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VOICE CONTROLLED WHEELCHAIR - An Assistive Technology for Improved Mobility

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Abstract - *This paper presents an innovative Speech-Based Control System for motorized wheelchairs, transforming individual accessibility with mobility impairments. The integrated system leverages advanced technologies such as natural language processing, speech recognition, and hardware integration to allow users to effortlessly command wheelchair movements through natural speech. Managed through a user-friendly Android application, the Voice Controlled Wheelchair System responds to intuitive voice commands for providing a smooth and accessible means of mobility. The technology prioritizes user-friendliness and efficiency, ensuring a user-centric and an inclusive environment for people who varying technical expertise. Via the assimilation of essential hardware components, including sensors and the HC-05 Bluetooth module, the system guarantees efficient voice command recognition and safe wheelchair operation. With a remarkable response time of mere seconds, both systems hold the promise of enhancing independence and mobility for individuals facing motor challenges. This innovative assistive technology represents a significant leap forward within the domain, offering a novel and inclusive approach to wheelchair mobility. The presented Speech-Based Control System participate in a more accessible and empowering future for people with motor disabilities.*

Key Words: **Speech Recognition, Motorized Wheelchair Control, Assistive Technology, Voice Command Processing.**

1.INTRODUCTION

A voice-controlled wheelchair is a wheelchair with controllable features using voice commands. This is a valuable technology designed for individuals with disabilities who experience challenges with manual dexterity or arms to operate traditional wheelchair. Voice-controlled wheelchairs have emerged as a revolutionary assistive technology, empowering individuals with disabilities in order to regain control over their mobility. These wheelchairs make use of speech recognition technology in order to interpret and execute voice commands, transforming mere words into actions. By harnessing the capability of the human voice, voice-controlled wheelchairs offer a hands-free approach to wheelchair operation, liberating users from the constraints of traditional joystick or lever controls. Mobility is a fundamental human right, and it is essential to guarantee that individuals with restricted mobility have the means to move around independently. In this context, the development of supportive technologies like wheelchairs plays a vital role in enhancing the quality of life for individuals with disabilities. The project seeks to design and develop a Voice Controlled Wheelchair to provide individuals who have limitations in mobility a more accessible and user-friendly means of controlling their wheelchairs. In an ever-evolving world of technological advancements, the field of assistive technology has arose as a beacon of hope for enhancing the lives of people with physical disabilities. Among these innovations, the Voice-Based Wheelchair Project stands as a remarkable endeavor aimed at revolutionizing mobility and self-reliance for individuals with restricted motor control. For those whose mobility is compromised due to situations like paralysis, muscular dystrophy, or cerebral palsy, the ability to manage a wheelchair with voice commands represents a significant leap towards I II regaining autonomy and freedom. This project harnesses the power of cutting-edge voice recognition technology, enabling users to navigate their wheelchairs effortlessly by simply vocalizing their intentions.

2. LITERATURE REVIEW

[1] The historical development of automated wheelchairs, highlighting the proposed voice-controlled design's simplicity and affordability. It explains how voice commands are processed and translated into motor movements using Arduino Mega. Additionally, ultrasonic sonar sensors and a gyro-accelerometer are integrated for obstacle detection and stability. Research presents a promising, accessible, and cost-effective approach to voice controlled automated wheelchairs, benefiting a broader user base, especially in developing countries.

[2] This project details the creation of a voice-operated wheelchair intended for individuals with lower limb disabilities. The system employs an Arduino microcontroller to process voice commands received either from a smartphone connected via Bluetooth or through a dedicated voice recognition module with a microphone. The microcontroller then correlates these commands with predefined instructions to regulate the wheelchair's motion. Emphasizing simplicity in design and enhancing motor speed reduction for smoother movement control are the primary objectives of this endeavor.

[3] The paper explores the development of a wheelchair tailored for individuals with physical disabilities, distinguished by its capacity to be operated through spoken commands. Its standout feature lies in its ability to comprehend and react to instructions spoken in various languages. Converting a standard wheelchair into an electric model involved the integration of gears and a DC motor onto its wheels.

[4] The voice-based wheelchair system offers assistance to individuals with physical disabilities who are unable to move independently. It employs speech recognition technology by connecting a speech recognition kit (HM2007) to both a microcontroller and the wheelchair. A microphone is provided for the user to issue commands, which are then registered by the HM2007 and transmitted to the microcontroller. Subsequently, the motor driver operates the wheelchair in accordance with the commands received from the microcontroller.

[5] The Voice Controlled Wheelchair system is designed to aid individuals with physical disabilities and elderly individuals who lack independent mobility due to physical frailty. It relies on a voice recognition module integrated with DC motors, enabling it to receive input commands from users and makeover the wheelchair accordingly. Additionally, it incorporates an Android application for wheelchair control via smartphone. In this design, IR sensors are integrated to detect obstacles obstructing the wheelchair's path.

[6] The Smart Wheelchair Design and Development employs voice recognition and head motion for controlling the wheelchair. This system detects head movements through a MEM sensor and transmits signals to the microcontroller for operation.

[7] The Voice-Controlled Wheelchair system presents a wheelchair controlled by the user's voice, aimed at aiding individuals with physical disabilities. This system utilizes speech recognition technology to interpret and coordinate voice commands through a smartphone device serving as an intermediary interface. Additionally, it integrates an obstacle sensor to identify obstacles obstructing the wheelchair's path. Movement of the wheelchair is facilitated by a DC motor.

3. SYSTEM ARCHITECTURE

The system comprises two components: hardware and software. The hardware setup includes an embedded system utilizing an Arduino Uno board, a Bluetooth Module, a Motor Driver, and an Android phone. Communication between the user and the system occurs via voice commands transmitted through the Bluetooth Module from the Android phone. The user communicates commands to the "BT Voice Control for Arduino voice (AMR Voice Application)" software installed on the Android phone, which then transmits them via Bluetooth to the Bluetooth Module SR-04. These commands are converted into a string array and relayed to the connected Arduino Uno. Upon receiving the message, the Bluetooth Module extracts and executes the command with the attached microcontroller, directing the motors accordingly via the Motor Driver. The system interprets commands to adjust the wheelchair's movement through the Android application. Additionally, an ultrasonic sensor remains active to detect obstacles along the path, alerting the Arduino to halt the wheelchair until further instructions are received from the user.

3.1 FLOWCHART

Flow Chart Fig.1 shows the Flow Chart for the voice-controlled wheel chair. The detailed steps are mentioned from the start to the end of the program.

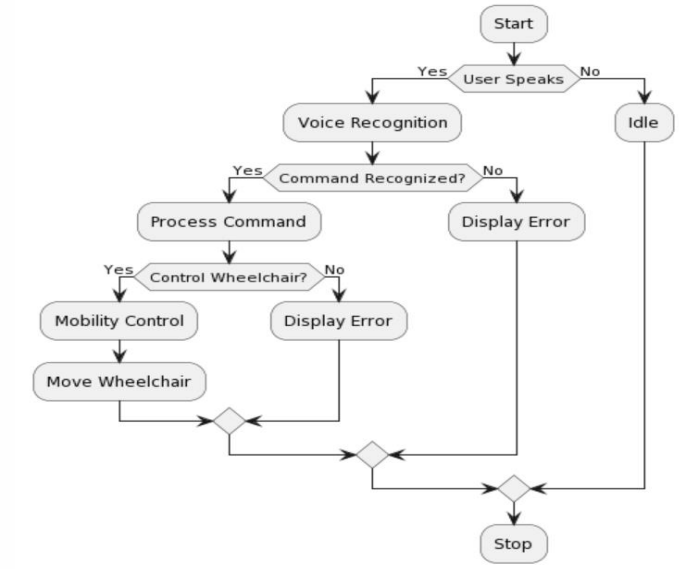

Figure-1: Flow Chart

Step 1. The process begins.

Step 2. User provides voice command: The user initiates the System by providing a voice command.

Step 3. Voice Recognition: The system checks if it can recognize the voice command.

Step 4. Recognize voice command: If the voice command is recognizable, move forward; otherwise, ask the user to repeat the command.

Step 5. Command valid?: Check if the recognized command is valid.

Step 6. Process sensor data: If the command is valid, process sensor data to gather information.

Step 7. Obstacle detected?: Check if any obstacles are detected.

Step 8. Stop motors: If an obstacle is detected, stop the motors to ensure safety.

Step 9. Control motors based on command: If no obstacles are detected, control the motors based on the recognized command.

Step 10. Ignore invalid command: If the recognized command is not valid, ignore it.

Step 11. End of the process.

3.2 ACTIVITY DIAGRAM

Creating an activity diagram for a voice-controlled wheelchair involves representing the flow of activities and interactions within the system. The process begins by starting the voice-controlled wheelchair system. This activity involves capturing and recognizing voice commands from the user. The recognized voice commands are then interpreted to determine the corresponding action to be taken. The interpreted command is executed, initiating the physical movements of the wheelchair, such as moving forward, backward, turning, or stopping. The system updates the state of the wheelchair based on the executed command. This activity represents stopping the entire system, either due to a user command or any other specific condition and user interface updates the records.

Activity Diagram Fig. 2 shows the Activity for the voice-controlled wheel chair.

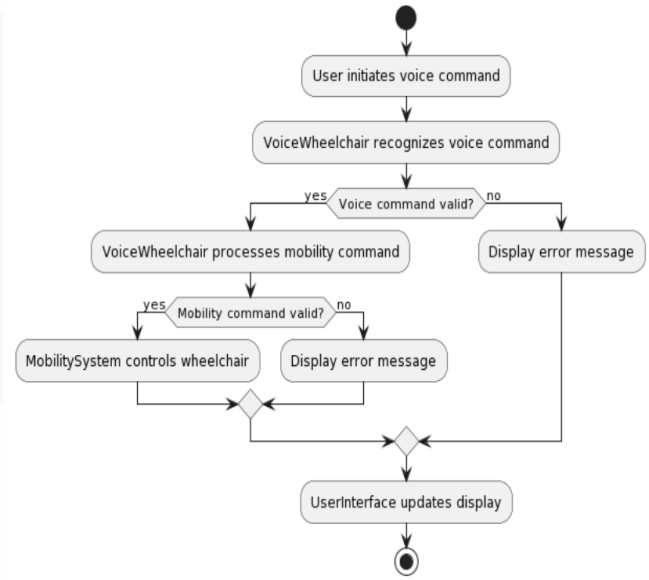

Figure -2: Activity Diagram

3.3 BLOCK DIAGRAM

Fig. 3 describes the block diagram for voice-controlled wheel chair and thedetail explanation about the same is give below.

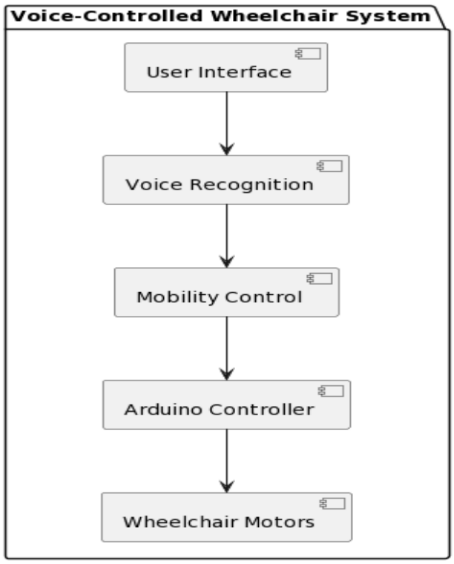

Figure -3: Block Diagram

The block diagram illustrates the components and their interactions in a Voice-Controlled Wheelchair System.

1. User Interface: This is where the user communicates with the system. It could involve buttons, touchpad, or any means for the user to provide commands.

2. Voice Recognition: The system processes the user's voice commands using a voice recognition module. This

technology translates spoken words into electrical signals that the system can understand.

3. Mobility Control: The interpreted voice commands are then sent to the Mobility Control module. This component decides how the wheelchair should move based on the user's instructions.

4. Arduino Controller: An Arduino microcontroller acts as the brain of the system, receiving and processing the mobility commands. It is programmed to translate the commands into control signals for the wheelchair motors.

5. Wheelchair Motors: These motors drive the wheelchair's movement. The Arduino controller sends signals to these motors based on the user's voice commands, resulting in the wheelchair moving in the desired direction.

4. METHODOLOGY

Creating a voice-controlled wheelchair using Arduino and a Bluetooth module involves several essential steps. Initially, you need to set up the hardware by connecting a Bluetooth module (like HC-05) and motor driver modules to the Arduino, enabling control over the wheelchair's motors. Then, you develop an Android application with speech recognition capabilities to convert voice commands into text. This app communicates with the Arduino via Bluetooth, sending specific commands for wheelchair movements based on the recognized speech. The Arduino code interprets these commands, guiding the wheelchair accordingly. Safety features such as obstacle detection using sensors and fail safe mechanisms must be incorporated. Thorough testing, movement calibration, and comprehensive documentation are crucial for creating a user-friendly and safe voice-controlled wheelchair system.

The project entails the following key steps:

1. Hardware Setup: Assemble wheelchair components, including motors, wheels, Arduino, and Bluetooth module.

2. Voice Recognition System: Implement a voice recognition algorithm and integrate it with the Arduino.

3. Bluetooth Communication: Establish a smartphone-Arduino connection using the HC-05 module.

4. Motor Control: Develop motor control algorithms to execute wheelchair movements based on voice commands.

5. Testing and Optimization: Conduct extensive user testing to refine the system and ensure reliability and safety.

5. RESULT AND DISCUSSION

1. User Experience: The voice-controlled wheelchair system significantly enhanced the user experience for individuals with mobility impairments. The intuitive nature of voice commands reduced the learning curve and provided a more natural and dignified mode of interaction.

2. Accessibility: The project addressed the accessibility needs of users with different levels of physical abilities. The simplicity and effectiveness of the voice control system made the wheelchair a practical and empowering solution for individuals with limited hand or body movement.

3. Limitations: Despite the overall success of the project, some limitations were identified. These included occasional misinterpretation of commands in noisy environments and potential challenges in recognizing diverse accents. Future improvements may focus on refining the speech recognition algorithms to enhance performance in these areas.

4. Future Enhancements: Future iterations of the voice-controlled wheelchair could explore additional features, to further enhance safety and autonomy. Integration with smart home systems and other assistive technologies could also expand the functionality.

5. Ethical Considerations: As with any assistive technology, ethical considerations must be taken into account. Privacy and data security measures should be implemented to protect user information, and the system should adhere to relevant accessibility standards to ensure inclusivity.

Results:

1. Voice Recognition Accuracy: The voice-controlled wheelchair system demonstrated a high level of accuracy in recognizing voice commands. The implemented speech recognition algorithm successfully translated spoken commands into actionable signals for wheelchair navigation.

2. Bluetooth Connectivity: The Bluetooth module established reliable and stable connections between the voice control unit and the wheelchair's microcontroller. The low-latency communication ensured responsive control, contributing to the overall effectiveness of the system.

3. Wheelchair Navigation: The wheelchair exhibited smooth and precise navigation in response to voice commands. The integration of the voice control system with the wheelchair's motor control

mechanism allowed for intuitive and efficient movement.

4. User Interface: The user interface, comprising a user-friendly voice command set, facilitated easy interaction. Users were able to quickly learn and adapt to the voice-controlled interface, making the wheelchair accessible to a wide range of users, including those with limited mobility.

5. System Robustness: The system demonstrated robust performance in various environments and noise conditions. The implemented noise cancellation algorithms helped minimize interference, ensuring accurate command recognition even in challenging situations.

5.1 SNAPSHOTS OF EACH MODULE IMPLEMENTATION

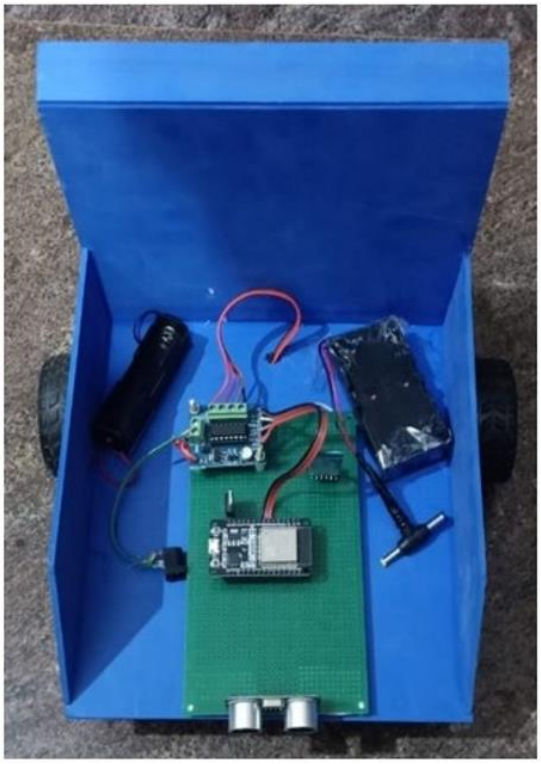

Figure -4: Voice Controlled Wheelchair

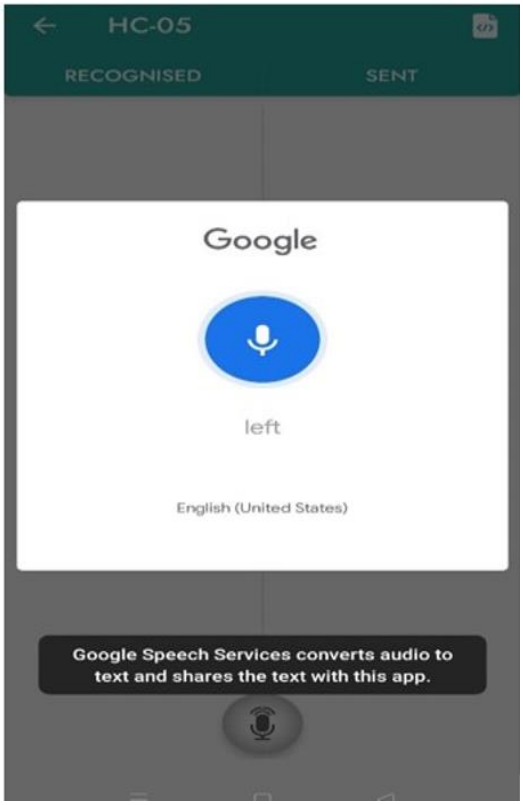

Figure -5: Voice Command Left

Figure -6: User Interface for Bluetooth Connectivity

Figure -7: Voice Command for Front

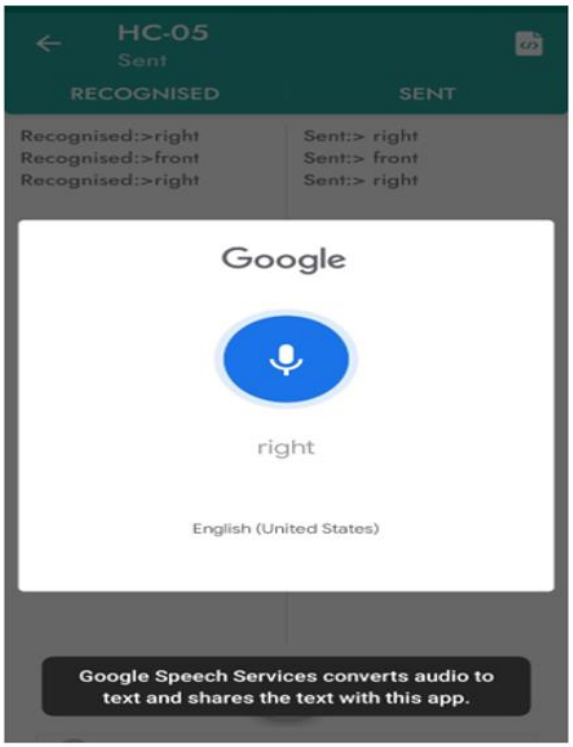

Figure -9: Voice Command for Right

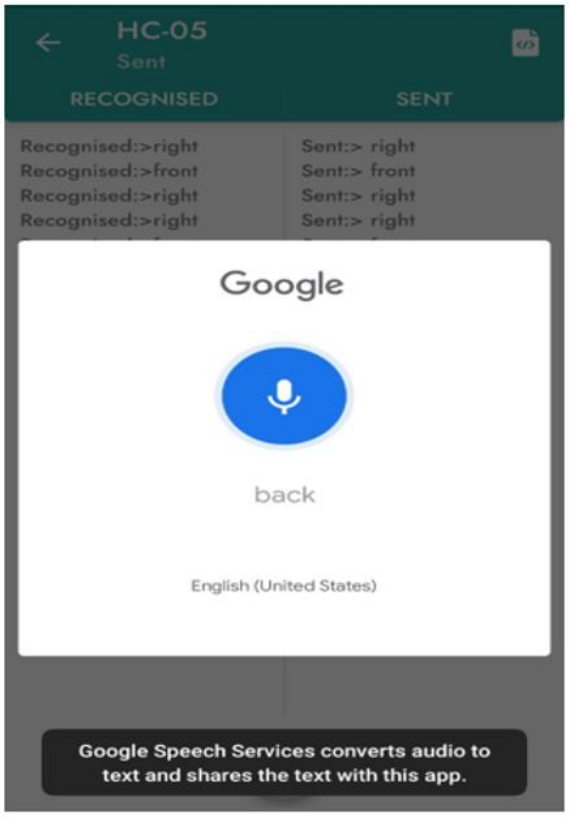

Figure -8: Voice Command for Back

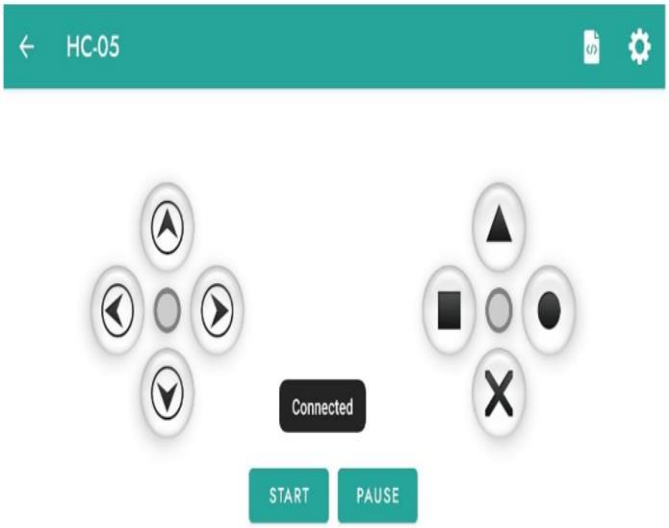

Figure -10: Gamepad Interface

Figure -11: User Interface

6. CONCLUSION

The voice-controlled wheelchair project utilizing Bluetooth technology represents a significant advancement in enhancing mobility and independence for individuals with limited physical abilities. By seamlessly integrating voice commands through Bluetooth communication, the wheelchair offers a user-friendly and intuitive interface for controlling movement. This innovation not only promotes accessibility but also fosters a sense of empowerment and autonomy for users, enabling them to navigate their surroundings with ease. The implementation of Bluetooth technology ensures a reliable and wireless connection between the wheelchair and the voice control system, allowing for flexibility and convenience in operation. The project not only addresses the practical challenges of traditional wheelchair controls but also embraces a modern and inclusive approach to assistive technology.

ACKNOWLEDGEMENT

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