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Voice Controlled and Obstacles Detection Robotic Vehicle

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Abstract: This work was developed in a way that the robot is controlled by voice commands. An android application with an Arduino that is used for required tasks. The connection between the android app and the vehicle is facilitated with Bluetooth technology. The robot is controlled by buttons on the application or by spoken commands of the user. The movement of the robot is facilitated by the one dc servo motors connected with Arduino at the receiver side. The commands from the application are converted into digital signals by the Bluetooth RF transmitter for an appropriate range (about 10 meters) to the robot. At the receiver end the data gets decoded by the receiver and is fed to the Arduino which drives the DC motors for the necessary work. The aim of Voice Controlled Robotic Vehicle is to perform the required task by listening to the commands of the user. A prior preparatory session is needed for the smooth operation
Keywords: Arduino, Bluetooth, Android application, DC motors, Speech commands.

I. INTRODUCTION

In today's rapidly evolving technological landscape, robotics is at the forefront of innovation, revolutionizing how we interact with machines and the environment around us. This project focuses on the development of a Voice-Controlled, Bluetooth-enabled Robotic Vehicle equipped with advanced obstacle detection capabilities. The primary goal of this project is to create an intuitive and user-friendly robotic vehicle that can navigate various terrains while avoiding obstacles autonomously. By integrating voice control and Bluetooth technology, users can command the vehicle effortlessly, enhancing accessibility and versatility in various applications, from education and research to entertainment and assistance in daily tasks. The incorporation of obstacle detection further ensures the vehicle's safety and efficiency, allowing it to traverse complex environments without human intervention. Through this project, we aim to demonstrate the potential of combining these technologies to create an intelligent robotic system that not only responds to user commands but also adapts to its surroundings in real time. As we delve deeper into the technical aspects, this project will outline the design, components, and functionality of the robotic vehicle, highlighting its potential applications and future developments in the field of robotics.

II. LITERATURE SURVEY

Voice control has become a prominent interface in robotics, facilitating hands-free operation. Research such as that by[1] Giachos et al. (2023) emphasizes the application of Natural Language Processing (NLP) to interpret user commands in robotic systems. Their findings show that integrating platforms like Google Assistant significantly enhances user interaction, making robots more accessible, particularly for users with disabilities.

Bluetooth technology is widely utilized in mobile robotics due to its simplicity and efficiency. [2] Zhuang et al. (2022) highlighted the effectiveness of Bluetooth modules, such as the HC-05, for enabling real-time communication between mobile devices and robotic vehicles. Their study found that Bluetooth allows for reliable control and monitoring, making it ideal for remote robotic applications.

Obstacle detection is crucial for the safe navigation of autonomous vehicles. Various sensor technologies have been explored, including ultrasonic and infrared sensors. [3] Zhmud et al. (2018) examined the use of ultrasonic sensors for real-time obstacle detection, demonstrating their ability to navigate complex environments effectively. [4] Meanwhile, De Jong Yeong et al. (2021) focused on sensor fusion techniques, advocating for combining multiple sensor inputs to improve detection accuracy and reliability.

Integrating voice control, Bluetooth communication, and obstacle detection into a single robotic platform has been an emerging research trend. . [5] Ang Jia He, et al.developed a hybrid system that combines these technologies, allowing for seamless navigation and user interaction. Their research indicates that such integration not only improves operational efficiency but also enhances the user experience by allowing the vehicle to respond to voice commands while navigating obstacles.

The applications for voice-controlled, Bluetooth-enabled robotic vehicles are extensive, spanning educational tools, assistive technologies, and more reviewed current trends in robotics and highlighted the need for advanced algorithms to improve voice command recognition and enhance obstacle detection capabilities. They suggest future research should focus on adapting these systems to various environments and user needs, potentially leading to more personalized and responsive robotic solutions.

III.DESIGN AND IMPLEMENTATIONS

To better visualize the system architecture and data flow, here's a detailed breakdown of the block diagram of the Voice-Controlled + Bluetooth-Controlled + Obstacle Detection Robotic Vehicle.

A. Overview of the system

Voice Control (via a voice recognition module or speech recognition software). Bluetooth Control (via a Bluetooth module, like HC-05, controlled by a mobile app). Obstacle Detection (via ultrasonic or IR sensors). These functionalities interact with a central microcontroller, typically an Arduino or Raspberry Pi, which processes the commands from both the voice and Bluetooth modules and interacts with the motor driver to move the vehicle. The obstacle detection system continuously monitors the vehicle's surroundings and provides input for navigation adjustments.

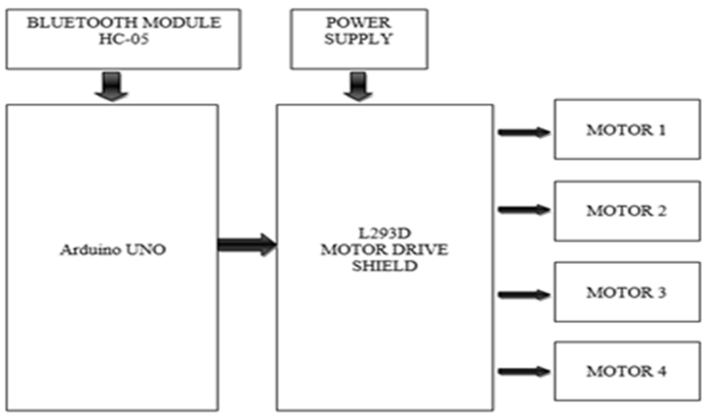

Fig1: Block Diagram of Voice Controlled and Obstacle Detection Robotic Vehicle

B. Implementation of transmitter

The implementation of a robotic vehicle with voice control, Bluetooth control, and obstacle detection combines advanced technologies to create a multifunctional system. The robotic vehicle uses a microcontroller like Arduino or ESP32 as its central processor, which integrates inputs from various modules. A Bluetooth module (e.g., HC-05) enables wireless communication with a smartphone or other devices, allowing users to send control commands manually via a paired app. For voice control, the system can utilize a smartphone app that translates voice commands into text-based instructions, which are then transmitted via Bluetooth to the robot.

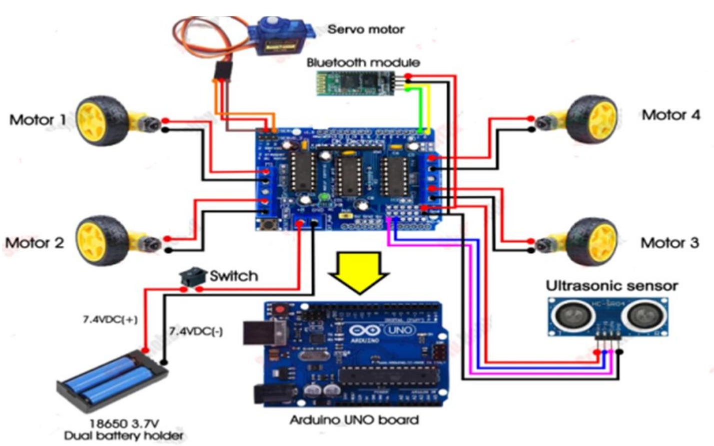

Fig 2: Transmitting model

C. Implementation of receiver

The implementation of the receiver for a voice-controlled, Bluetooth-controlled, and obstacle-detection robotic vehicle involves a microcontroller-based system that interprets incoming commands and translates them into motor actions. The receiver module consists of a Bluetooth communication interface, such as the HC-05 or HM-10, which pairs with a smartphone or other Bluetooth-enabled devices. Commands transmitted via Bluetooth are received by the microcontroller, processed, and used to control the vehicle's movement. For voice control, the smartphone app or voice module translates spoken commands into signals that the receiver decodes, enabling hands-free operation.

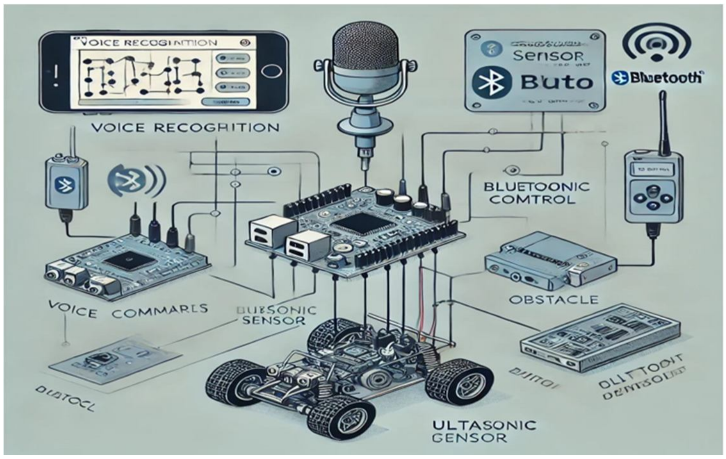

Fig 3: Receiver model

D. Algorithm

The software for this project involves multiple components working together to achieve the desired functionality. Each of the main subsystems (Voice Control, Bluetooth Control, and Obstacle Detection) has its own set of software requirements. Below are the key software applications and components used in this project. Bluetooth Library: The HC-05/HC-06 Bluetooth module communicates with the Arduino via serial communication. The program listens to serial data (commands like for Go, Back, Left, Right, Stop). Arduino Code: The program checks for commands received via Bluetooth and processes them to control the robot's movement through the Motor Driver (L298N).

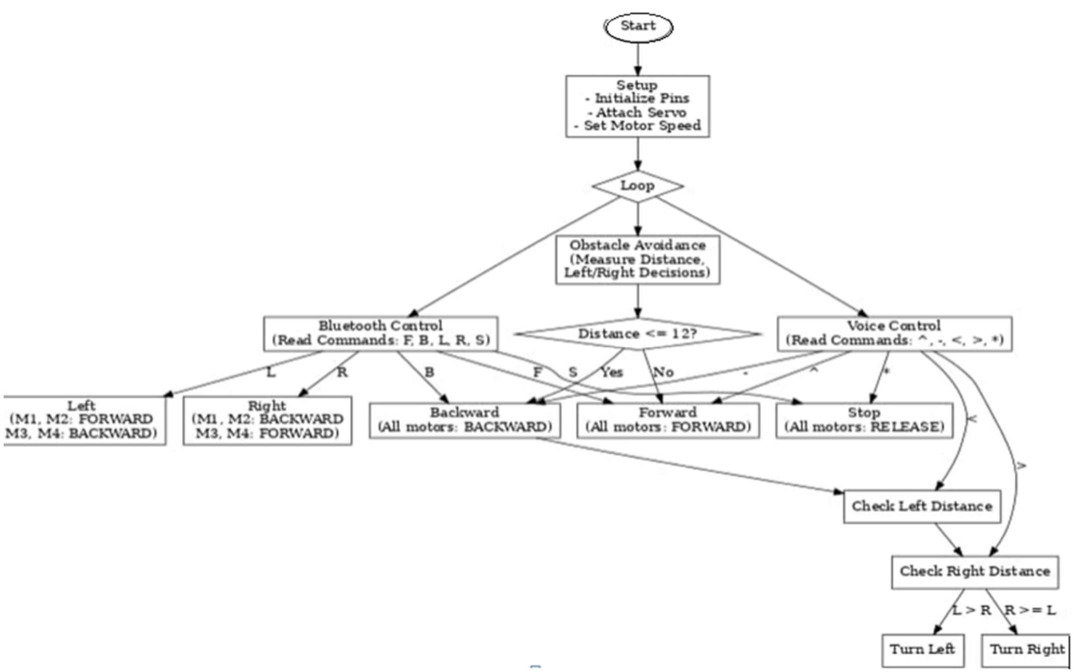

Fig 4: Flow chart of the task

E. Results and Discussion

The robot successfully responded to a predefined set of voice commands such as ”Move Forward,” ”Move Backward,” ”Turn Left,” ”Turn Right,” and ”Stop.” These commands were processed by a voice recognition module, which was integrated into the system either via a dedicated voice recognition chip or through a smartphone-based voice assistant.

Operational Test: In an ideal, quiet environment, the robot was able to move in the correct direction as per the voice command without any noticeable delay or error. The response was immediate upon voice command recognition. The robot’s movement was smooth and reliable under these conditions.

The Bluetooth functionality was integrated with a mobile application that communicated with the robot via the HC-05 Bluetooth module. Commands were issued through a graphical interface on the app, where users could control movement (forward, backward, left, right) and stop.

Operational Test: The Bluetooth control worked seamlessly within the expected range of 10-20 meters. The vehicle responded promptly to the control inputs, with minimal latency between command and action. The robot moved in all directions with precision when directed by Bluetooth.

Ultrasonic sensors (HC-SR04) were used for obstacle detection. The robot was able to autonomously detect objects in its path and avoid collisions by stopping, turning, or backing away based on the proximity of obstacles.

Operational Test: The system demonstrated the ability to detect and avoid stationary obstacles, ensuring that the robot did not collide with objects in its immediate vicinity. When obstacles were detected, the robot exhibited smooth, non-colliding avoidance maneuvers. The obstacle detection algorithm was triggered when the sensors detected an object within 15-30 cm.

IV. CONCLUSIONS

In conclusion, the voice-controlled, Bluetooth-controlled, and obstacle-avoidant robotic vehicle performed well under most test conditions. The system demonstrated high functionality and accuracy in both controlled and noisy environments, with Bluetooth control achieving near-perfect accuracy. Voice command accuracy, however, was sensitive to noise levels and command speed.

The robot’s speed was appropriate for most use cases, but obstacle avoidance reduced speed for safety. The primary challenge was the limited obstacle detection range and the robot’s occasional inability to detect small or irregularly shaped objects. The test scenarios revealed that while the robot excelled in predictable environments, improvements in sensor accuracy and response times will be necessary for enhanced performance in real-world, cluttered, or dynamic environments.

Future work will focus on integrating additional sensors, improving voice recognition in noisy environments, and optimizing the robot’s path-planning algorithms to enhance its autonomous capabilities.

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