International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Obstacle Avoiding Car Using Voice Control

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ABSTRACT

This project presents the development of a smart robotic vehicle that combines voice control with obstacle avoidance functionality. The goal is to design a system that can be operated using simple voice commands and is capable of navigating its environment by avoiding obstacles in real time. Voice commands such as “forward,” “backward,” “left,” “right,” and “stop” are given through a smartphone using a Bluetooth-based voice control application. These commands are transmitted to a microcontroller (Arduino Uno), which processes them and controls the car’s movements via a motor driver. Simultaneously, an ultrasonic sensor detects any obstacles in the car’s path, allowing the system to stop or change direction to prevent collisions. The project demonstrates practical applications of embedded systems, wireless communication, and sensor integration, making it relevant for modern applications in robotics, assistive technologies, and smart automation. It also enhances the understanding of real-time system control, making it a valuable learning

Introduction

With the rapid advancement of embedded systems and wireless communication, voice-controlled automation is becoming increasingly prevalent in robotics and smart systems. This project focuses on developing a voice-controlled robotic car integrated with an obstacle avoidance mechanism, which combines wireless communication and sensor-based control for autonomous navigation.

The system is designed to receive voice commands from a user via a smartphone and execute movement instructions such as forward, backward, left, right, and stop. These commands are sent over Bluetooth to a microcontroller (Arduino), which drives the car accordingly using a motor driver. In addition to voice control, an ultrasonic sensor is mounted on the vehicle to detect obstacles in real-time and prevent collisions by stopping or rerouting the car automatically. This project not only serves as an effective application of electronics and telecommunication principles such as signal processing, interfacing, and real-time control, but also represents a step toward building intelligent systems that interact naturally with humans. It is a cost-effective, practical demonstration of automation that can be scaled for industrial or assistive applications.

1.1Project Overview:

This project aims to develop a robotic vehicle that can be operated through voice commands and is capable of autonomously avoiding obstacles in its path. The system combines voice recognition via a smartphone app with real-time obstacle detection using ultrasonic sensors.

The user gives voice commands through a mobile device, which are transmitted to the vehicle’s microcontroller (Arduino Uno) via a Bluetooth module (HC-05). The Arduino processes these commands and controls the movement of the car through a motor driver (L298N) connected to DC motors. Meanwhile, an ultrasonic sensor (HC-SR04) constantly monitors the vehicle’s surroundings to detect any nearby obstacles. If an obstacle is detected within a certain distance, the vehicle automatically stops or changes direction, regardless of the voice command, ensuring safe and intelligent navigation .This project integrates key aspects of electronics, embedded systems, wireless communication, and sensor technologies, making it an ideal practical learning experience for ENTC students. It serves as a basic prototype for applications in autonomous vehicles, assistive mobility devices, and smart robotics.

1.2Aim:

To design and develop a voice-controlled robotic car that can intelligently detect and avoid obstacles using ultrasonic sensors, enabling hands-free and safe navigation through wireless communication and embedded system technology.

1.3Objectives:

Voice Control Integration: To develop a system that allows the robotic car to be controlled using simple voice commands such as "forward," "backward," "left," "right," and "stop ."Obstacle Detection and Avoidance: To implement an ultrasonic sensor-based obstacle detection system, ensuring the vehicle can autonomously avoid obstacles in its path by stopping or rerouting when necessary.. Wireless Communication: To enable communication between the mobile device and the robotic car using Bluetooth, facilitating real-time command transmission. Embedded System Design: To design and implement a control system using an Arduino microcontroller that processes voice commands and controls the motor movements of the car. Real-time Operation: To ensure the system operates in real time, with the robot responding to voice commands and obstacle detection instantaneously for smooth and autonomous navigation

1.4problem statement:

With the growing demand for automation and intelligent systems, it has become crucial to integrate efficient control methods into robotic vehicles. A significant challenge in current autonomous systems is ensuring that the vehicle can not only navigate accurately but also avoid collisions in dynamic environments. Additionally, the need for hands-free control, particularly in scenarios where manual operation is difficult, has led to the development of voice-controlled systems. The problem this project addresses is the development of a voice-controlled autonomous vehicle that can navigate obstacles efficiently. The vehicle should be able to respond to voice commands for movement while simultaneously detecting and avoiding obstacles, ensuring safe navigation without human intervention. This project proposes a solution by combining voice recognition with real-time obstacle detection to create a system that offers both hands-free control and autonomous functionality.

II. Literature Review

In recent years, various advancements in robotics and automation have led to significant improvements in both autonomous navigation and human-machine interaction. The combination of voice control and obstacle avoidance in robotic vehicles is an emerging area of interest. Several studies and projects have explored the integration of these technologies, and some of the key contributions are outlined below:

1. Voice-Controlled Robots:

The use of voice recognition to control robots has gained popularity due to its ease of use and natural interface. Research by Jain et al. (2017) demonstrated the implementation of voice commands for controlling a robotic arm. The system used a Bluetooth interface to transmit commands from a smartphone to a robot, providing a simple and effective way to control robotic movements. A similar approach was used by Saha et al. (2018) to develop a voice-controlled vehicle, where the robotic car responded to commands for direction and speed adjustment. These studies showed the potential of voice-based control in simplifying human-robot interaction.

2. Obstacle Avoidance Systems:

Obstacle avoidance is a critical feature in autonomous navigation systems. A common method for real-time obstacle detection is the use of ultrasonic sensors. Research by Sharma et al. (2016) and Kumar et al. (2019) involved using ultrasonic sensors (like the HC-SR04) to detect obstacles in the path of a robot. These sensors measure the distance to objects and provide input to the microcontroller, which processes this information to control the robot's movement. Obstacle avoidance was achieved by altering the robot's direction when an object was detected within a predefined range.

3. Integration of Voice Control and Obstacle Avoidance:

The integration of voice control and obstacle avoidance in a single robotic system has also been explored. In a study by Patel et al. (2020), a robotic vehicle was designed to navigate using voice commands while avoiding obstacles. The system used an Arduino microcontroller for controlling the robot's movement and an HC-SR04 ultrasonic sensor for detecting obstacles. Voice commands were received via Bluetooth from a smartphone app, and the robot's movement was adjusted accordingly. This hybrid approach proved to be an effective solution for autonomous vehicles with human-like control.

4. Real-Time Navigation and Embedded Systems: Real-time operation and control are essential in autonomous navigation systems. The development of such systems using embedded platforms like Arduino and Raspberry Pi has been widely studied. Singh et al.

III. Methodology

The methodology for developing the obstacle-avoiding, voice-controlled car involves both hardware integration and software programming. The system is divided into three main functional blocks: voice command reception, obstacle detection, and motion control.

Voice Command Interface Input Device: A smartphone with a voice-to-text app or a dedicated voice recognition module

Communication: The smartphone communicates with the Arduino via a Bluetooth module (HC-05).

Command Set: Recognized commands include "Forward", "Backward", "Left", "Right", and "Stop".

Data Flow: The spoken command is converted into text, then transmitted as a serial string to the Arduino through Bluetooth.

Obstacle Detection System

Sensor Used: HC-SR04 Ultrasonic Sensor is mounted on the front of the car to detect objects.

Working Principle:

The sensor emits ultrasonic waves .The time taken for the echo to return is used to calculate the distance from an obstacle.

Control Logic and Motion Execution

Microcontroller: Arduino Uno processes the received voice command and sensor input.

Motor Control: An L298N motor driver receives signals from Arduino to control two DC motors.

Decision Algorithm:

If command = "Forward" AND no obstacle → move forward.

Software Implementation

Platform: Arduino IDE is used for programming.

Libraries: Software Serial. h for Bluetooth communication, and custom code for sensor integration.

Main Loop:

Continuously listen for Bluetooth input. Check ultrasonic sensor reading. Execute motor commands based on logic

IV. Results and Discussion

9.1 Hardware Results1. Voice Command Reception:

The HC-05 Bluetooth module successfully received voice commands from the Android smartphone.
The signal strength and range were adequate for smooth wireless communication (approx. 8–10 meters in open range).

2. Obstacle Detection:
The HC-SR04 ultrasonic sensor effectively detected obstacles within a range of 2 cm to 400 cm.
The obstacle avoidance logic stopped or rerouted the car immediately when an object was detected within a set threshold (e.g., 15–20 cm).

3. Motor Control:
The L298N motor driver controlled the DC motors as expected.
Direction control (forward, backward, left, right) worked reliably based on the Arduino output, and the car maintained stable movement.

4. Power Management:
The Li-ion battery pack provided sufficient voltage and current to power the motors and control board.
Power consumption was efficient, giving 30–45 minutes of operation on a full charge.

9.2 Software Results

1. Command Recognition and Processing:
The Android voice control app accurately converted speech to text in most environments with low noise.
Commands such as “Forward,” “Backward,” “Left,” “Right,” and “Stop” were correctly interpreted and transmitted.

2. Embedded Code Execution:
The Arduino code successfully processed commands and controlled the car's movement in real-time.
Ultrasonic sensor data was read and processed without delay, ensuring smooth obstacle avoidance.

3. System Integration:
The integration between hardware components and the software logic was seamless.
Voice command execution and obstacle avoidance worked in tandem without conflict.

V. Conclusion

In this project, a voice-controlled obstacle avoiding robotic car was successfully designed and implemented using an Arduino Uno, Bluetooth module, ultrasonic sensor, and DC motors. The system allowed a user to control the car through voice commands, which were processed via a smartphone and transmitted to the car via Bluetooth. Simultaneously, the ultrasonic sensor enabled the vehicle to detect and avoid obstacles, enhancing safety and automation.

The integration of hardware and software components demonstrated reliable performance in both voice command recognition and real-time obstacle avoidance. The project highlights the growing potential of human-machine interaction and embedded systems in robotics and automation. The final outcome met all defined objectives and validated the system's effectiveness in basic autonomous navigation with voice interface.

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