Unmanned Voice Controlled Robotic Car Used in Application of Inaccessible Area

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I. ABSTRACT

A voice-controlled robotic system presents a practical solution for operations in hazardous and inaccessible environments where human intervention may be risky [1], [2], [9]. Verbal commands are fundamental to human communication, making voice-based control intuitive for robotic systems [3], [8]. In this project, a robotic vehicle has been developed that operates through voice instructions transmitted via an Android smartphone, using Bluetooth communication with the HC-05 module and an Arduino Uno microcontroller [1], [4], [6]. The vehicle's movement is powered by two DC gear motors managed through a motor driver circuit (L293D), enabling it to move forward, backward, left, and right based on the commands [5], [7]. Commands captured through the Android application are converted into control signals, sent via Bluetooth to the Arduino, and executed through the motor driver shield [4], [5]. An ultrasonic sensor was integrated for obstacle detection and avoidance, safeguarding the robot's movement in complex terrains [2], [10]. Initial tests validated the reliability and effectiveness of the system in inaccessible areas, demonstrating its practical applications in real-world scenarios [2], [10].

II. KEYWORDS

Robotic Vehicle, Plan, Voice control, Micro controller, Bluetooth, Module, Performance, Arduino UNO and Android Application.

III. INTRODUCTION

Robotics is an evolving field that continuously adapts to technological advancements, similar to Darwin's theory of "Survival of the Fittest," where only the most efficient technologies survive over time [9]. Although numerous methods exist to design and control robots, predicting which technology will dominate the future remains uncertain. The need for robotic systems that can function in hazardous and inaccessible environments, such as disaster sites, extreme temperature zones, caves, or battlefields, has grown significantly [2], [9]. Deploying unmanned vehicles in such areas reduces human risk and increases operational efficiency. This project focuses on designing a voice-controlled robotic vehicle operated through an Android smartphone application, establishing communication via the Bluetooth module HC-05 [1], [4]. The robotic car receives voice commands wirelessly, transmitted by the smartphone and processed by the Arduino Uno microcontroller embedded in the system [1], [5], [6]. By employing the Android interface, the user can issue instructions to move the vehicle forward, backward, left, and right, enabling flexible navigation even in inaccessible terrains [5], [7].

A motor driver circuit (L293D) facilitates the control of the two DC gear motors based on instructions received from the Arduino [5]. An ultrasonic sensor is incorporated to detect obstacles in the vehicle's path, enhancing the reliability and safety of operation [2], [10]. The Bluetooth-based wireless communication ensures seamless interaction between the smartphone and the robotic car, providing a practical, low-cost solution for remote navigation tasks [4], [7].

Additionally, the foundation of this voice-control system relies heavily on Speech Recognition technology, which allows machines to interpret and act upon spoken commands without requiring traditional input devices [3], [8]. As speech continues to emerge as a dominant human-machine interaction method, integrating it into mobile robotic platforms offers a promising avenue for accessible and intuitive robot control [8].

IV. OBJECTIVE OF THE PROJECT

-To design and develop a robotic vehicle that can be operated through human voice commands, minimizing the need for manual control.

-To explore the functionalities of the Arduino Uno microcontroller and implement its features using the Arduino IDE for embedded system applications.

-To establish efficient wireless communication between a mobile application and the robotic vehicle using the Bluetooth HC-05 module, enabling real-time control.

V. LITERATURE SURVEY

The field of robotics has witnessed significant advancements over the past decades, fuelled by rapid technological developments and the increasing need for automation [9]. Studies show that global interest in modern robotics surged by approximately 19% in 2003, with subsequent growth of 18% the following year, reflecting a consistent rise in demand for autonomous systems [9]. Over 600,000 household robots were already in use by the late 2000s, and projections indicated several million more would be deployed in the coming years [9].

Various researchers have explored diverse approaches to enhancing robotic systems using mobile devices, Bluetooth communication, and microcontrollers. Pathak et al. [5] demonstrated the use of Android smartphones to control robotic vehicles via Bluetooth, showcasing simplified hardware design and efficient remote communication. Their work emphasized leveraging the powerful computing capabilities of Android platforms for robotic navigation.

Similarly, Yeole et al. [6] implemented a robotic vehicle controlled through an Android smartphone utilizing the ATMEGA328 microcontroller. Their design incorporated Bluetooth connectivity to transmit control commands, with features such as obstacle detection and feedback systems integrated to improve user interaction.

Pahuja and Kumar [7] developed an Android-controlled Bluetooth robot employing the 8051 microcontroller, offering wireless mobility control for basic movement functionalities. Their approach highlighted how Android applications could efficiently manage robot movement directions.

Furthermore, Nasereddin and Abdelkarim [4] focused on building smartphone-controlled robots specifically through Bluetooth modules like HC-05, providing a low-cost, accessible method for real-time robot navigation. This system allows simple voice commands and button-based control mechanisms from mobile devices.

Kim et al. [1] explored the development of a voice-controlled unmanned vehicle using the Arduino platform, integrating voice recognition capabilities directly into the robotic control system. Their research demonstrated reliable voice-activated operations without the need for physical controllers.

Li et al. [2] designed an autonomous robotic car capable of navigating inaccessible environments, incorporating sensors for obstacle avoidance and autonomous pathfinding, making it suitable for use in areas hazardous to human entry.

Zhang [3] contributed to the domain by implementing voice recognition systems for the control of unmanned robots, demonstrating how natural language processing can effectively replace traditional manual control interfaces in robotic systems.

Speech recognition, as detailed by Huang et al. [8], has evolved as a pivotal technology enabling more intuitive human-robot interaction, allowing users to operate robotic vehicles using simple voice commands without specialized training.

Additionally, Siegwart et al. [10] emphasized the importance of integrating robust obstacle detection mechanisms, such as ultrasonic sensors, to enhance robot navigation in complex terrains, which aligns with the protective measures incorporated into our robotic car project.

VI. METHODOLOGY

TECHNOLOGIES USED FOR BUILDING A VOICE CONTROLLED ROBOTIC VEHICLE

1. Voice Recognition Software:

The voice recognition software interprets voice inputs and converts them into actionable commands for the robotic vehicle, allowing it to respond effectively to user interaction [1]. This system is key to enabling voice-based control, making it more accessible and user-friendly.

2. Microphone:

The microphone captures the user's voice input, which is then relayed to the voice recognition software for processing, as seen in other systems designed for assistive technology [3].

3. Motor and Motor Driver:

The motor, coupled with its driver, plays a critical role in managing the vehicle's movement. This setup allows the vehicle to move in response to processed commands, with precise torque control [2].

4. Sensor:

Various sensors, such as ultrasonic sensors and cameras, are used to detect obstacles and objects in the environment. These sensors contribute to the vehicle's ability to navigate autonomously [3].

5. Wireless Communication:

The vehicle utilizes wireless communication technologies, including Wi-Fi, Bluetooth, and Zigbee, to receive commands and communicate with other devices. In this project, the Bluetooth module HC05 has been specifically chosen for seamless connectivity [1].

6. Battery and Power Management:

The vehicle is powered by a rechargeable battery, and the power management system ensures efficient energy use while reducing the need for frequent battery replacements [2].

VII. PROPOSED SYSTEM

Voice recognition and speech processing are well-established fields within robotics, with numerous applications in assistive technologies [1]. The goal of this project is to design a voice-controlled system aimed at aiding individuals with disabilities by recognizing vocal commands and enabling seamless interaction with the robotic vehicle. This system incorporates an Arduino Uno microcontroller, connected to an L293D motor driver shield, and is controlled via a Bluetooth module HC05. By integrating two servo motors and voice control through an app interface, this system empowers individuals with mobility impairments to independently navigate their environment [2][3].

VIII. FLOW CHART

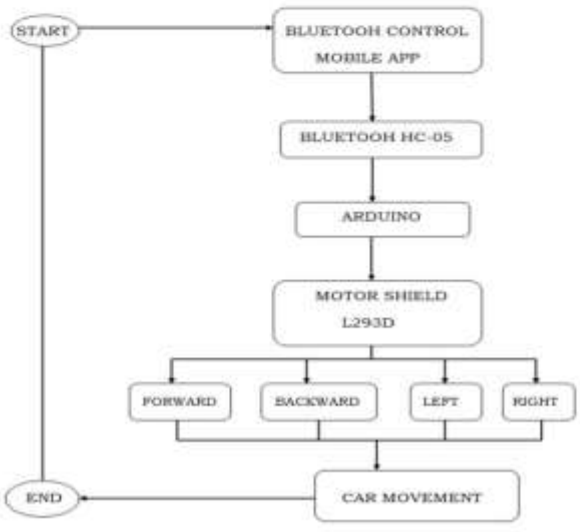

Fig.: Flow Chart of the model

Commands are sent to the robotic vehicle through a mobile application. Initially, the device must pair with the HC-05 Bluetooth module to establish a connection. Once the pairing is successful, the user can begin inputting commands displayed on the app's screen. After a command is selected, these instructions are sent to the Arduino via the Bluetooth module. The Arduino processes the command, and if the uploaded code matches the given instruction, it activates the Motor Shield L293D, which allows the car to move forward, backward, and turn left or right as required [1][2]. The flowchart for the voice-controlled robotic car system is shown above.

IX. SYSTEM ARCHITECTURE

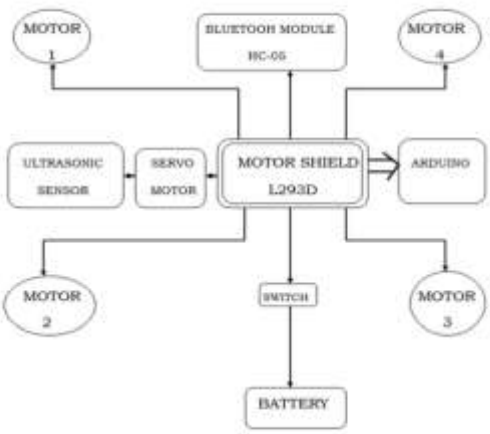

Fig.: Block Diagram of the model

The diagram presented depicts a Voice Controlled Robotic Car, featuring a Motor Shield L293D that is linked to an Arduino. The design includes a Bluetooth Module HC-05, a Servo Motor, an Ultrasonic Sensor, four DC Motors and a battery supply, all connected to the Motor Shield L293D, as illustrated in the previous figure.

X. CIRCUIT DIAGRAM

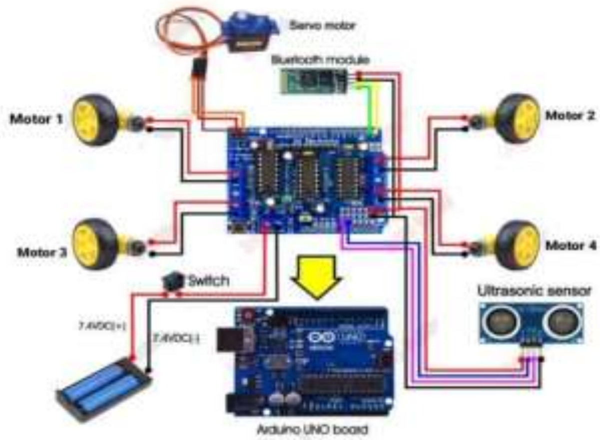

Fig.: Circuit diagram of voice controlled robotic car

The circuit diagram of the vehicle is shown in the figure, where the L293D motor driver shield is mounted on the Arduino UNO. The four motors, labelled M1, M2, M3, and M4, are connected to the PWM pins as specified. The RX and TX pins of the HC-05 Bluetooth module are linked to D0 and D1 of the motor shield L293D. The remaining two pins of the Bluetooth module are connected to Ground and +5v, respectively. The ultrasonic sensor's two pins are attached to the A0 and A1 analog pins on the L293D, with the other two pins connected to Ground and +5v. The servo motor is linked to terminal 1 of the servo connection, and the battery is connected to the external motor power pin on the L293D [1][2].

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XII. RESULTS AND CONCLUSION

Voice-controlled commands are effectively delivered through the HC-05 Bluetooth module, triggering the intended operations that allow the voice-controlled vehicle to operate. This project minimizes human effort in environments and circumstances where direct human interaction is tough and demanding. These systems can be utilized effectively in settings like industrial sites, surveillance zones, caves, and more.
Table : Few tests done through Bluetooth to the robotic vehicle that includes passed and failed cases.

Test case	Input	Expected output	Output	Result
When the voice is not recognized by application	The speech recognition module should process the voice command to identify "Go."	To confirm the results, the vehicle's movement should be monitored and compared to the anticipated outcome.	It alerts the user to attempt again	Failure
When the voice is identified and a valid command (direction) is issued	The microcontroller or processor must then produce the appropriate control signals for the motor control module, which will turn the vehicle to the left and propel it forward.	The output may also be observed using sensors or cameras mounted on the vehicle, and the results can be evaluated to confirm that the vehicle is moving as intended.	A message will be dispatched to execute the respective actions and move in that direction	Success
When an incorrect command is entered	The input cannot be processed	It might be an erroneous command	The application notifies the user with an error message.	Failure

XIII. REFERENCES

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