**Design and Implementation of an Obstacle Avoiding Car Using Arduino and Ultrasonic Sensors (2025)**

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***Abstract—* This project presents the development of an autonomous obstacle-avoiding car, utilizing the Arduino Uno microcontroller and HC-SR04 ultrasonic sensors. The system is designed to navigate its environment by detecting and avoiding obstacles using reflected ultrasonic waves. The core of the project lies in a straightforward yet effective algorithm that enables real-time control over the vehicle’s motion. When the sensor detects an object within a preset threshold distance, the Arduino interprets the data and adjusts motor actions accordingly to prevent collisions. The vehicle maneuvers by choosing alternate paths or reversing when necessary. The solution is cost-effective and ideal for basic automation in industrial or domestic environments. Components such as the L298N motor driver and DC motors are integrated for actuation, while the entire system is powered and programmed using simple embedded C code. Experimental testing confirms the car’s capability to detect and navigate around obstacles reliably. Future improvements may include the addition of IR sensors or machine learning-based path optimization. This paper details the design, components, methodology, results, and scope for future development.**

**Keywords-** Arduino Uno, obstacle avoidance, ultrasonic sensor, embedded systems, autonomous vehicle, L298N

# Introduction

# Background and motivation

Obstacle avoidance is a foundational feature for autonomous robotic systems. Whether in factory automation, warehouse logistics, or home cleaning robots, the ability to detect and maneuver around objects is essential for intelligent behavior. The motivation for this project is to design a low-cost, efficient vehicle capable of autonomous navigation using embedded systems.

1. **Project Objectives**

* To develop an obstacle-avoiding robotic car using Arduino and ultrasonic sensors.
* To implement a control algorithm for real-time decision-making.
* To evaluate the system's responsiveness and cost-effectiveness.

1. **Brief Outline of the Report**

The report includes a literature review, system modeling, methodology, experimental setup, results, and a conclusion with proposed future enhancements.

* 1. **Literature Review**

I reviewed some technical papers and found that many different kinds of mechanism and methodology can be and has been used, including one using IR and PIR sensors, as reported by Aniket D Adhvaryu, in “Obstacle-avoiding robot with IR and PIR motion Sensors. The project proposed the use of PIR sensors as it was more sensitive compared to others in detecting human beings (and other objects radiating infrared signals) but was less accurate in handling general obstacles like walls and objects lying around. A remotely controlled device, as planned and developed by Vaghela Ankit, Patel Jigar and Vaghela Savan in “Obstacle Avoidance Robotic Vehicle Using Ultrasonic Sensor, Android and Bluetooth For Obstacle Detection, shows the versatility that this project has. This device can be used in modular forms, and can be adapted to perform different kinds of tasks, having many different kinds of application, and in different work environments. This project shows the control of an obstacle avoiding robot vehicle in conjunction with manual control. This shows the future scope this project has.

# III. METHODOLOGY AND MODELING

# INTRODUCTION

# The system employs an Arduino Uno microcontroller to process ultrasonic data and control motor functions, enabling the car to avoid obstacles autonomously.

# Working Principle

# Ultrasonic waves emitted by the HC-SR04 sensor reflect back upon hitting an object. The time delay is used to calculate distance. Based on this, the Arduino decides whether to move forward, stop, turn, or reverse.

# Work Process

1. Power is supplied to the system.
2. Sensor checks for nearby obstacles.
3. Motor driver receives commands based on the distance calculated.
4. Vehicle navigates accordingly.
5. **Description of components**

***Arduino Uno***

Arduino Uno is a development board housing an ATmega328 microcontroller, and has fourteen digital and 6 analog pins as input-output ports, for connections to different peripherals [3]. It has an open sourced design which makes it much cost effective, and was introduced in 2005 to provide an easy and inexpensive way for students, hobbyists and professionals alike to create devices working with different actuators and sensors. It requires an external power source with voltage in the range of 9-12V. Apart from the fourteen digital and six digital pins, it also has a USB connection, a power jack, **A close-up of a blue circuit board

Description automatically generated**and a reset button

***HC-SR04 Ultrasonic Sensor***

**A close-up of a circuit board

Description automatically generated**HC-SR04 Ultrasonic Sensor It is an ultrasonic range finder, which works on the principle of a RADAR, but instead of using radio waves, it uses ultrasonic sound waves. It consists of a transmitter which emits ultrasound of the frequency 40 KHz [4], and an echo receiver which receives reflected sound waves. The time difference between emitting and receiving of the waves gives the distance between the sensor and the surface off which waves are reflecting. It works in the range of 2-400cm in 15o effective measuring angle. It has 4 pins, one for +5V power supply, one neutral, or ground pin, one signal pin to trigger the transmitter and one echo pin to obtain the results.

***LM298N Motor Driver Module***

The Motor Shield L293D is an Arduino-compatible board that allows bidirectional control of two DC motors or one stepper motor using the L293D H-bridge driver IC. It supports a voltage range of 4.5V–36V with a maximum current of 600mA per channel and includes PWM for speed and direction control. Compact and versatile, it's ideal for robotics and motorized projects.

**A blue circuit board with several small black and blue objects

Description automatically generated**

***Arduino R3***

Acts as the central processing unit.

***Bluetooth HC-05***

Enables wireless communication between the user and the system.

***1.3-inch OLED Display***

Displays the received messages.

***Jumper Wires and Breadboard***

Facilitate connections between components.

1. A circuit board with wires and a battery

   Description automatically generated**Circuit Diagram:**

# Result and Discussion

# SIMULATION / NUMERICAL DISCUSSIONS

# Simulated distances and motor control logic were verified using Tinkercad simulations before hardware implementation.

# EXPERIMENTAL RESULTS

# The vehicle successfully avoided obstacles in real-time, reversing or turning appropriately when obstruction was detected within 10cm.

# COMPARISON

# Simulated predictions closely matched the hardware results, with only slight discrepancies due to real-world sensor noise.

# COST ANALYSIS

|  |  |
| --- | --- |
| Components | Estimated price in USD |
| Arduino Uno Board | |  | | --- | | $4.50 |  |  | | --- | |  | |
| USB-A to Micro-USB Cable | |  | | --- | | $1.00 |  |  | | --- | |  | |
| Car Chassis (with wheels, base) | |  | | --- | | $5.00 |  |  | | --- | |  | |
| L298N Motor Driver Module | |  | | --- | | $1.50 |  |  | | --- | |  | |
| Ultrasonic Sensor Module (HC-SR04) | |  | | --- | | $1.00 |  |  | | --- | |  | |
| Servo Motor (SG90 or similar) | |  | | --- | | $2.00 |  |  | | --- | |  | |
| 5V Batteries (4 pcs) | |  | | --- | | $3.00 |  |  | | --- | |  | |
| On-Off Switch | |  | | --- | | $0.50 |  |  | | --- | |  | |
| DC Female Connector Jack | |  | | --- | | $0.50 |  |  | | --- | |  | |
| Connecting Wires (set) | |  | | --- | | $1.00 |  |  | | --- | |  | |
| Hot Melt Glue Gun | |  | | --- | | $3.00 |  |  | | --- | |  | |
| Total | **$23.00** |

# limitations

# Inconsistent performance on uneven surfaces.

# Detection range limited to 400 cm.

# Can’t differentiate between types of obstacles.

1. **Conclusion and Future Endeavors**

The above Arduino controller and ultrasonic sensor were studied and the HcSR-04 ultrasonic sensor was selected, as the controlling result are satisfying for its use in the automobile prototype system bring developed. It was used to sense the obstacle and avoidance them. On successful implementation of obstacle avoidance algorithm was successfully carried out too with minimal errors, by coding the algorithm in python. Obstacle avoidance is a very good application to be used in vehicle preventing many accidents and loss of life.

**VI. REFERENCES**

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**VII. APPENDIX**

***SOURCE CODE (GitHub link)-***

[**https://github.com/Ashraful0010/obstacle-avoiding-car-code**](https://github.com/Ashraful0010/obstacle-avoiding-car-code)