Obstacle Avoidance Robot Using Arduino

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***Abstract*— This particular project focuses on building an uncomplicated mobile robot that navigates by the use of obstructions. An Arduino embedded system is employed to operate the movement of the robot depending on the sensor information available. This is made possible by the use of ultrasonic sensors mounted non-intrusively in front of the robot to determine when an obstacle is present. As a result, whenever an obstruction is perceived by the robot, the robot is able to initiate evasive action by turning in a certain direction.**

The robot contains motors that are used to rotate the wheels. While moving, the Arduino receives the appropriate sensor data and sends commands to the motors to stop, move forward, turn left or right or withhold motion. This helps the robot avoid obstacles within the environment and move safely.

Key words – Arduino UNO, motor shield L293d, ultrasonic sensor HC-SR04, DC Motor, servo motor

I. INTRODUCTION

In the present scenario, robots are becoming increasingly effective in several areas, such as carrying out industrial operations and assisting individuals in their day-to-day activities. One of the most captivating aspects of contemporary robots is their autonomous navigation and effortless avoidance of obstacles. The Obstacle Avoidance Robot is a basic robot that aims to accomplish exactly that—it can traverse a locale without colliding with any impeding objects.

It uses an Arduino microcontroller, which is a versatile small computer that can be programmed to execute a perspective of functions to control this robot. The robot is also equipped with an ultrasonic sensor that helps in the orientation of objects within their proximity by sending and receiving sound waves. From this, the robot can ascertain whether there is an object within its frontal region and its response to it.

As in most robotic systems, when an obstacle is sensed, an Arduino is programmed to turn on or off the motors of the robot, which can either stop, turn or change its course to evade the obstacle. Thus, the robot can operate within a space without the danger of colliding into any objects in its path.

The objective of this project is to show how simple robotics and programming can aid in the design of a robot which can navigate without human assistance which makes it effective for home use. In addition, we learn about the robotic parts such as sensors and motors and how these parts work with programming in order to make the robots more intelligent and flexible.

II. LITERATURE SURVEY

Obstacle-avoidance robots are autonomous devices designed to detect and avoid obstacles in their path using sensors and decision-making algorithms. These robots are commonly built using microcontrollers like **Arduino**, which acts as the brain of the robot, processing input from various sensors and controlling the motors that drive the robot's movement. The main component used for obstacle detection is the **ultrasonic sensor**, such as the **HC-SR04**, which measures the distance between the robot and any objects around it by emitting sound waves and measuring the time it takes for the sound to return. If an object is detected within a certain distance (typically less than 30 cm), the robot will take action to avoid it, such as stopping, reversing, or turning to the left or right.

The basic operation of an obstacle-avoidance robot involves continuously reading data from the sensors. When an obstacle is detected, the Arduino processes this information and decides the appropriate action to avoid the obstacle. For instance, if the robot encounters an obstacle directly in front, it might reverse slightly and turn either left or right. If obstacles are detected on the side, it might choose to move in the opposite direction. The motors, controlled by a motor driver such as the **L298N**, execute these movements by receiving commands from the Arduino. The system also includes a **power supply**, usually in the form of batteries, to power the motors, sensors, and the Arduino itself.

In terms of hardware, the components typically used in such robots include the Arduino microcontroller, ultrasonic sensors, DC motors or servo motors for

movement, a motor driver to control the motors, and a power source like a battery pack. These parts are connected together on a breadboard or via direct wiring. The Arduino processes the data from the sensors and sends appropriate signals to the motor driver to control the movement of the robot. This allows the robot to respond to its environment by navigating around obstacles autonomously.

The software running on the Arduino is typically straightforward. It involves reading the data from the ultrasonic sensor to determine the distance to nearby objects. If the robot detects an obstacle, it will execute a set of commands to avoid the obstacle. These commands may involve stopping, backing up, or turning in a direction that avoids the object. The robot then resumes moving forward once the path is clear. A simple code structure can achieve this functionality by using basic control structures like loops and conditional statements. The code can be expanded to incorporate more sophisticated behaviors as needed.

In the broader context of research, obstacle-avoidance robots have been widely studied, especially in the field of mobile robotics. Much of the research focuses on improving the accuracy and reliability of sensors, such as using infrared or LiDAR sensors in addition to or instead of ultrasonic sensors. Other research looks at improving the decision-making algorithms, often by integrating artificial intelligence (AI) techniques to allow the robot to adapt to dynamic environments, learn from past experiences, and make smarter navigation decisions. Additionally, more complex algorithms, such as **A* pathfinding** or **Dijkstra's algorithm**, are used in larger systems to optimize the robot's movement through more complex environments.

Overall, obstacle-avoidance robots built with Arduino are a great starting point for exploring robotics, and they have wide applications in areas like automation, warehouse management, and even search-and-rescue missions. Research in this field continues to push the boundaries of what these robots can do, with improvements in sensor technology, path planning, and energy efficiency light weight and portability of android OS based smart phone has overtaken the sophistication of technologies like programmable glove, static cameras etc., making them obsolete. Although recent researches in this field have made wireless gesture controlling a ubiquitous phenomenon, it needs to acquire more focus in relevant areas of applications like home appliances, wheelchairs, artificial nurses, table top screens etc. in a collaborative manner [3].

"Obstacle Avoidance Robot" has been designed and developed by Paul Kinsky, Quan Zhou mentioned that robot with a few mechanical components to add two more functions to the main body, namely the laptop holder and the camera holder. AT89S52 development board is designed, developed and tested in a large scale, which was used to control the motors smoothly. the cameras with relatively low cost are fixed and adjusted on the camera holder for good calibration of the computer vision. Users establish the serial communication method between the upper laptop and the lower development board with USB port. The laptop will send out a signal of the motor condition to the development board [4].

"obstacle avoidance car" has been designed and developed by FaizaTabassum, et.al has mentioned that Obstacle Avoidance Car successfully detects and avoids obstacles. Simple algorithms used to steer and reducing the turning radius, successfully navigated the vehicle. In conclusion, the group successfully interfaced every component that was originally planned. Timer interrupts for IR pulse generation. Obstacle detection using IR transceiver. Servo mechanism using PWM. Steering system using Lego and Servo. [5].

III. METHODLOGY

The basic block diagram for the implementation of the project is as shown in figure1.

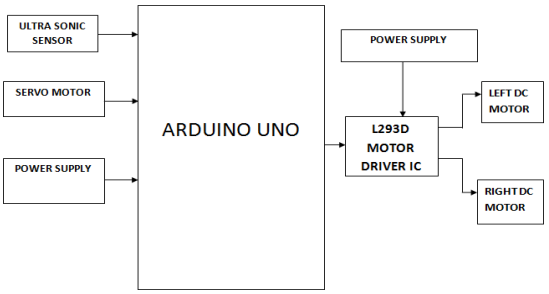

Fig. 1. Block Diagram of the system

The sonar system as used in HC-SR04 ultrasonic sensor, works in the same principle as bats do to compute distance. It provides an excellent non-contact range detection from distance close of about 2 cm upto 400 cm or 1feet to 13 feet. Its operation is not influenced by the sun or black color. The ultrasonic sensor gives out the short and high frequency sounds.

When they sense the presence of any object, they bounce back the sound wave which goes back in to the sensor through Echo pin. Now the user sets the Trigger and Echo pins low and moves the robot forwards. The microcontroller will receive a high input from the Echo pin when an obstacle is detected.

Each time the function expects pin to go high and starts counting, after which it will stop when the pin goes low again. It returns the time for which the pin was held high in microseconds or when the pulse was not completed before the set time or none was received then it returns. The timing has been determined means it gives length of the pulse and will show errors in shorter pulses. Pulses ranging from 10 microseconds to 3 minutes are taken into account.

Then the obtained time is transformed into distance. If the object is at a reasonable distance then the speed of the robot slows down and moves to the left side, If there is an obstruction on the left sided turn then it will turn on the right side instead.

TABLE I. INPUT PINS FOR MOVEMENT

Movement	Pin10	Pin11	Pin 12	Pin 13
Forward	1	0	0	1
Backward	0	1	1	0
Left	1	0	1	0
Right	0	1	0	1

Arduino board is connected with DC Motor through Motor driver board (pin10, pin11, pin12, pin13) which provides power to the actuators. Actuators are used to move robot in Forward, Backward, Left and Right directions. The brief description of inputs pins for movement of robot is given in below in table. The movement of robot will be stop whenever there is an obstacle is 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.

A. Sensors For Obstacle Avoidance

Varieties of sensors are available which can be used for the detection of obstacles some of the very popular sensors are: Infrared sensors (IR), Ultrasonic sensors, Cameras, which can be used as a part of Computer Vision, Sonar. It can measure the distance in its field of view of about thousands to hundreds points In the design of robot, we are using ultrasonic sensors for obstacle detection and avoidance The ultrasonic sensors continuously emits the frequency signals, when obstacle is detected this signals are reflected back which then considered as input to the sensor.

B. Sensors For Obstacle Avoidance

Infrared sensors (IR), Ultrasonic sensors, Cameras, Sonar, which can all be incorporated in Computer Vision applications. It is capable of measuring distance within its field of view attaining thousands to hundreds measurements. In the construction of a robot therefore, ultrasonic sensors are incorporated for the purpose of obstacle detection and avoidance. The ultrasonic sensors constantly send out signal frequencies, and when an obstacle is present, the signals bounce back thereby being collected as output to the sensor.

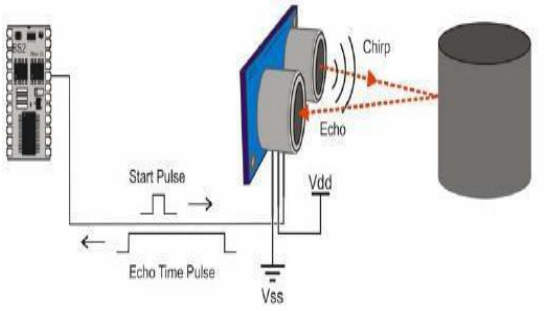

Fig. 2. Ultrasonic Sensor.

The ultrasonic sensor consists of a multi vibrator, which fixed at its base. The multi vibrator is combination of a resonator and vibrator the ultrasonic waves generated by the vibration are delivers to the resonator. Ultrasonic sensor actually consists of two parts: the emitter which produces a 40 kHz sound wave and detector which detects 40 kHz sound wave and sends electrical signal back to the microcontroller. HC-SR04 ultrasonic sensors are used which consist of 4 pins VCC, Trigger, Echo and GND

Features of Ultrasonic Sensor:

- Compact and light weight
- High sensitivity and high pressure
- High reliability
- Power consumption of 20mA
- Pulse in/out communication
- Narrow acceptance angle
- Provides exact, non-contact separation estimations within 2cm to 3m
- The explosion point LED shows estimations in advancement
- 3-pin header makes it simple to connect utilizing a servo development link

IV. APPLICATIONS

1. Used in mobile robot navigation systems
2. Used for household work like automatic vacuum cleaning
3. Used in dangerous environments, where human penetration could be fatal.
4. Automatic change over's of traffic signals
5. Intruder alarm system
6. Counting instruments access switches parking meters
7. Back sonar of automobiles

V. FLOW CHART

Figure 4 shows the Flow Chart of the working of the obstacle avoidance robot. Initially it checks obstacle within 30cm.If there is an obstacle it stops moving and turns towards left and checks if there is an object closer than 30 cm . The check has two possible outcomes, yes or no. Yes, meaning that there is indeed some object closer than 30 cm. No, meaning that there is no objects detected within 30cm. If there is nothing within 30 cm the robot can simply move forward as the path is clear. If there is something closer than 30 cm the robot must perform obstacle avoidance .The first stage of obstacle avoidance is to stop the robot! If you don't stop the robot immediately it will crash! After the robot has stopped it needs to see what way it should go. It does this by looking both directions, much like you should when you cross the road. First the robot turns left, takes a reading, turns right, and takes a reading. Another check occurs to see what direction is the best way to go. If left is the way to go it has to turn back to the left and then go forward. If right is the way to go the robot simply moves forward as it is already facing in the right direction.

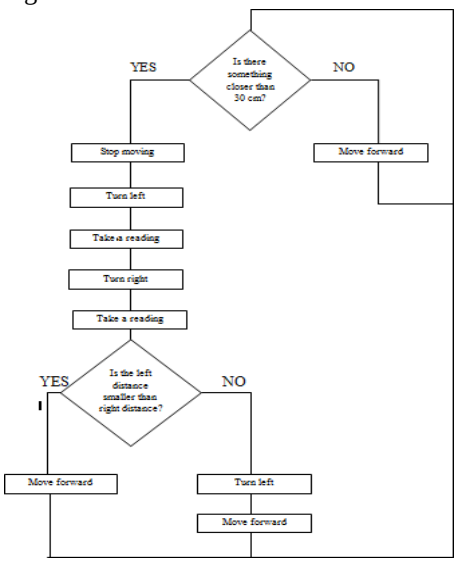

Fig. 3. Flow chart of obstacle avoidance robot

VI. RESULT

The result is obtained for obstacle avoidance robot using Arduino, if the robot moves forward if any obstacle detect it check for other directions and moves where there is no obstacles it moves in forward direction, to sense the obstacle ultrasonic sensor is used. We used servo motor to rotate the ultrasonic sensor

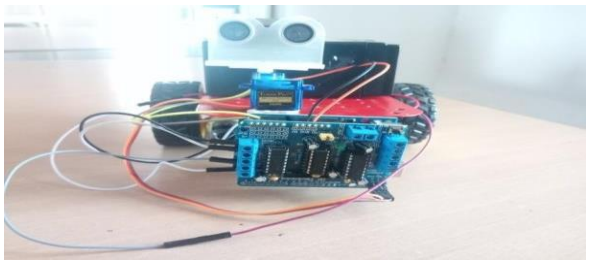

Fig. 4. Result of the project.

VII. CONCLUSION AND FUTURE SCOPE

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, three 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 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. In future cameras can be used to detect the obstacle however, it is better to get CCD or industrial use ones to get clear and fast pictures. Even the ones we mentioned in the camera holder part will be better because of the special software.

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