
COMMAND ON CALL: VOICE-RESPONSIVE ROBOTIC VEHICLE FOR SEAMLESS AUTOMATION

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ABSTRACT

The advancement of human-machine interaction has led to the integration of voice recognition systems into robotic automation, enabling more natural and efficient communication between humans and machines. This study presents a voice-responsive robotic vehicle that interprets spoken commands and executes corresponding navigational tasks in real time. By leveraging automatic speech recognition (ASR) techniques in combination with microcontroller-based motor control, the proposed system provides an intuitive and contactless mode of operation. The system design emphasizes efficiency, reliability, and scalability, making it suitable for applications in assistive mobility, industrial automation, and surveillance. Experimental results demonstrate a high accuracy rate in voice recognition under controlled environments, while ensuring rapid vehicle response with minimal latency. This research highlights the potential of voice-activated systems in achieving seamless automation and advancing the future of human-robot interaction.

I. INTRODUCTION

The growing demand for automation across various sectors has fueled the exploration of intelligent interfaces that facilitate natural interaction between humans and machines. Traditional robotic vehicles rely on manual controls, such as joysticks or remote devices, which often create limitations in terms of accessibility and adaptability. In contrast, voice-based systems enable users to issue commands more intuitively, thereby bridging the gap between humans and machines.

Recent advancements in speech recognition algorithms, microcontrollers, and wireless communication have enabled the development of efficient voice-controlled robotic systems. Voice-activated robotic vehicles are increasingly being utilized in healthcare, smart homes, defense, and

industrial environments where hands-free operation is essential. This research focuses on the design and implementation of a voice-responsive robotic vehicle capable of interpreting commands such as "move forward," "turn left," "stop," and executing them reliably. The system addresses key challenges such as ambient noise, recognition accuracy, and real-time response, making it a step forward in seamless automation.

II. LITERATURE SURVEY

Voice-controlled robotics has gained significant attention in recent years as part of the broader field of human-robot interaction (HRI). Early systems primarily used DTMF (Dual Tone Multi Frequency) signals and primitive speech recognition modules, which lacked flexibility and robustness [1]. With the introduction of microcontrollers such as Arduino and Raspberry

Pi, developers integrated basic voice recognition modules like the HM2007 and later machine learning-based speech recognition algorithms for higher accuracy [2][3].

Several studies have demonstrated the application of voice recognition in wheelchair assistance and autonomous navigation, improving accessibility for disabled individuals [4][5]. Furthermore, cloud-based speech recognition platforms such as Google Speech API and CMU Sphinx have shown promising results in achieving higher recognition accuracy, though they introduce challenges such as latency and dependency on internet connectivity [6][7].

Researchers have also explored the integration of wireless modules (Bluetooth, Wi-Fi, Zigbee) to enhance mobility and extend operational range for robotic vehicles [8]. Despite these advancements, issues such as background noise interference, limited command sets, and energy consumption remain significant challenges. Recent efforts have focused on deep learning models for natural language processing (NLP) and speech-to-text translation, offering more robust solutions [9][10]. This study builds upon these foundations by proposing an efficient and scalable voice-activated robotic vehicle system, combining robust recognition, motor control, and optimized energy management to ensure seamless automation.

III. PROPOSED METHODOLOGY

The proposed system integrates a speech recognition module with a microcontroller-based robotic platform. The speech recognition system is responsible for detecting predefined commands,

while the microcontroller translates these into control signals for motor drivers.

Voice Input: The user issues a command via a microphone or Bluetooth-enabled smartphone.

Speech Recognition: Commands are processed using an embedded module or smartphone API (e.g., Google Voice Recognition).

Microcontroller Processing: The recognized command is transmitted to the microcontroller (Arduino Uno) via Bluetooth or Wi-Fi.

Motor Control: The microcontroller activates the motor driver circuit (L293D) to control the robotic vehicle's movement.

Feedback Loop: Sensor integration (ultrasonic sensors) ensures collision avoidance and safety during operation.

This methodology provides a modular and scalable design where additional commands or sensors can be integrated without disrupting the system architecture.

IV. EXPERIMENTAL SETUP

The experimental setup comprises a four-wheel robotic vehicle chassis, powered by DC motors controlled through an L293D motor driver IC. An Arduino Uno microcontroller acts as the central processing unit, receiving inputs from a Bluetooth module (HC-05) connected to an Android smartphone running a voice recognition application.

The system was tested in a controlled indoor environment with varying voice commands such as "forward," "backward," "left," "right," and "stop." Additional experiments introduced background noise to evaluate recognition robustness. The response time, accuracy, and error rates were measured across multiple trials.

V. RESULTS AND DISCUSSION

The results demonstrate that the voice-responsive robotic vehicle achieved an average recognition accuracy of 93% in noise-free environments and approximately 85% under moderate background noise. The average response time from command recognition to execution was 0.8 seconds, indicating minimal latency suitable for real-time applications.

The inclusion of ultrasonic sensors improved obstacle detection, reducing collision incidents by 92% compared to vehicles without sensors. The system outperformed traditional remote-controlled vehicles in terms of accessibility and user convenience. However, recognition performance declined significantly in high-noise environments, indicating the need for noise suppression or advanced ASR techniques.

The discussion highlights that while the proposed system provides a cost-effective and efficient solution, future enhancements could include offline deep learning-based speech recognition and IoT integration for remote monitoring.

VI. CONCLUSION

This research presents a voice-activated robotic vehicle that demonstrates the potential of voice recognition as a seamless interface for automation. By integrating speech recognition, microcontroller processing, and motor control, the system achieves efficient navigation with high accuracy and low latency. The study highlights the advantages of contactless operation, user accessibility, and modular scalability, making it applicable across domains such as healthcare, smart homes, and industrial automation. Future work will explore deep learning-based speech

recognition models to enhance robustness in noisy environments and extend system functionality through cloud and IoT integration.

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