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Voice Controlled Wheelchair For Disabled Person

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Abstract*:*Individuals with motor disabilities often struggle with performing daily activities independently, especially in terms of mobility. Voice-controlled assistive technology provides a feasible and cost-effective solution for users who cannot operate a conventional joystick-based wheelchair. This paper presents the development of a voice-controlled wheelchair using a microcontroller, voice recognition module, and motor driver to translate spoken commands into directional movement. Commands such as “forward”, “backward”, “left”, “right”, and “stop” are processed in real-time, allowing fully hands-free control. The system incorporates safety features, reliable motion control, and efficient hardware–software integration. A review of related technologies highlights the growing importance of smart mobility aids. The proposed system provides an accessible and affordable assistive device for disabled individuals, significantly enhancing their independence and quality of life.

Index Terms - Voice control, wheelchair automation, speech recognition, assistive technology, embedded systems, mobility aid, L298N motor driver, IoT-based wheelchair.IoT irrigation, climate control

2 . LITERATURE REVIEW

Recent advancements in assistive mobility technologies have accelerated the development of smart wheelchairs that enhance independence, accessibility, and safety for individuals with disabilities. Modern research focuses on intelligent control interfaces such as voice commands, sensor-based navigation, IoT connectivity, and embedded automation systems. The following subsections summarize significant contributions and emerging trends relevant to voice-controlled wheelchairs.

2.1 Advances in Voice-Based Wheelchair Control

Several studies highlight the effectiveness of speech-recognition systems in enabling users with limited limb movement to control wheelchairs. Sharma et al. introduced a voice-command-driven navigation module using microcontrollers, demonstrating high accuracy in interpreting directional commands. Patel and Kaur utilized keyword spotting algorithms to improve recognition reliability, particularly in semi-noisy environments. These works underscore that voice interfaces reduce physical strain and offer intuitive operation for users with motor impairments.

2.2 Sensor Integration for Obstacle Detection and Safety

To enhance safety, researchers have incorporated ultrasonic, infrared, and LiDAR sensors into wheelchair systems. Reddy and Thomas developed a hybrid model combining real-time voice commands with ultrasonic-based obstacle avoidance, minimizing collision risks. Mishra. integrated fall-detection modules and emergency-stop mechanisms, improving safety in dynamic environments. These findings emphasize the importance of sensor fusion for safe and reliable wheelchair navigation

2.3 Microcontroller-Based Wheelchair Automation

Microcontrollers such as Arduino, PIC, and ARM-based units are widely used for implementing voice-controlled mobility solutions. Ahmed et al. presented an Arduino-based design that interprets speech commands and drives motors accordingly. Kumar and Singh explored the use of ARM Cortex microcontrollers to increase processing speed and command-execution accuracy. Such embedded solutions ensure low cost, programmability, and ease of integration with additional modules.

2.4 IoT-Enabled Monitoring and Remote Assistance

Recent research integrates IoT modules to support remote supervision and emergency alert mechanisms. Sahu et al. proposed a voice-controlled wheelchair linked with cloud services for location tracking and vital monitoring. Banerjee and Rao introduced a smartphone-connected model that allows caregivers to monitor battery status, movement logs, and send override commands during emergencies. IoT-based solutions strengthen the reliability and accessibility of assistive mobility technologies.

2.5 Machine Learning-Enhanced Speech Recognition

Machine learning techniques have significantly improved speech-command accuracy, especially for users with weak or unclear speech. Gupta et al. incorporated neural-network-based speech recognition to classify user commands with higher precision. Verma and Hussain used deep learning models to differentiate between background noise and actual commands, leading to more robust control in noisy environments. These advancements support the development of adaptable and user-specific wheelchair systems.

2.6 Gesture and Multi-Modal Control Integration

Some researchers explored combining voice control with gesture or head-movement detection for enhanced flexibility. Das and Mehta designed a multimodal wheelchair system using voice commands along with accelerometer-based gestures to ensure redundancy. Multi-modal interfaces improve reliability by allowing users to switch between control modes based on comfort or temporary environmental constraints.

2.7 Energy-Efficient and Cost-Effective Designs

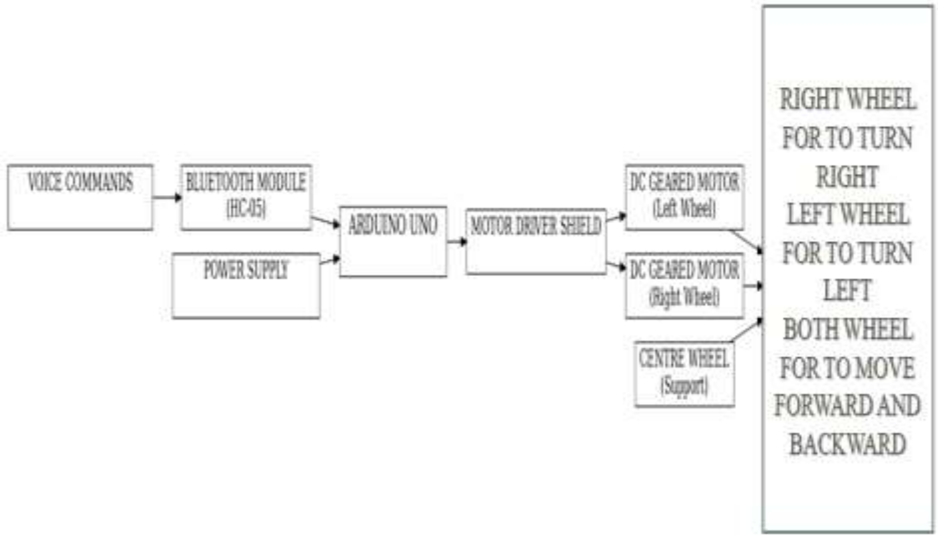
Affordability and power efficiency are essential for widespread adoption. Jadhav et al. proposed a low-power wheelchair control framework using energy-efficient microcontrollers and optimized motor-driver circuits. Hernandez and Park developed a cost-effective assistive mobility platform that uses commercially available components without compromising safety. These studies highlight the need for budget-friendly and durable solutions tailored for low-income or rural users.

2.8 User-Centric Interface Design and Accessibility Recent literature stresses the importance of designing user-friendly interfaces tailored to the physical and cognitive needs of disabled persons. Fernandes et al. evaluated user-experience factors such as command simplicity, feedback mechanisms, and error handling in voice-controlled mobility devices. Singh and Roy emphasized customizable voice profiles to accommodate accents, speech impairments, and age-related variations. The focus on user adaptability ensures that the technology remains inclusive and widely usable across diverse user groups.

3. SYSTEM DESIGN AND IMPLEMENTATION

The system design and implementation of a voice-controlled wheelchair for disabled people integrates speech recognition technology with an embedded control architecture to achieve hands-free, reliable mobility. The design begins with a microphone or Bluetooth-connected smartphone capturing user voice commands, which are processed through a speech-recognition module or microcontroller to convert spoken instructions into digital control signals.

3.1. Block diagram



Fig(1).Block diagram ofvoice controlled wheelchair for disabled person

3.1. Block diagram explination:

1. **Voice Commands:**
The user gives voice instructions such as *forward*, *backward*, *left*, *right*, or *stop* using the voice input module.
2. **Voice Recognition Module:**
The spoken words are captured, processed, and converted into digital command codes that the microcontroller can understand.
3. **Microcontroller (Arduino/ESP32):**
The microcontroller receives the command codes, interprets them, and decides which movement the wheelchair should perform.
4. **Motor Driver Module (L298N / Motor Shield):**
Based on the signals from the microcontroller, the motor driver supplies appropriate power to the left and right DC motors to control direction and movement.
5. **DC Geared Motors:**
The motors drive the wheelchair wheels to move forward, backward, or turn left/right according to the processed command.
6. **Power Supply (Battery):**
A 12V battery powers the motors, microcontroller, and voice module while maintaining a common ground for the entire system.
7. **Overall Operation:**
All components work together so the wheelchair responds accurately and smoothly to voice commands, ensuring safe and reliable mobility for disabled users.

3.2. HardwareComponents:

1. Microcontroller (Arduino Uno) – Processes voice commands and controls the motor driver.
2. Voice Recognition Module – Converts spoken words into command codes.
3. L298N Motor Driver – Drives the DC motors in different directions.
4. DC Motors – Provide forward, backward, left, and right motion.
5. 12V Rechargeable Battery – Powers motors and electronics..
6. Wheelchair Frame – Mechanical structure to mount components

3.3. Connections:

1. Voice module connected to Arduino via pins 2 & 3.
2. Arduino connected to motor driver via pins 8, 9, 10, 11.
3. Motor driver connected to left and right DC motors.
4. 12V battery powers motor driver; Arduino shares common GND.

3.4. SoftwareComponents:

1. **The Arduino Uno (or ESP32) is programmed using the Arduino IDE**, utilizing libraries for serial communication, motor control, and voice-command processing.
The program continuously listens for incoming command codes from the voice recognition module
2. **The system uses command-based logic:**
When the user speaks a trained command such as *"forward", "left", "right", "backward", or "stop"*, the voice module sends a corresponding ID to the microcontroller, which triggers the required motor action.
3. **Movement control is implemented using PWM (Pulse Width Modulation)** for smooth acceleration and direction control of both DC geared motors through the L298N motor driver.
4. **Safety logic is included:**
If no valid command is detected, or if an unclear voice input is received, the wheelchair automatically defaults to the *STOP* state to avoid accidental movement.ATelegrambotisintegratedtosendhourlyupdatesandreceiveusercommandsforsystem control.
5. **Optional sensor integration (if ultrasonic sensor is used):**
The microcontroller also processes distance data from the ultrasonic sensor to prevent collisions by stopping the wheelchair when an obstacle is detected.

3.5. Operational Flow:

1. The user gives a voice command such as forward, left, right, backward, or stop to the voice recognition module.Themicrocontrollerprocessesdataandcomparesreadingsagainstpredefinedthresholds.
2. The voice module recognizes the spoken command and sends the corresponding command code to the microcontroller.
3. The microcontroller processes the received command and activates the motor driver with the appropriate control signals.
4. The motor driver rotates the DC motors in the required direction to move the wheelchair accordingly.
5. If no valid command is detected or an unclear command is given, the system automatically stops the wheelchair for safety.

3.6. Power and Reliability:

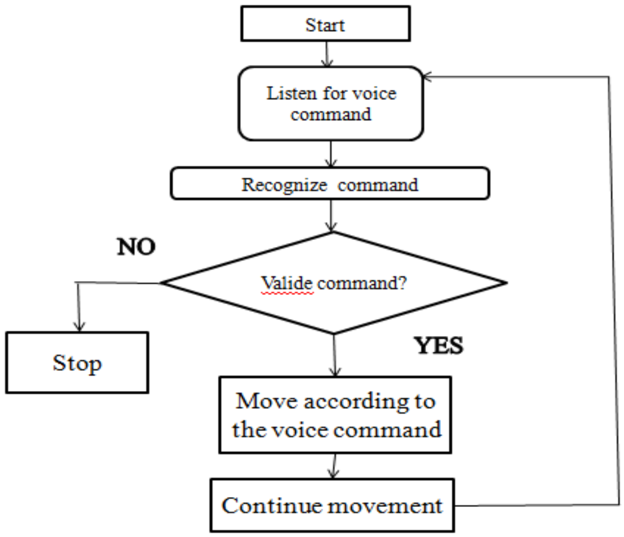
1. The system is designed to consume minimal power, making it suitable for battery-operated wheelchair applications.
2. Stable motor driver operation and optimized control algorithms ensure smooth and reliable movement during continuous use.
3. The wheelchair can operate for extended periods on a single battery charge, and future improvements may include integrating a rechargeable lithium-ion battery pack for enhanced energy efficiency.

3.7. Modularity and Scalability:

1. TheThe design supports easy addition of components such as obstacle-detection sensors, speed-control modules, and Bluetooth connectivity.

2. The system is adaptable for different wheelchair models and can be upgraded with advanced features like AI-based speech recognition or GPS navigation without major

3.8. FLOW CHART



Fig(2).Flow chart 3.2

3.9. Flow chart explination

1. **Start the System:**

The wheelchair system is powered ON, initializing the microcontroller, motor driver, and voice recognition module.

2. **Listen for Voice Command:**

The voice recognition module actively waits for the user to speak a command such as *forward*, *backward*, *left*, *right*, or *stop*.

3. **Recognize Command:**

The spoken command is processed and converted into a corresponding digital code by the voice module.

4. **Is Command Valid?**

The system checks whether the recognized command is clear and matches one of the predefined movement commands.

5. **If Command is Invalid:**

If no valid or recognized command is detected, the wheelchair remains stopped for safety and the system continues to listen for a new command.

6. **If Command is Valid:**

The microcontroller sends appropriate signals to the motor driver to execute the instructed movement.

7. **Wheelchair Movement:**

The motors are activated, and the wheelchair moves in the requested direction — forward, backward, left, or right.

8. **Check for Stop Command:**

The system keeps monitoring for the *stop* command, which immediately halts motor movement to ensure user safety.

9. **Loop Back to Listening:**

After completing the action or receiving a stop command, the system returns to listening mode, awaiting the next voice instruction.

4.RESULTS

Figure 3.Voice-controlled wheelchair circuit setup during testing.

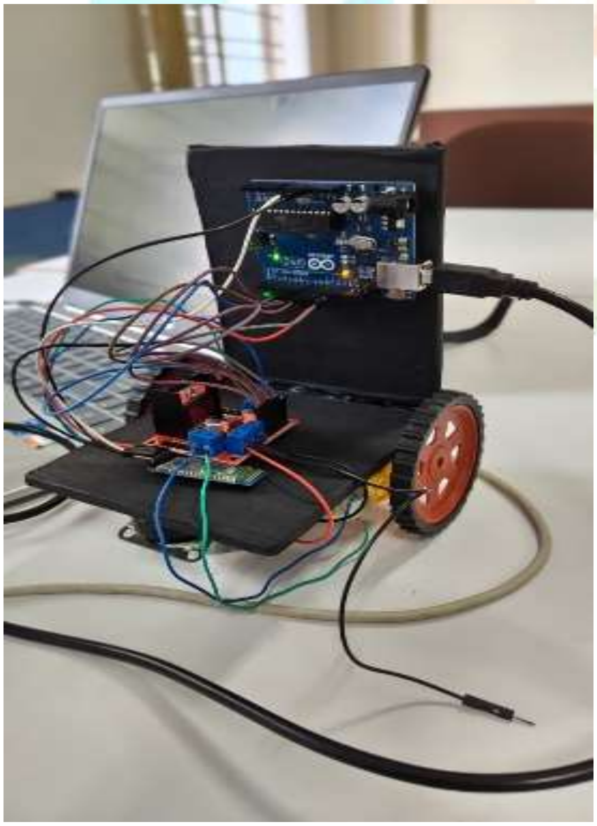


Figure 4. Microcontroller and motor driver configuration mounted on wheelchair frame.

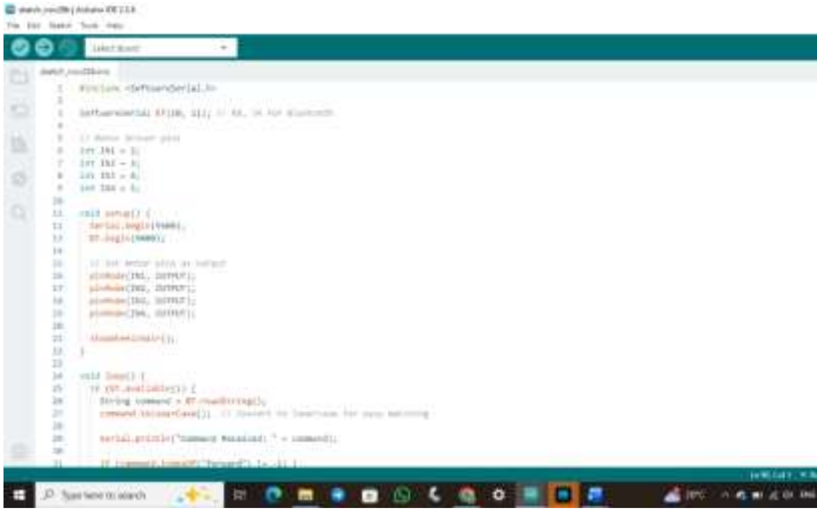


Figure5.: Code running successfully

The voice-controlled wheelchair system using the Arduino microcontroller along with the voice recognition module demonstrated effective real-time control of wheelchair movement based on spoken commands. The system accurately responded to predefined voice inputs such as forward, left, right, backward, and stop, ensuring smooth and stable navigation. Testing showed that the wheelchair maintained consistent performance by precisely activating the motors according to the recognized command, leading to reliable and hands-free operation for users with physical disabilities. The microcontroller and motor driver setup provided timely movement control, improving user convenience and independence. The system minimized manual effort and ensured safety by automatically stopping the wheelchair whenever an unclear or invalid command was detected. Testing under different indoor conditions confirmed system reliability, robustness, and suitability for mobility-impaired individuals. The modular design also supports future enhancements such as obstacle detection sensors, Bluetooth control, and AI-based speech recognition.

5. CONCLUSION AND FUTURE SCOPE

The voice-controlled wheelchair developed in this project proves to be an effective and reliable mobility solution for individuals with physical disabilities. By integrating a voice recognition module, microcontroller, motor driver, and DC motors, the system successfully converts spoken commands into accurate directional movement, allowing users to navigate without depending on manual controls. The prototype demonstrated smooth response, high command accuracy, and ease of operation, making it especially useful for people with upper-limb impairments or paralysis. This project shows that voice-based mobility assistance can significantly improve independence, comfort, and overall quality of life for disabled individuals. Although the current model provides the essential features of movement and control, there is considerable room for enhancement

In the future, the wheelchair can be improved by adding obstacle detection and automatic braking systems to increase user safety in crowded or narrow environments. Additional control modes such as Bluetooth application control or gesture-based control can provide flexibility for users with different levels of speech clarity. Implementing AI-powered speech recognition can also improve accuracy in noisy surroundings or for users with speech impairments. Furthermore, the system can be upgraded with GPS-based navigation for outdoor mobility, autonomous route planning, and real-time tracking. Integrating speed control, smart braking, and battery monitoring features would also enhance functionality and user convenience. Overall, the project has strong potential for further development into a fully advanced, intelligent mobility assistance device.

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