Design and Fabrication of Obstacle Avoiding Robot Using Arduino Uno

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Abstract — The project involves the design and development of an autonomous robotic vehicle capable of avoiding obstacles using ultrasonic sensors. The robotic system is controlled by an ATmega328 microcontroller, which processes input from the sensors to guide the vehicle's movement. The robot is designed to intelligently navigate its surroundings by altering its direction when an obstacle is detected. The ultrasonic sensor continuously monitors the area ahead, sending data to the microcontroller, which then activates the motors to steer the vehicle away from potential collisions. Although IR sensors are typically used for similar tasks, they were found to be incompatible with our system, so ultrasonic sensors were chosen for their reliability and accuracy.

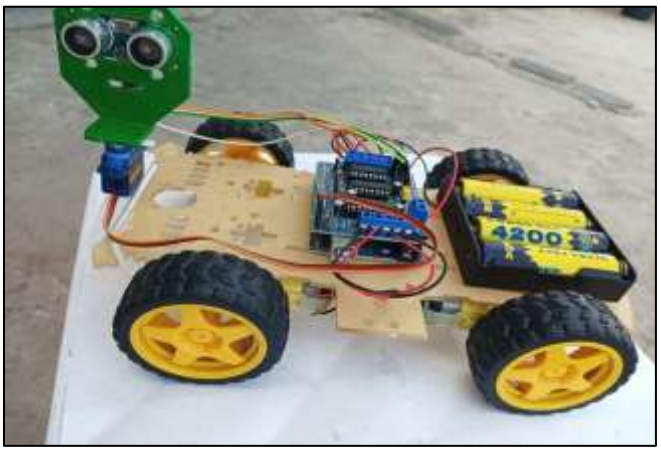
Keywords: Obstacle Avoidance, Ultrasonic Sensor, Atmega328 Microcontroller, Autonomous Robotic Vehicle, Motor Control, Sensor-Based Navigation, Obstacle Detection, Microcontroller-Based Robotics, Ultrasonic Sensing, Autonomous Navigation, Robot Actuation, Motor Driver, Intelligent Robotics

I. INTRODUCTION

Obstacle avoidance is a critical feature in autonomous robotic systems, enabling them to navigate through dynamic and unpredictable environments without human intervention. The robot continuously monitors its surroundings using sensors, such as ultrasonic or infrared, to detect objects in its path. Upon sensing an obstacle, the robot calculates an alternative route, avoiding the object and resuming its movement.

While several methods exist for guiding robots, edge detection remains one of the most commonly adopted techniques for obstacle avoidance. This method helps the robot identify the edges or boundaries of obstacles and adjust its course accordingly. However, its primary limitation is the requirement for the robot to pause in front of an obstacle to acquire an accurate measurement before proceeding. This pause, while ensuring precise detection, reduces the efficiency of real-time navigation.

Other navigation methods like wall-following, where the robot keeps a fixed distance from the walls, and line following, where the robot follows a pre-defined path marked by a line, are also widely used but may not always be suitable for environments filled with dynamic obstacles. The challenge for any obstacle avoidance system is to balance accuracy in detection with the smoothness of movement, ensuring the robot can adapt quickly and continue operating without frequent interruptions.



II. LITERATURE SURVEY

"Line follower and obstacle avoidance bot using arduino"[1]. Has been designed and developed by Aamir Attar etal to create an autonomous robot which intelligently detects the obstacle in its path and navigates according to the actions that user set for it. So this system provides an alternate way 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 per capita cost.

[2]. "Obstacle-avoiding robot with IR and PIR motion Sensors" has been designed and developed by Aniket D. Adhvaryu et al has proposed that developed robot platform was not designed for specific task but as a general wheeled autonomous platform. It can therefore be used for educational, research or industrial implementation. Students can use it to learn the microcontroller programming using C++, Arduino Uno 1.6.5 compiler, IR and PIR sensors characteristics, motor driving circuit and signal condition circuit design. Research on obstacle avoidance robot at the polytechnic level can help students to develop communication, technical skills and teamwork. The design of such robot is very flexible and various methods can be adapted for another implementation. It shows that PIR sensors are more sensitive compared to IR sensors while detecting human being.

[3]. "Obstacle Avoidance Robotic Vehicle Using Ultrasonic Sensor, Android and Bluetooth for Obstacle Detection" has been designed and developed by Vaghela et.al has mentioned that enormous amount of work has been done on wireless gesture controlling of robots. Various methodologies have been analyzed and reviewed with their merits and demerits under various operational and functional strategies. Thus, it can be concluded that features like user friendly interface, 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.

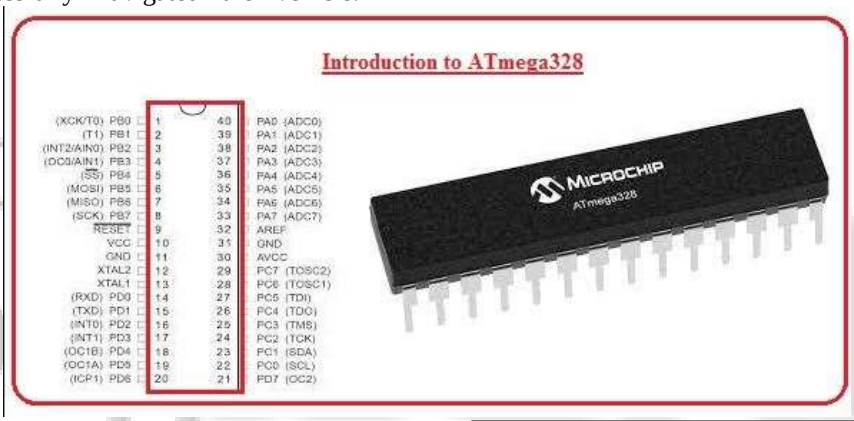
[4]. "Obstacle Avoidance Robot" has been designed and developed by Paul Kinsky, Quan Zhou mentioned that robot with a few mechanical components to add two more functions to the main body, namely the laptop holder and the camera holder. AT89S52 development board is designed, developed and tested in a 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.

[5]. "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.

III. COMPONENTS

A. ATmega328 Microcontroller

- Description: The ATmega328 is an 8-bit AVR microcontroller widely used in embedded systems and robotics projects. It is the core controller for your obstacle-avoiding robot, processing input signals from the sensors and controlling the robot's movements. It has 32 KB of flash memory, 1 KB of EEPROM, and 2 KB of SRAM. It operates at 16 MHz and can be easily programmed using Arduino UNO.
- Function: Receives data from sensors, processes the signals, and controls the motors through the motor driver based on sensor input.

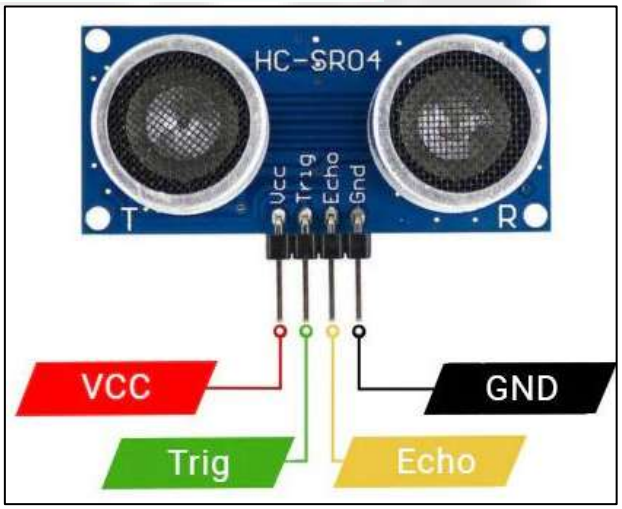


B. Ultrasonic Sensor (HC-SR04)

Description: The ultrasonic sensor uses sound waves to measure the distance between the robot and any obstacle in its path. It sends out ultrasonic pulses and measures the time it takes for the echo to return after hitting an object.

Function: Detects obstacles by calculating the distance between the robot and nearby objects. It sends this data to the microcontroller for further action.

Working Range: Typically 2 cm to 400 cm, with an accuracy of ±3 mm



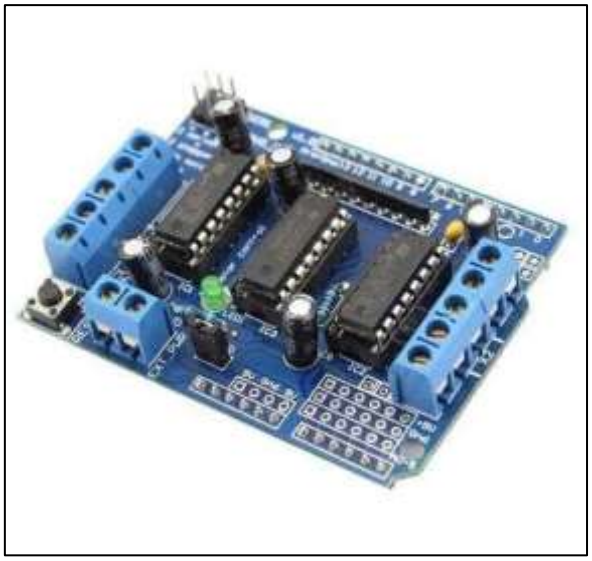
C. DC Motors

- Description: Direct Current (DC) motors convert electrical energy into mechanical energy, enabling the robot to move. The speed and direction of these motors are controlled by the microcontroller through a motor driver.
- Function: Drives the wheels of the robot to move forward, backward, or turn, as instructed by the microcontroller.

– Voltage Requirement: Typically operates on 6V to 12V depending on the motor specs.

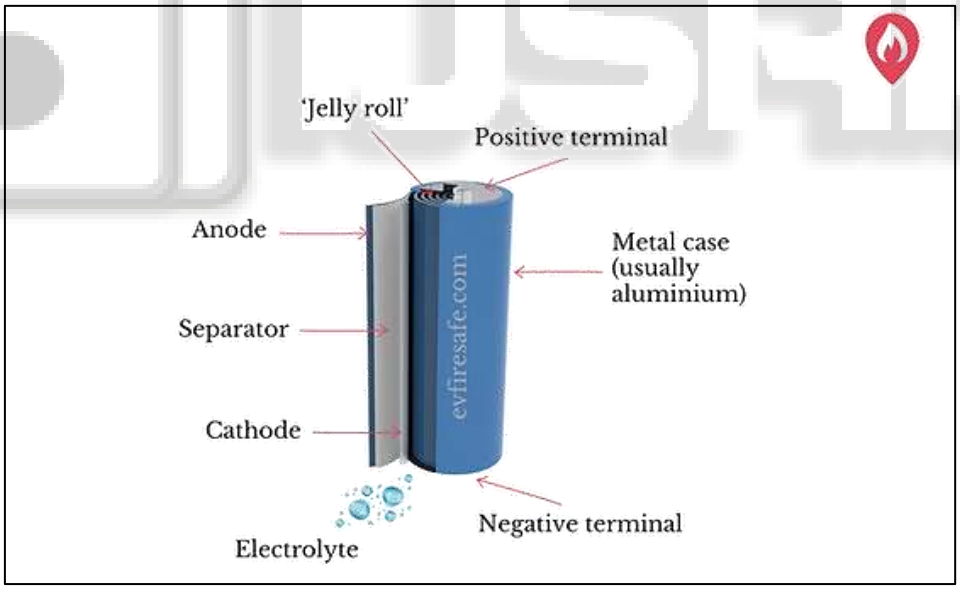
D. Motor Driver (L298N)

– Description: The L298N motor driver is an H-Bridge dual motor controller that allows the microcontroller to control the direction and speed of the motors. It provides an interface between the low-power signals from the ATmega328 and the high-power requirements of the motors.
– Function: Controls the forward and backward movement of the robot's motors based on signals from the microcontroller. It can control two motors independently.



E. Battery

– Description: The battery provides the necessary power to run the microcontroller, motors, and other components. Typically, a rechargeable Li-ion battery or a battery pack is used.
– Function: Supplies power to all the electronic components, ensuring the robot operates autonomously.
– Voltage Requirement: Generally ranges between 7.4V to 12V, depending on the motors and other components.

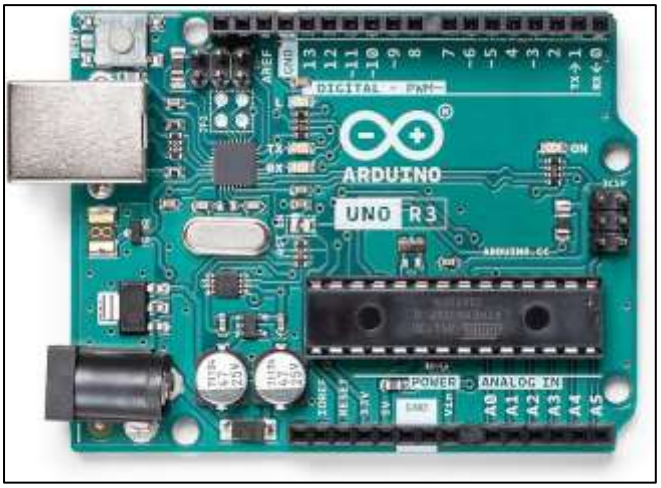


F. Arduino Uno

– Description: The Arduino Uno is a popular open-source microcontroller board based on the ATmega328P microcontroller. It is widely used in electronics projects due to its simplicity, versatility, and extensive community support. The board contains all necessary components required for the operation of the microcontroller, making it easy for beginners and experienced developers to create embedded systems. It can be programmed using the Arduino Uno, which uses a simplified version of C++.

G. Functions in this Project:

In your Obstacle Avoidance Robotic Vehicle, the Arduino Uno plays a key role in controlling the robot. It receives input from the ultrasonic sensor and processes the data to determine the presence and distance of obstacles. Based on this information, the Arduino Uno sends signals to the motor driver (such as L298N) to control the motors, enabling the robot to change direction and avoid collisions.



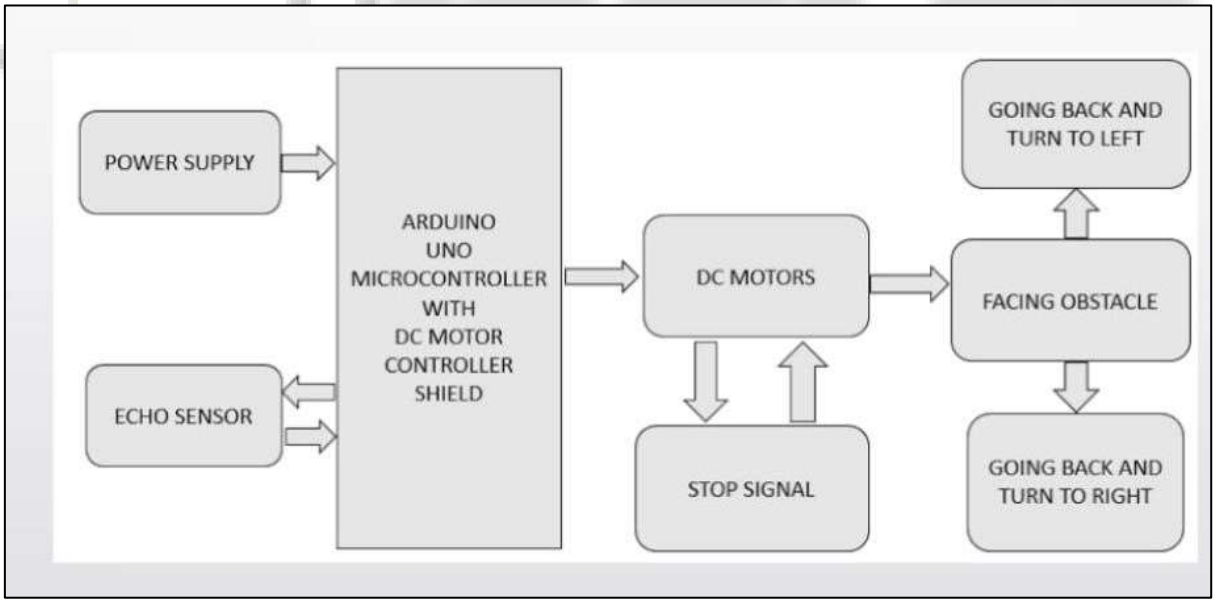
H. Servo Motor

Description: A servo motor is a rotary or linear actuator that allows precise control of angular or linear position, velocity, and acceleration. It consists of a motor coupled with a sensor for position feedback, usually a potentiometer. Servo motors are commonly used in robotics, automation, and control systems because of their high accuracy and easy control through pulse-width modulation (PWM).

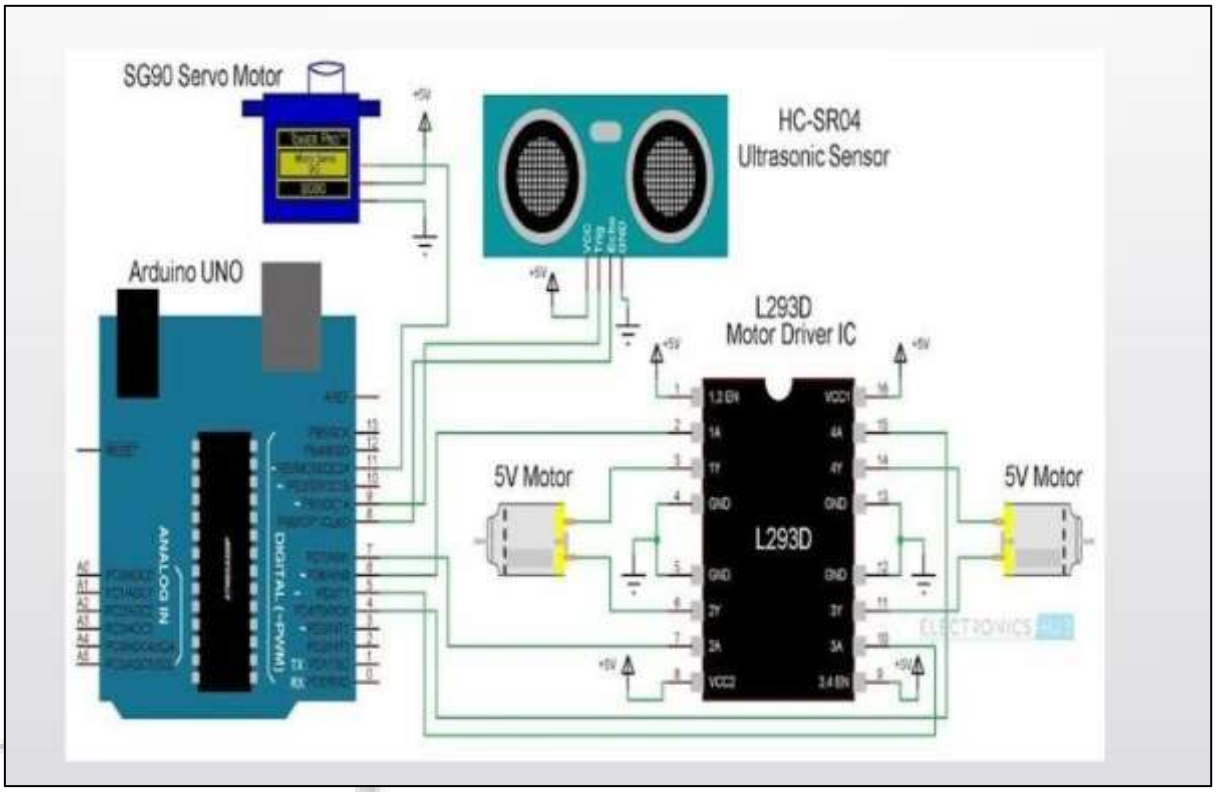
List of Components and Cost

Component Name	Rating	Quantity	Cost
Arduino uno	ATmega328P	1	500
Ultrasonic Sensor		1	350
Motor	100RPM	4	800
Motor Drivers	L293D IC	1	350
Bread board		1	200
Tyres		4	100
Battery	9V	4	400
connector		1	50
HW Battery	9V	1	30
Others			320
Total		18	3,100

I. Block Diagram



J. Circuit Diagram



IV. Working Principle

The obstacle avoidance robotic vehicle uses ultrasonic sensors for its movements. Arduino is used to achieve the desired operation. The motors are connected through motor driver IC to Arduino. The ultrasonic sensor is attached in front of the robot.

Whenever the robot is going on the desired path the ultrasonic sensor transmits the ultrasonic waves continuously from its sensor head. Whenever an obstacle comes ahead of it the ultrasonic waves are reflected back from an object and that information is passed to the Arduino. The Arduino controls the motors left, right, back, front, based on ultrasonic signals. In order to control the speed of each motor pulse width modulation is used (PWM).

When ultrasonic sensor detect the object which is kept inside the path it will send the signal toward the Arduino UNO and according to that it will rotate the motor M3 & M4 in forward direction and rotate the motor MI & M2 in reverse direction such a way that the robot get moving in left direction.

V. Applications

- Used in mobile robot navigation systems.
- Used for household work like automatic cleaning vacuum.
- Used in dangerous environments, where human penetration could be fatal.
- Automatic change overs of traffic signals
- Intruder alarm system.
- Back sonar of automobiles.

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.

VII. Future Scope

In the future, the sensing can be increased. A Bluetooth module and a camera can be attached, so that the user can see the obstacle and take pictures and also can take videos of it.

As the sensor can detect only the obstacles with reflective surface, so in future work can be carried out to detect and avoid obstacles of absorbing surface.

VIII. CONCLUSION

The Goal of Our Project is to create an Autonomous Robot which intelligently detects the obstacle in its path and navigates according to the actions we set for it.

This project provides an obstacle avoiding robot that detects obstacles coming in its path and avoids it by moving in another direction. The robot is built with Arduino that processes the information to various parts. For object detection, ultrasonic sensors have been used that provides a wider field of view. Servo motor has been used for rotating the sensor. The robot is able to move by using two geared motors. It is perfectly avoiding the obstacles coming in its path.

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