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Voice and Joystick Controlled Wheelchair for Physically Disabled Person

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Abstract - The Wheelchair Voice Controller project is designed to assist individuals with physical disabilities by enabling wheelchair operation through voice commands. The system uses a voice recognition module connected to a microcontroller that interprets commands such as "forward," "backward," "left," "right," and "stop," and sends corresponding signals to motor drivers that control the wheelchair's movement. This hands-free control method provides users with greater independence and ease of navigation in daily environments. To enhance reliability, the system also includes a joystick as an alternative manual control. This dual-mode functionality ensures continuous operation in scenarios where voice control may be ineffective, such as noisy surroundings or when the user is unable to speak. Both input methods allow smooth transitions and responsive control for better user experience.

The project emphasizes a balance between performance, cost-effectiveness, and usability, aiming to create a practical and affordable solution for people with mobility challenges. Overall, the project addresses the growing need for intelligent assistive technologies that improve the quality of life and independence for individuals with physical limitations.

Key Words: *Mobility assistance, Voice-controlled wheelchair, Speech recognition, Arduino Mega R3, Motor control, Assistive technology, Joystick Control*

1.INTRODUCTION

Wheelchairs play a vital role in enhancing the mobility and independence of individuals with physical disabilities. Generally, there are two primary types of wheelchairs. The first is the self-propelled wheelchair, which allows users to move by manually rotating the rims attached to the rear wheels using their hands and arms. The second type is the assistive-controlled wheelchair, which typically incorporates a joystick that enables either the user or a caregiver to navigate the wheelchair in the desired direction. However, both types rely heavily on the user's upper limb strength, dexterity, and coordination.

The assistive-controlled wheelchair, on the other hand, incorporates control interfaces such as a joystick, enabling the user or a caregiver to navigate the wheelchair with minimal physical effort. While this design significantly reduces the physical demands on the user, it still requires a certain degree of motor control and hand coordination, which may not be feasible for users with severe impairments such as quadriplegia, muscular dystrophy, or advanced-stage arthritis.

Such innovations not only enhance autonomy and quality of life for users but also reduce caregiver dependency, contributing to a more inclusive and accessible environment. The integration of microcontrollers, wireless communication, and sensor technologies continues to evolve, opening new avenues for personalized and intelligent wheelchair systems that adapt to individual user needs.

2. RELATED WORK

The development of assistive technologies, particularly intelligent wheelchairs, has been an area of extensive research aimed at improving mobility for individuals with disabilities. Various studies have explored different control mechanisms, including voice recognition, gesture-based control, and obstacle detection, to enhance user experience and safety. Early research in **neural systems and rehabilitation engineering** laid the foundation for modern assistive mobility technologies. Studies published in IEEE Transactions on Neural Systems and Rehabilitation Engineering (2002) [1] explored the integration of control systems with rehabilitation engineering to enhance wheelchair usability. These efforts provided a significant base for the advancement of intelligent mobility aids. A notable study by **Uchida et al. (2018) [2]** introduced a **voice-controlled automatic wheelchair** that employs speech recognition for movement control. Their findings demonstrated the feasibility and effectiveness of using voice commands to navigate a wheelchair, offering a more accessible solution for individuals with limited motor functions. Similarly, **Alim et al. (2021) [3]** developed a **voice-controlled intelligent wheelchair system** using **Arduino**. Their work emphasized improving system efficiency and reliability by integrating speech recognition technology for real-time command execution.While voice-based control is a promising solution, alternative approaches have also been explored. **Upender and Vardhini (2020) [4]** proposed a **hand gesture-based wheelchair** equipped with an emergency alert system. Although different from

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voice-controlled designs, their study highlighted the significance of providing multiple input methods for individuals with varying disabilities. Further research by **Suryawanshi et al. (2013) [5]** presented a **voice-operated intelligent wheelchair** with integrated obstacle detection, enhancing both navigation and safety. Similarly, **Karka Bahadur Rai et al. (2015) [6]** designed a **voice-controlled wheelchair using Arduino**, demonstrating a cost-effective solution for assistive mobility. Their study validated the practical application of microcontrollers in wheelchair automation. These studies collectively highlight the advancements in **voice-controlled wheelchair systems**, emphasizing the importance of integrating **speech recognition, obstacle detection, and emergency response features**. The insights gained from prior research serve as a foundation for the current work, focusing on enhancing accuracy, safety, and user adaptability in intelligent wheelchair design.

3. METHODOLOGY

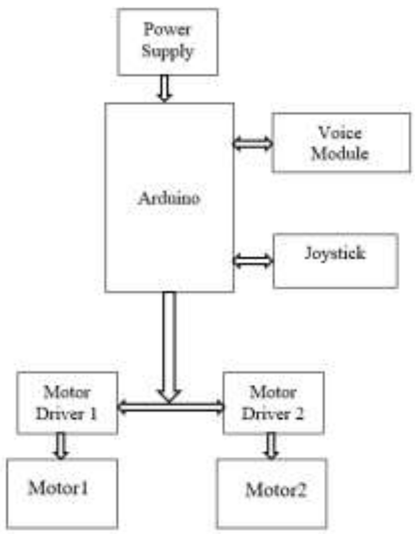

Fig 1. Block Diagram of Voice Controlled Wheelchair

***A. Arduino Mega R3*:** Serves as the central microcontroller responsible for managing inputs and coordinating motor control. It is chosen for its multiple UART ports, allowing simultaneous communication with the voice module and other peripherals. It features a powerful ATmega2560 processor, offering more memory and I/O pins compared to Arduino Uno, making it ideal for complex projects.

***B. Power Supply*:** A 12V battery powers the motors directly, while a voltage regulator steps down the voltage to 5V for the Arduino and connected modules.

C. Voice Module (V3 Voice Recognition Module): The V3 Voice Recognition Module serves as a key interface for hands-free control of the wheelchair. It supports offline voice recognition, enabling users to issue predefined commands such as “Forward,” “Backward,” “Left,” “Right,” and “Stop” without the need for internet connectivity. This enhances the system's reliability in both indoor and outdoor environments, including those with limited or no network access.

D. *Joystick Module:* Provides an alternative manual control option. The joystick outputs analog signals, which are read by the Arduino to determine direction and speed.

E. *Motor Drivers (BTS7960)*: Two motor drivers control the left and right DC motors respectively. These high-power drivers receive direction and speed commands from the Arduino and adjust the motor operation accordingly.

F. DC Motors: Responsible for the actual movement of the wheelchair. They respond to signals from the motor drivers to move forward, backward, or turn.

4. WORKING

1. Power Supply and System Initialization

The wheelchair system is powered by a 12V rechargeable battery, which supplies power to both the motors and control units. A voltage regulator steps down this voltage to 5V to power the microcontroller (Arduino Mega R3) and peripheral modules. Upon startup, the Arduino Mega initializes all connected devices, including the VC-03 voice recognition module, joystick interface, and dual BTS7960 motor drivers. The multiple UART ports of the Arduino Mega allow reliable and simultaneous communication with all modules.

2. Voice Command Input and Processing (V3 Module)

The Elechouse Voice Recognition Module V3 is a speaker-dependent, offline module that enables voice-based control of devices without requiring internet access. It communicates with the Arduino Mega via UART and identifies pre-trained voice commands. Once a command is recognized, it sends a unique ID to the Arduino, which then performs the corresponding motor action for wheelchair movement. The module supports up to 80 voice commands, with 7 active commands available at a time for real-time recognition. Its offline functionality ensures reliability in environments with limited or no connectivity, enhancing user independence and mobility.

Fig 2. Voice Recognition Module

The table below lists commonly used voice commands

Commands	Output
Front	Motor 1 and motor 2 moves forward
Back	Motor 1 and motor 2 moves backward
Left	Only Motor 1 moves forward and rotates to left
Right	Only Motor 2 moves forward and rotates to right

Table 1. Voice Commands

These voice commands serve as direct inputs to control the wheelchair's movement based on user instructions. Each recognized command triggers specific motor actions, enabling smooth navigation in the intended direction without manual intervention.

3. Joystick-Based Manual Control

In addition to voice control, a joystick module provides manual input capability. The joystick generates analog voltage signals corresponding to the user's input direction. These signals are read by the Arduino's analog pins and translated into directional commands. This dual-control approach ensures that the wheelchair remains functional even in situations where voice input is not practical, such as noisy environments or user speech limitations.[3]

Fig 3. Joystick

4. Motor Control and Wheelchair Movement

The Arduino Mega receives inputs from either the voice module (V3) or joystick and generates corresponding control signals. These signals are transmitted to two BTS7960 motor drivers, which in turn manage the direction and speed of the two drive motors.

The BTS7960 is a high-current H-Bridge motor driver module based on the Infineon BTS7960 IC, designed for controlling large DC motors. It is ideal for applications like electric wheelchairs, robotic vehicles, and other projects requiring high-power motor control. The BTS7960 can handle a continuous current of up to 43A and operates at a voltage range of 5.5V to 27V, making it suitable for heavy-duty motor control. Its dual full-bridge configuration allows precise bidirectional control, enabling smooth turns and accurate speed adjustments for the wheelchair.

5. BLDC Motor (24V) – Principle and Operation

The MY1016Z3 is a 24V, 250W brushed DC gear motor widely used in electric mobility applications such as e-bikes, scooters, and wheelchairs. It features an integrated gearbox that reduces the output speed to approximately 300 RPM while significantly increasing torque, making it suitable for applications requiring strong low-speed performance. With a typical gear ratio of around 9.78:1 and an output shaft equipped with a 9-tooth sprocket, the motor delivers up to 17 N·m of torque. Its compact and durable design, along with reversible direction control, makes it ideal for precise, heavy-duty motion in mobility devices.

In the voice-controlled wheelchair project, two MY1016Z3 motors are used to drive the rear wheels, enabling forward, reverse, and differential steering. The motors are controlled by BTS7960 motor drivers, which receive PWM signals from the Arduino Mega based on inputs from either a joystick or the VC-04 voice recognition module. This setup allows for smooth, user-responsive movement with both manual and voice control options. The motor's high torque and integrated gearbox ensure reliable performance on varied surfaces, making it a crucial component in achieving efficient and user-friendly mobility.[8]

Fig 4. DC Motor

5.ADVANTAGES

- Enables mobility for users with severe upper limb impairments.
- Dual control (voice + joystick) ensures high reliability and adaptability.
- Cost-effective solution using commonly available components.
- Offline voice recognition avoids internet dependency.
- Easy to modify and upgrade for future needs.

6.FUTURE SCOPE

- Obstacle Detection: Adding ultrasonic or infrared sensors to detect obstacles and avoid collisions.
- GPS Integration: To allow autonomous outdoor navigation and location tracking.
- Health Monitoring: Integrating sensors to monitor vitals like heart rate or body temperature.
- Mobile App Control: Developing a smartphone application for additional control and monitoring.
- AI Enhancement: Using machine learning to improve command recognition and personalize control based on user habits.

7. RESULTS

The developed wheelchair system was successfully controlled using both a V3 voice recognition module and a joystick interface. The integration allowed seamless switching between the two modes without interference, ensuring smooth control of the wheelchair in various directions. The Arduino Uno served as the central controller, receiving input from both control modules and driving the BTS7960 motor drivers accordingly.

Fig 5. Prototype of the Voice-Controlled Wheelchair

To evaluate the system's performance, a series of tests were conducted in a controlled environment. The voice commands were tested under normal indoor conditions with moderate background noise. Out of 50 test commands, the system successfully recognized and executed 46 commands, achieving a 92% accuracy rate. Misrecognitions mainly occurred due to overlapping words or unclear pronunciation.

The joystick showed a higher accuracy rate with nearly instantaneous response to directional inputs, making it more reliable in terms of responsiveness. Usability testing was also conducted by allowing users to navigate a basic obstacle course using both control modes. Most users preferred the joystick for fine control and quicker maneuvering, while voice control was appreciated for its hands-free convenience. Users with limited hand mobility expressed a strong preference for the voice control option.

Fig 6. Implementation view

Fig 7. Circuit view

8. CONCLUSION

This research paper presented the design and implementation of a voice and joystick-controlled wheelchair for physically disabled individuals. The proposed system enhances mobility through dual control mechanisms—allowing hands-free operation via voice commands and providing an alternative manual option using a joystick. The use of the Arduino Mega R3, BTS7960 motor drivers, and the MY1016Z3 DC motors ensures a responsive and reliable experience. Testing results showed high accuracy and user satisfaction, especially among users with limited mobility. The modular nature of the system also opens up opportunities for future enhancements. Overall, this project contributes a practical, affordable, and scalable solution to the domain of assistive technologies.

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