilized. In order to guarantee that the Arduino and motor driver receive the proper voltage, voltage regulators are frequently utilized.

V. METHODOLOGY

Block Diagram



Fiq.1.Block diagram of obstacle avoiding robot

Several crucial steps are involved in the process of building an obstacle detection and avoidance robot with an Arduino and an ultrasonic sensor:

1. Configuration of Hardware

Obtaining and configuring the required hardware components is the first step. The HC-SR04 ultrasonic sensor is attached to the Arduino Uno, which serves as the main controller, in order to detect obstacles. To control the robot's movement, DC motors are attached to a motor driver (L293D), which communicates with the Arduino. The battery pack powers the entire system, while the breadboard and connecting wires are utilized to build the required electrical connections.

2. Integration of Sensors and Motors

The robot's front is equipped with the HC-SR04 ultrasonic sensor, which is connected to the Arduino. The sensor is in charge of sending out ultrasonic waves and timing how long it takes for them to return after hitting an obstruction. The robot's distance from the obstacle is determined using this information. The DC motors, which enable the robot to move in response to sensor inputs, are controlled by the L293D motor driver.

3. Arduino coding

This step involves writing the code that controls the robot's actions using the Arduino IDE. The software checks distance data against a preset threshold after reading it from the ultrasonic sensor. The robot stops when it detects a barrier (i.e., when the distance is less than the threshold), changes course (typically by turning), and then resumes its journey once the path is unobstructed. To regulate obstacle detection and movement, basic control logic is employed, such as loops and if-else expressions.

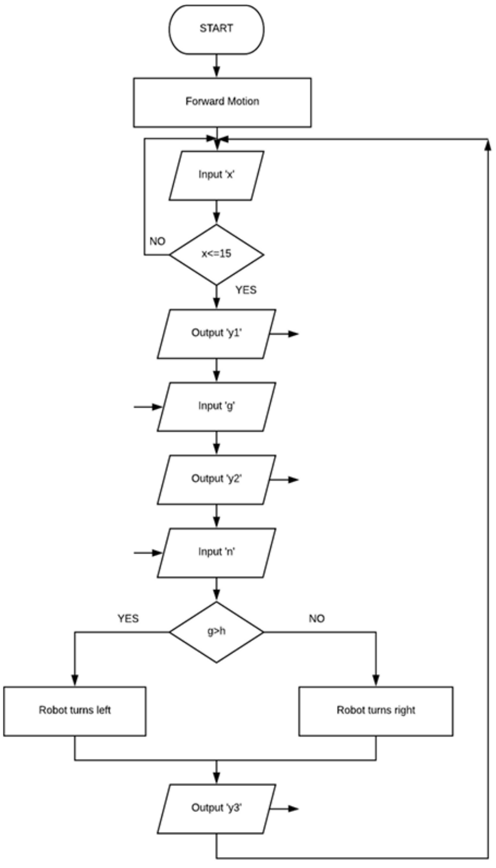


Fig.2.Flowchart of internal code

4. Calibration and Testing

The system is tested after the code has been uploaded to the Arduino and the hardware has been put together. The robot is positioned in an obstacle-filled environment, and its reaction is monitored. The location of the sensors, threshold values, or motor control logic are changed if the robot exhibits unpredictable behaviour or is unable to detect impediments effectively. Optimizing the system guarantees dependable and seamless obstacle avoidance.

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5. Last-Minute Modifications and Enhancement

Additional adjustments are performed to enhance the robot's performance following the initial testing period. This can entail modifying the sensor angles, adding more sensors to improve coverage, or honing the logic to manage increasingly intricate situations. In order to maximize the robot's operating time, battery life and power efficiency are also taken into account.

6. Implementation

The robot is deployed for its designated mission after the system's dependability has been confirmed. Now capable of automatically identifying and avoiding obstacles, the obstacle-avoiding robot may go across a variety of situations.

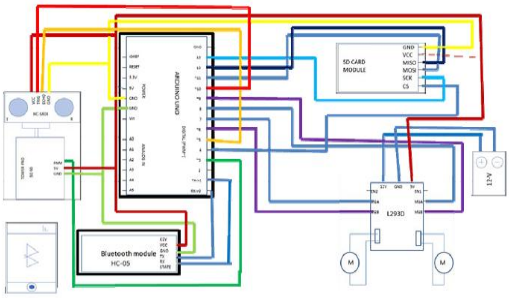

Fig.3.Pin diagram of obstacle detection and avoidance robot

RESULTS

Reliable performance in identifying obstacles and navigating the environment was demonstrated by the obstacle detection and avoidance system that used an Arduino and an ultrasonic sensor. The robot stopped and changed its route by turning left or right to avoid the obstacle once the ultrasonic sensor correctly identified impediments within a predetermined range, usually 15 to 20 cm. The Arduino processed sensor data quickly, guaranteeing prompt replies, while the DC motors, managed by the L293D motor driver, allowed for smooth movement. The battery pack allowed the system to run for several hours, making it energy-efficient. Even though the robot did well in controlled settings like smooth floors, little barriers or uneven terrain could have an impact on how well it functioned.

System Outputs:

The obstacle detection and avoidance robot's system outputs include the ability to detect obstacles using distance measurements from the ultrasonic sensor. If an obstacle is detected within the threshold range , the robot will either continue forward or stop and change direction. Based on the sensor data, the movement control outputs provide the motors instructions to either go ahead or change direction (left or right). Furthermore, the robot's status, such as obstacle detection or movement actions, may be shown by optional visual indicators like LEDs or a display. In order to monitor power and offer error or system status signals in the event of a malfunction, the system can also output battery voltage levels. The robot can navigate and avoid obstacles on its own thanks to these outputs.

CONCLUSIONS AND FUTURE SCOPE

1.Conclusions

A practical and economical approach to autonomous navigation is demonstrated by the obstacle detection and avoidance robot that uses Arduino and ultrasonic sensors. Using ultrasonic sensors, the device successfully identifies impediments in its route. An Arduino microcontroller then processes the data to enable safe navigation and collision avoidance. This study demonstrates the possibilities of straightforward yet efficient robotics systems and lays the groundwork for more complex uses like industrial robots or driverless cars. It is a great instructional and useful tool that also offers invaluable practical experience in robotics, sensor integration, and embedded systems. All things considered, the project succeeds in achieving its objective of intelligent and dependable navigation in changing surroundings.

A rechargeable battery powers the system, and a motor driver, like the L298N, is used to regulate the DC motors for movement. It is appropriate for school projects and small-scale applications because to its price and simplicity. Adding more ultrasonic sensors for 360° obstacle detection or more sophisticated sensors like LiDAR for increased accuracy can improve the technique even more. Predictive and adaptive obstacle avoidance could also be made possible by AI algorithms, and remote monitoring and control could be made possible by IoT integration. This method offers a scalable solution for robots that avoid obstacles in regulated settings, such as houses, laboratories, or classrooms.

2.Future Scope

Arduino-powered obstacle-avoiding robots have a lot of potential for the future in a variety of industries. They can help with hospital automation and assistive equipment for the blind and visually impaired in the healthcare sector, and they can automate material handling, inspection, and maintenance in the industrial sector. They back pest control and precision farming in agriculture. Additionally, these robots can be used in military and disaster response settings, where they can traverse dangerous terrain for reconnaissance or rescue, as well as in transportation, including autonomous trucks and last-mile delivery systems. They serve as platforms for AI and robotics research as well as instructional tools that encourage STEM study. They improve cleaning and smart home automation in houses, and they can help with rubbish collection and animal monitoring in environmental initiatives. As AI, IoT, and sensor technologies progress, these robots.

REFERENCES

1.Pradeep Kumar, Swetha Suresh B,"object following robot using raspberry pi and open", JEET - volume35 number 4 - May 2016 [2] [3] [4] [5] [6] [7] [8]

2.J.Borenstein and Y.Koren, "Obstacle avoidance with ultrasonic sensors," in IEEE Journal on Robotics and Automation, vol. 4, no. 2, pp. 213 218, April 1988.

3.J. L. Crowley, "Dynamic world modelling for an intelligent mobile robot," in IEEE 7th Int. Conf. Pattern Recognition Proc., 1984, Montreal, FQ, Canada, pp. 207-210.

4.C. Quick," Animate versus inanimate", RoboticsAge, pp. 15-17, Aug. 1984.

5.We used lucid chart for algorithm flowchart. [https://www.lucidchart.com]

6.R Ismail,Z omar,S Suaiban,"object following robot using PIR sensor and IR senors " ,IOP conf.2016.

7.Pradeep Kumar , swetha Suresh B ,"object following robot using raspberry pi and open CV", IJEET - volume35 number 4 - May 2016

8.K. Vikram ; S. Padmavathi, "Facial parts detection using Viola Jones algorithm", 4th International Conference on Advanced Computing and Communication Systems (ICACCS) – 2017

9.Shimil Jose ; V. V. Sajith Variyar ; K. P. Soman, "Effective utilization and analysis of ros on embe dded platform for implementingautonomous car vision and navigation modules" International Conference on Advances in Computing, Communications and Informatics (ICACCI)– 2017.

10. Ganesha Udupa ; Josh Freeman ; Vikas Nimbewal ; Rajesh Kumar Choudhary ; Swaroop Sasikumar ; SreerajV.Nair,"Design and manufac ture of Amrita Surya Vahin— A solar auto rickshaw ", International Conference on Robotics and Automation for Humanitarian Applications (RAHA) – 2016.

11.Jitihsha Agrawal, "Solar Operated low cost Obstacle avoidance Robot", Department of etc, YMCA university of science and technology (state government university) Faridabad, IJSRD, volume 3, issue 72015ISSN2321-0613.

12.Kirti Bhagat, Sayali Deshmukh, Shraddha Dhonde, Sneha Ghag, "Obstacle Avoidance Robot", Bachelor of computer engineering, IJSETR, volume 5, issue 2, February 2018.

13.Kolapo Sulaimon Alli, Moses Oluwafemi Onibonoje, Akinola S. Oluwole, Michael Adegoke Ogunlade, Anthony C. Mmonyi, Oladimeji Ayamolowo and Samuel Olushola Dada, VOL. 13, NO. 3, February 2018 ISSN 1819-6608, Development of an Arduino-based obstacle avoidance

14.Miguel Molina, Angelo Vera, Carolina Molina, Priscila Garzon, "Design and Construction of an Obstacle Avoiding Robot Based on Arduino Platform and Programming Tools" 2018 IEEE. https://doi.org/10.1109/uemcon.2018.8796577

15.Prajwalasimha S N, "Design And Development Of Real Time Self Navigation Robot For AgriculturalActvities" IJAREEIE,Vol 5 issue 5 may 2018.