Proceedings of the International Conference on Sustainable Computing and Smart Systems (ICSCSS 2023)
IEEE Xplore Part Number: CFP23DJ3-ART; ISBN: 979-8-3503-3360-2

An Intelligent Voice-Recognition Wheelchair System for Disabled Persons

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2023 International Conference on Sustainable Computing and Smart Systems (ICSCSS) | 979-8-3503-3360-2/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICSCSS57650.2023.10169364

***Abstract*— This study illustrates the creation of an intelligent voice-recognition wheelchair for disabled persons who cannot manually man-oeuvre their wheelchairs. Using voice recognition, the patient operates the wheelchair, and a GPS device included in the wheelchair can track the patient's position and communicate the data to a Smartphone. To carry out the people's orders, the voice module V3 records and can recognize the patient's voice. This module converts the voice commands into letters, subsequently transmitted to the Wi-Fi module to operate the wheelchair. The Wi-Fi module sends commands to the motor drive for the wheels. In addition, three levels of motor speed adjustment are available: low, medium, and high. This device also utilizes an Infrared sensor to automatically identify obstacles, allowing the patient's family members to know exactly where they are. Disabled People can be used this device, which simultaneously provides a voice-controlled wheelchair, obstacle detection, motor speed control, and patient GPS tracking via mobile phone; it will be a successful solution for disabled people across the world.**

Keywords—Wheelchair, Disabled people, Infrared Sensor, Voice recognition, GPS module,

I. INTRODUCTION

An artificial source of movement is necessary for those who are paralyzed, have polio, or have lost their hands and legs due to an illness or accident. They have created "smart wheelchairs" that respond to voice orders from the disabled user to move. The voice instructions of the disabled user will be maintained in the voice recognition system before usage to stop outsiders from controlling it. They integrate sensors and a joystick as additional features to give the user even more security. For many reasons, it will benefit those with impairments [1]. Using a basic wheelchair presents several difficulties for people with disabilities, which increases the risk of accidents. Most of the time, persons with disabilities use their hands to operate basic wheelchairs. To avoid typical mishaps, there are creating a wheelchair with extra safety measures. The number of errors will be reduced because users use voice commands, sensors, and a joystick [2]. There are developing a wheelchair similar to this one to make it more comfortable for those with impairments who reside in nursing homes or hospitals. The voice recognition module will recognize the customer's voice. A sensor will be mounted on a wheelchair with intelligence. Two DC motors, an Arduino board, and a speech recognition module powered by a single battery. Ultrasonic sensors also give extra close-range protection against obstructions [3].

Modern technologies and the Internet of Things (IoT) have considerably streamlined daily life. This technology could produce new goods that will help those in need. People with physical disabilities are frequently disregarded, and as they cannot move independently, many see them as a burden on society. Physically disabled people can be helped in several ways to carry out their regular daily duties by merging motion gesture technologies with the typical wheelchair [4]. Nowadays, motion gesture technology is a commonly utilized sensor in a wide range of IoT applications. To help the physically disabled who are poor, it is crucial to build an intelligent wheelchair that is simple to use and economical. There are primarily driven by a desire to help the physically challenged who must research this area [5]. The suggested solution is simple and cost-effective, making it suitable for usage in underdeveloped countries like Bangladesh. This collaborative piece of research-based work will transform the medical business since it is easy to use and has detailed instructions.

Due to the regularly decreased changes brought on by limited mobility, many mental health problems and social isolation result. Even though many persons with physical limitations can get by with standard manual or self-automated wheelchairs, some of them find it difficult or impossible to use them independently [6]. People with quadriplegia and those with Multiple Sclerosis have significant disabilities that prevent them from operating wheelchairs with traditional joystick controls. Wheelchairs traditionally have their constraints in terms of their restricted usefulness, mass, and adaptability. The wheelchair may feature unique user controls that can be adapted to specific activities or refer to them [7]. The most well-known contrast is between electric wheelchairs, which are driven by battery and electric motors, and manually controlled wheelchairs, which are either pushed manually by the wheelchair user or by an attendant from behind. The suggested system describes a wheelchair that may be operated using user voice instructions and a Smartphone [8]. It facilitates movement for older persons with mobility issues and those with physical disabilities. People can thus help them improve their life by keeping this factor in mind. Voice recognition is a crucial technology that permits human connection with wheelchair-controlling devices.

II. Literature Review

An automated wheelchair is intended to support and help people with paraplegia (AWC). The suggested chair is beneficial for those with a more severe disability, such as people with quadriplegia, who can only move their heads because they are too elderly or ill to use their other limbs. A wheelchair built around a microcontroller was created, and it can follow the patient's head motions [9]. There are both mechanical and electrical parts in the system. Accelerometers monitor and record head motions while tracking the patient's location in all four directions. The study also discusses the accelerometers that drive the wheelchair's motors and coordinate their indoor movement and the Bluetooth technology utilized in wheelchairs. The wheelchair's design was primarily influenced by its mobility and the patient's health. Sensors connected to the Internet of Things monitor blood oxygen levels and heart rate [10]. The ultrasonic sensors' aid in obstacle detection makes moving the chair in a specific direction easier. The integrated accelerometer aids the chair in determining how the patient wishes to move by recording their motion along the x- and y-axes. Then, the microcontroller receives the signal. With the aid of viper motors and under the direction of acceleration, the wheelchair can move left, right, forward, and backward.

A brain-computer interface (BCI) or mind-machine interface is the name for the direct channel of communication between the brain and external equipment (MMI) [11]. There are existing issues for those with ALS, or amyotrophic lateral Sclerosis, also known as (Stokes), which leaves them completely paralyzed and unable to converse with others. So, these patients could gain from utilizing the BCI system to enhance their standard of living. This study offers a brain-activated wheelchair control system that allows the patient to maneuver the wheelchair from one place to another using a motor imagery model [12]. Hence, the user controls the wheelchair's four directions of movement: left, right, forward, and backward. Also, the wheelchair learns how to maneuver inside the home, and the user may select his destination by blinking his eyes. To conduct preliminary research on the BCI Control, an actual wheelchair and one replicated in a virtual environment were tested. The system will be developed as an independent piece of hardware and tested in a real-world setting.

They propose a Raspberry Pi-based wheelchair with safety features [13]. This system uses a raspberry pi, an LCD graphic display, R.F. technology, and a motorized circuit. A wheelchair circuit and a control circuit make up the proposed system. The controller circuit enables the user to navigate across an LCD with directional graphics. The controller circuit lets the user guide the wheelchair using a directional graphical LCD. The wheelchair circuit contains an R.F. receiver [14]. As soon as it gets these signals, it activates the wheelchairs motors to perform the desired movement. A disabled person may easily man-oeuvre the wheelchair thanks to this, while another person can do the same thing while standing three to four meters away. The system also offers emergency support functions that are accessible to impaired people. When someone needs help or is distressed, a button automatically broadcasts their GPS whereabouts to loved ones through SMS [15]. Also, if the patient falls out of their wheelchair or cannot hit the button, all they need to do is cry for assistance, and the system will transmit the GPS locations to the person's family members through SMS.

III. Proposed System

The system's main objective is to improve disabled people's mobility and independence. Intelligent voice recognition technology allows users to operate the wheelchair with spoken instructions, minimizing their dependency on manual controls and increasing their independence. The device was designed to improve wheelchair use for those with impaired motor skills or low physical dexterity. Those with trouble using the manual controls can continue moving with the wheelchair due to voice instructions. The purpose of the technology is to offer a simple interface for controlling a wheelchair. With voice recognition technology, users may intuitively express their goals, eliminating the necessity for convoluted button schemes or joystick controls. The goal is to make using a wheelchair as natural and straightforward as possible.

The system was designed with the comfort and security of the wheelchair user in mind. Voice recognition technology enables instantaneous action and accurate management, lowering the potential for mishaps and improving usability. Safeguards like obstacle recognition and collision avoidance might be included in the system for further peace of mind. The goal is to use IoT features to improve the wheelchair's usability and network connection. Connecting it to the user's other intelligent devices, sensors, and home automation systems allow new capabilities, including remote monitoring, personalized locations, and environmental intelligence. The wheelchair block diagram for people with disabilities is shown in Figure 1.

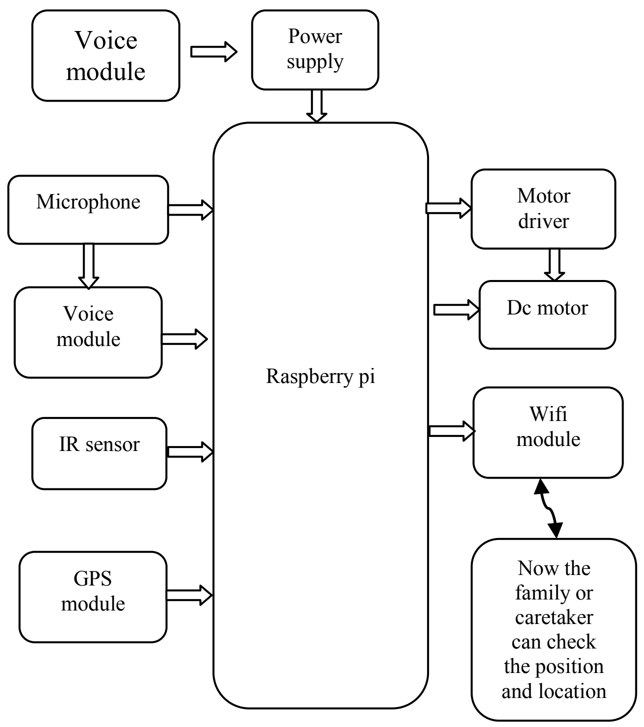

Fig. 1. Block diagram of the wheelchair for disabled people.

The proposed system is intended to help elderly individuals who cannot walk independently due to disability and those with physical limitations. Under the suggested approach, persons with disabilities can live somewhat autonomously. A new method of interacting between people and devices is speech recognition technology. For wheelchair control in this work, speech recognition is used. The initiative is made to function with voice commands for these people so that a disabled or impaired person may offer direction orders by just speaking into the provided microphone.

The technology uses advanced voice recognition algorithms to understand the wheelchair user's spoken commands correctly. When discussing the reliability of a system, robustness refers to how well it copes with a wide range of inputs, such as speakers' accents, speech patterns, and background noise. The system's intended responsiveness is in real-time so that the wheelchair will respond quickly to human input. The user's voice may control the wheelchair via IoT technology, which reduces latency and allows for smooth communication between the two. The Internet of Things allows the wheelchair to communicate with and integrate with other electronic gadgets, sensors, and infrastructure. This networked capability paves the way for new features like smart home integration, remote monitoring, and information exchange with medical staff.

The proposed system might provide flexible options to meet the requirements of different users. One example is the capacity to learn and adapt to individual users' preferences over time. Fault-tolerant methods and redundancy in key components may be included in the system to ensure continuous operation. This method reduces the potential for system failures and malfunctions, increasing the system's dependability and safety. The success of such a system in practice would be contingent on many variables, such as the technologies used, the ability of the development team, and the results of real-world testing and user input.

This device included a GPS tracking device that showed the wheelchair's locations in real-time on the webserver to show the whereabouts of the impaired individual. They use the wifi module to connect to the cloud and utilize GPS to track people's whereabouts. The primary objective of the design is for the wheelchair to respond to human commands. Until the impediment is found, the wheelchair is moved forward by the backward control. By giving the wheelchair commands, it can travel in that direction when the person's vocal input is recognized. Electrical signals are utilized to drive the wheelchair's left or suitable motor, and these signals are used to communicate the orders to the wheelchair. To the left and right wheels of the wheelchair, there are essentially two motors attached. Specific hardware ports are used to transfer the electrical signals to these motors. Often, a parallel port is used as the communication port. This parallel port has a few fundamentally established pins that take electrical signals to instruct the wheelchair.

The motors may be instructed to move in one of five directions: forward, backward, left, right, and stop. The wheelchair reacts to voice orders from its user to carry out any movement's functions and only needs these five commands to move. Similarly, the reverse command runs opposite to the wheel revolution. Left-wheel movement causes the right wheel to go ahead while the left wheel travels backward. The left wheel moves forward when the proper instruction is given, while the right wheel moves back. Both motors will cease rotating in response to the stop instruction. There are primarily four parts in the system development. The first step is creating an electrical circuit for voice recognition, the second is creating an interface, the third is creating a circuit to control the motor of the direction, and the fourth is creating a customized manual wheelchair to connect the control unit.

The Raspberry Pi can handle voice recognition by digitizing audio input via a microphone. It may use various voice recognition frameworks or APIs to analyze and interpret spoken instructions correctly. To control the wheelchair's mobility, the Raspberry Pi may communicate with motor controllers or motor driver circuits. The wheelchair may move forward, backward, turn, or stop depending on the user's spoken orders due to its ability to interpret commands from the speech recognition system into motor controls. Wheelchair system, various sensors may be connected to the Raspberry Pi. For instance, it may communicate with sensors that can identify obstructions in the wheelchair's route, such as ultrasonic or infrared.

To prevent collisions, the Raspberry Pi can evaluate the sensor data, make choices, and modify the wheelchair's motions. The Raspberry Pi may provide a user interface for interacting with the wheelchair system. It may include displays or text-to-speech capabilities to convey information to the user, such as system status, battery life, or confirmation of actions done. This ensures the user hears back from the wheelchair and is updated on its functioning. The Raspberry Pi is the Intelligent Voice-Recognition Wheelchair System's central processing unit, coordinating the system's many parts. Voice recognition is facilitated, user instructions are translated, motor functions are managed, sensors are integrated, user feedback is given, communication is made possible, and data may be stored and analyzed for future developments.

IV. Result and Discussion

In this study, the design and development of a wheelchair with a voice detection module to control every move of the wheelchair are described. A simple Android application that can be downloaded on a Smartphone may also be used to manage the wheelchair. The gear is set up according to the protocol, and a demonstration of how an Android Smartphone and a wheelchair interact is provided. The system continually monitors input and evaluates it against previously saved commands. The Raspberry Pi board is loaded with the program containing the sensor threshold values via software. If the information is correct, the motor turns in response to the input, which pushes the wheelchair.

A wheelchair, a motor driving circuit, a voice recognition module, an IR sensor, GPS, a motor, and a raspberry pi board are the software and hardware components needed to operate a wheelchair through voice command. Following the schematic diagram in Figure 2, they will connect various features.

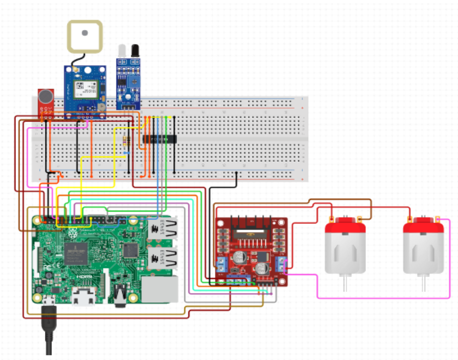

Fig. 2. Circuit diagram

This voice command input is transmitted through a web server, which sends it to the wifi module through a cloud server. The raspberry pi is connected to a wifi module that enables mobile device control of the wheelchair. Moreover, there is an Infrared sensor that scans the path for obstructions. Table 1 shows how to manage the intelligent wheelchair after establishing a connection with the WIFI module. Users can tell the wheelchair to move forward by F, backward by B, right by moving R, left by moving L, and stopped by moving S.

TABLE I. Table of Voice Commands

Voice commands	Direction
F	Forward
S	Stop
B	Backward
L	Left
R	Right

Table 1 show how the intelligent wheelchair responds to user voice instructions and wifi module orders from a Smartphone. The autonomous wheelchair system may be more easily operated with the addition of capabilities like location recognition for safety movement, a GPS-based positioning system for monitoring, and live data provided to caretakers. Figure 3 shows the user's family member or caregiver's real-time GPS location view and the user's latitude and longitude being received on the caretaker's mobile phone.

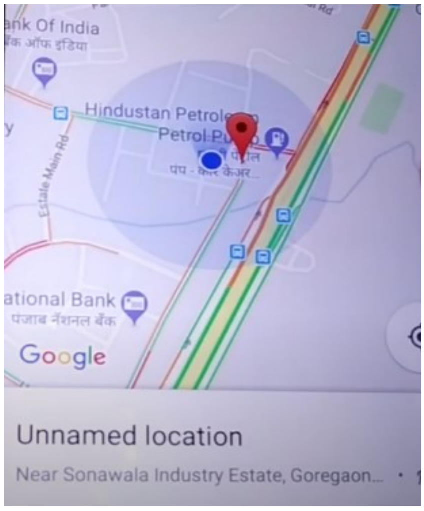

Fig. 3. Location of the people in a wheelchair

Using a Smartphone, the proposed model wheelchair For Physically Disabled People With GPS Tracking And Voice Recognition System is carried out. A processing unit called a raspberry pi subsequently processes the acquired data. The processed data is subsequently sent through a wireless network. This article describes the hardware and software designs for the wheelchair for disabled people with a voice recognition system. The mechanical, architectural, electrical, and electronic circuitry are all covered in the hardware section. A controller and innovative phone application are programmed utilizing a transmission unit like wifi in the software component.

A. *Accuracy and Performance*

Utilize a high-quality mic or a recording device, the set that can capture speech input with clarity and accuracy. Noise-canceling features may improve voice recognition precision and reduce background noise. Use cloud-based voice recognition services, such as Amazon Transcribe or Google Cloud voice-to-Text, which provide powerful and precise speech recognition capabilities. These services achieve great accuracy by combining sophisticated machine-learning algorithms with a large quantity of training data. Advanced computing approaches make it possible to do voice recognition locally on edge devices like the Raspberry Pi or other Internet of Things (IoT) devices rather than depending entirely on cloud services. Lowering latency and enabling real-time reaction improves performance and user experience.

To improve the audio quality of the data, the microphone is capturing, use signal processing methods like noise reduction, echo cancellation, and beam forming. The voice recognition system's accuracy is boosted by this preprocessing step, particularly in noisy settings. IoT sensors should be integrated into wheelchair systems to collect contextual data that will help orders be understood correctly. Some sensors that may offer information about the wheelchair's movement, location, and surroundings include proximity sensors, accelerometers, and gyroscopes. This information enables the system to modify its reactions.

The wheelchair system can communicate with IoT devices, including microphones, sensors, and actuators, with minimal delay. This allows real-time communication and shortens reaction times, improving performance and increasing user happiness. Use synchronization techniques to maintain consistency across the many IoT devices in the system. For instance, numerous microphones should be employed to eliminate conflicts and enhance accuracy, and their collected audio streams should be correctly updated.

B. *Efficiency*

IoT features and voice recognition techniques often need intensive computing processing. Ensuring the system's hardware and software are built to perform the necessary computing workloads effectively is essential. Reducing processing time and resource utilization involves choosing suitable processors, optimizing algorithms, and using effective coding techniques. IoT technologies are used in the system; hence effective network connection is essential. The design should be built to send and receive data the most efficiently possible, with the least delay and bandwidth use. Network efficiency may be improved using data compression, intelligent data filtering, and prioritizing methods.

To enable effective interaction between the user and the wheelchair, the system's user interface has to be simple and easy to understand. Voice recognition accuracy and reaction speed are crucial to guarantee a seamless and effective user experience. The system should reduce the need for repeated or duplicate voice instructions and quickly provide the user response. The architecture of the system, its hardware and software implementation, as well as user behaviour all have an impact on how efficient it is. Iterative changes, feedback gathering, and continuous monitoring are essential for increasing the system's effectiveness over time.

V. CONCLUSION

The wheelchair is monitored by the user's commands and by utilizing a Smartphone connected through Wi-Fi. This allows independent movement for the elderly or crippled, ending their captivity. If the user exits the wheelchair unexpectedly, alerts are issued, and the person stops when an impediment is identified. For the patient's faster recovery, the wheelchair also offers movement stimulation. The proposed device was successfully created and used; for most instructions, the voice recognition system works to operate a wheelchair and adjust the seat using specified voice commands. Also, the patient may voice-command their wheelchair's speed. The solution is user-friendly, rapid, and affordable due to a tracking device using an Android application to monitor the patient's location. A significant recognition is how the hardware is positioned inside the wheelchair. There are also the possibilities for quick wheelchair access at any moment.

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