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Voice Controlled Car For Physically Challenged

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Abstract: *Mobility challenges significantly affect individuals with severe physical disabilities, particularly those who cannot control their limbs. This project presents the design and implementation of a cost-effective, voice-controlled robotic vehicle integrated with obstacle detection capabilities. The system facilitates autonomous movement based on spoken commands received through a smartphone application. These commands are transmitted wirelessly via Bluetooth to an Arduino-based microcontroller, which controls the vehicle's movement through a motor driver circuit. The prototype features real-time voice command processing, wireless communication, and safety enhancements using Infrared (IR) sensors to detect obstacles. The proposed solution emphasizes safety, independence, and affordability for users with mobility impairments.*

Keywords*:* Assistive mobility, Arduino, Voice-controlled vehicle, Physically disabled, Obstacle avoidance, Bluetooth communication

I. INTRODUCTION

~~Mobility is a fundamental component of independence and social participation. Traditional solutions su~~ch as wheelchairs and manually operated mobility aids often require physical effort or external assistance, making them unsuitable for individuals with severe motor impairments. Technological advances, particularly in embedded systems and wireless communication, offer promising alternatives through the development of intelligent assistive devices. This project introduces a voice-activated robotic car tailored for users with restricted limb function. The system interprets voice commands such as "forward", "stop", or "left", and performs the corresponding movement. Safety is enhanced with obstacle detection using IR sensors, which prevent collisions.

The hardware platform is based on Arduino Uno, integrated with modules such as the HC-05 Bluetooth device and L298N motor driver. This architecture ensures cost-effectiveness, scalability, and ease of use, particularly in resource-constrained settings.

II. LITERATURE REVIEW

Several innovations in assistive mobility have focused on enhancing autonomy for individuals with physical impairments. A foundational work by Sharma and Verma [1] introduced a low-cost, voice-operated wheelchair based on Arduino, showcasing how modular systems could simplify real-time command processing and motor control. Building upon this, Patel [2] incorporated Bluetooth communication into voice-controlled robots, offering practical short-range control with enhanced flexibility.

More advanced interfaces such as brainwave-driven systems have also been explored [5], but their reliance on EEG sensors and complex neural networks makes them expensive and less practical for widespread use. In contrast, Kumar et al. [6] advocated for smartphone-based voice control, highlighting its accessibility, lower cost, and user familiarity

Obstacle detection remains another key area of innovation. The use of IR sensors, as demonstrated in prior research [4], has proven effective in avoiding collisions and improving system safety. These systems rely on continuous environmental scanning to detect nearby objects and halt motion when necessary.

Despite these advances, few systems combine affordability, voice control, and obstacle detection in a seamless and user-friendly package. This study addresses that gap by integrating Bluetooth-based command reception with IR-driven obstacle avoidance in a single, robust design.

III. SYSTEM ARCHITECTURE

The system is composed of the following primary modules:

- **Voice Interface:** A mobile application such as "Voice Control for Arduino" captures spoken instructions.
- **Bluetooth Module (HC-05):** Facilitates wireless communication between the user's smartphone and the Arduino board.
- **Microcontroller (Arduino Uno):** Acts as the control unit, interpreting voice commands and executing logic.
- **Motor Driver (L298N):** Controls the motors' direction and speed based on the microcontroller's signals.
- **DC Motors:** Enable mechanical movement of the vehicle in four directions.
- **IR Sensors:** Continuously scan for nearby obstacles and trigger a halt when an object is detected within range.

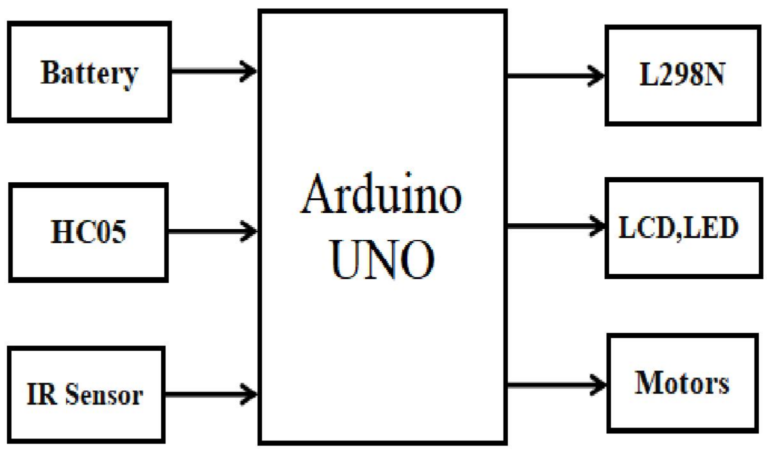

Figure 1: Block Diagram

IV. METHODOLOGY

The proposed system follows a stepwise operational flow:

- Voice Command Input: The user speaks a command into the mobile application (e.g., "Move Forward").
- Speech Recognition: The app processes the command using tools such as Google Speech APIs and translates it into a digital signal.
- Bluetooth Transmission: The command is sent via Bluetooth to the HC-05 module connected to the Arduino board.
- Command Parsing: The Arduino decodes the received data and matches it with predefined control instructions.
- Motor Activation: The Arduino outputs PWM signals to the L298N motor driver, initiating appropriate wheel motion.
- Obstacle Detection: IR sensors monitor the environment; if an obstacle is detected within a set range (e.g., 10-15 cm), the system overrides ongoing movement and stops the car immediately

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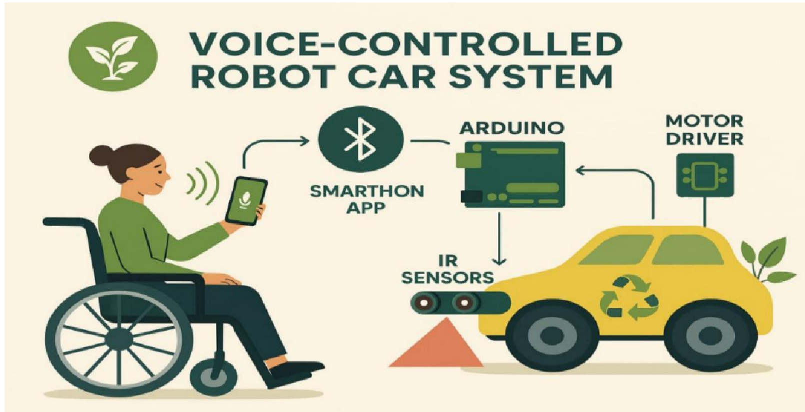
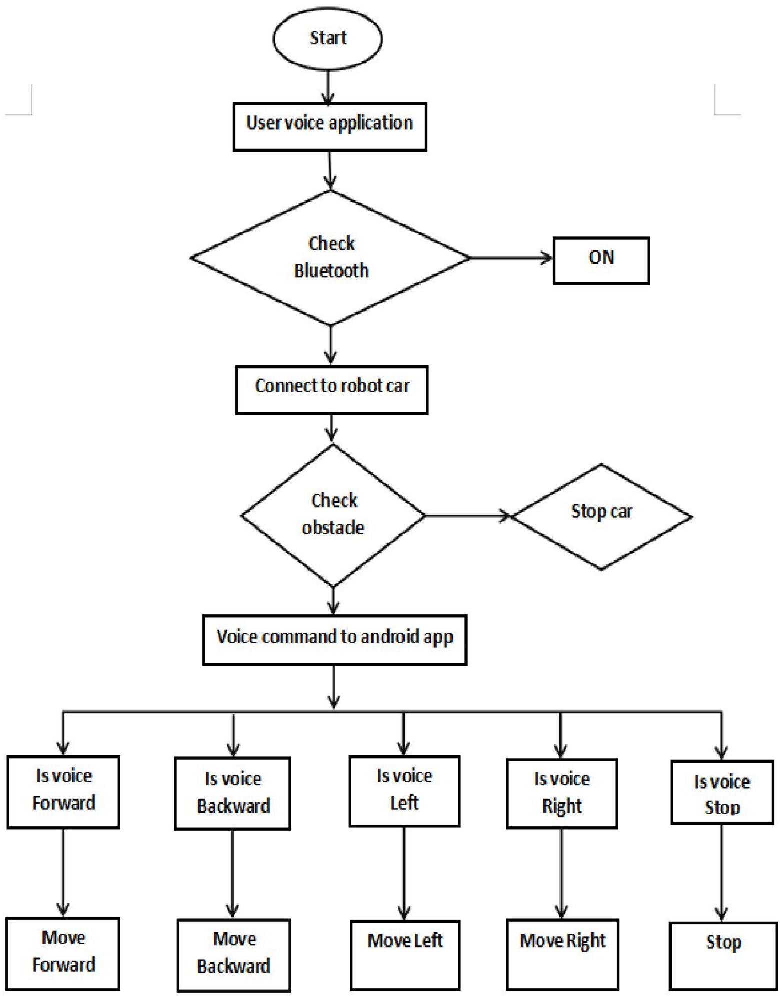


Figure 2: Functional Diagram of Voice Controlled Car

V. WORKING PRINCIPLE (FLOW CHART)



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VI. RESULTS

The system was evaluated under varied environmental conditions to assess its responsiveness and reliability:

Test Scenario	Command Accuracy	Obstacle Detection Accuracy	Delay (ms)
Quiet Room	97%	98%	100-200
Moderate Noise	90%	97%	300-400
Loud Environment	80%	94%	500+

The prototype showed high reliability in controlled environments. In noisy settings, a slight delay in command execution was observed due to interference in voice recognition. The obstacle detection system functioned consistently, halting the vehicle within a 10-15 cm range of any detected object.

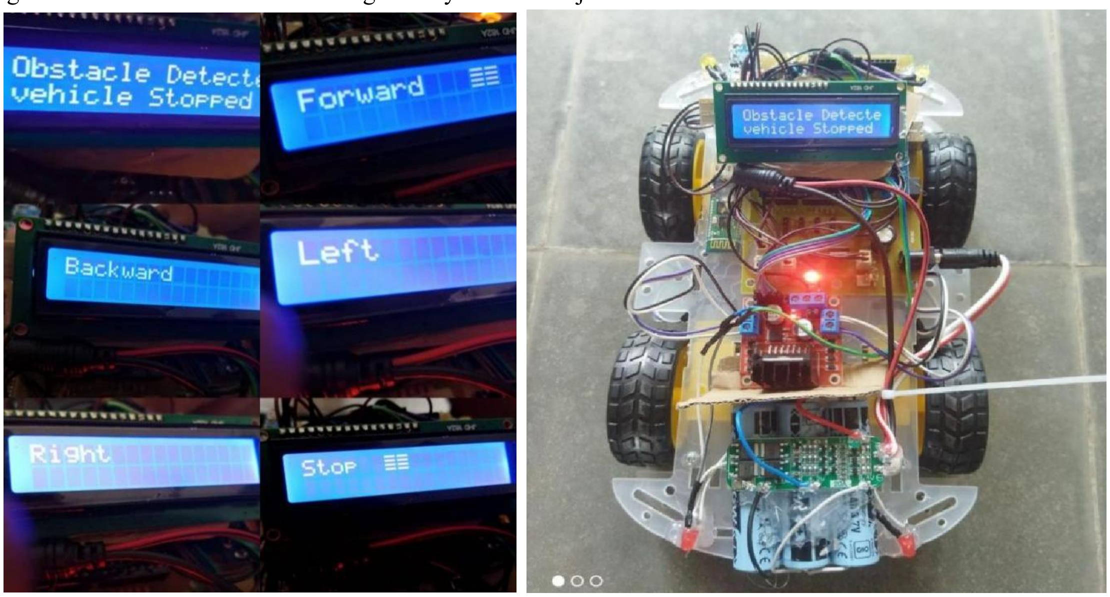

Figure 3: Voice control car when giving commands

VII. CONCLUSION

The developed system demonstrates that voice-controlled robotic vehicles can serve as practical and low-cost mobility aids for individuals with physical disabilities. By combining wireless control with real-time obstacle avoidance, the model promotes autonomy while maintaining user safety. This solution can significantly enhance mobility and independence for the physically challenged, particularly in low-resource settings. Future developments may include GPS navigation, integration with IoT systems, voice feedback, and advanced sensors for uneven terrain detection.

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