A Voice-Activated Mobility Wheelchair Powered by Solar Energy

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Abstract:- A smart wheelchair gives a person independence and ease. A smart wheelchair is a mechanically driven vehicle that can be easily operated by the user's hand for self-mobility. As a result, using the wheelchair's wheels requires less effort from the user. Additionally, this makes it possible for people who are physically or visually handicapped to go from one location to another. Only the movement of the person's hands will allow the wheelchair to travel forward, backward, left, and right, even if the person's body is completely or partially paralyzed. The wheelchair and the person can communicate wirelessly. In order to operate the experimental version of our system, a joystick that is attached to a NodeMCU transmitter is used to control the wheelchair. The wheelchair can also be controlled via voice instructions sent over Bluetooth from the Dabble smartphone application. In order to move the wheels in response to user input, the L298n motor driver needs help from the joystick signals and voice commands supplied to the receiver NodeMCU. The L298n that sits in between the microcontroller and the wheels aids in converting the voltage needed to operate the wheels.

Keywords:- *ESP32 Microcontroller, ESP8266 Microcontroller, NodeMCU, L298n Motor Driver, Dabble App, IR Sensor, Obstacle Detection.*

I. INTRODUCTION

Smart Wheelchairs are electric powered wheelchairs which help the user or guardian accompanying. Designed to have self-mobility with the help of the user command, It reduces the user’s human effort and force to drive the wheels for wheelchair. Furthermore, it also provides an opportunity for visually or physically impaired persons to move from one place to another. In this work, Smart Wheelchair is controlled using NodeMCU ESP32 and L298n motor driver via joystick and this wheelchair is also capable of obstacle avoidance using ESP8266, IR sensor and a buzzer is presented. A disabled person requires a wheelchair to perform functions that require him/her to move around. Caretaker is not always able to actively monitor disabled person individuals. The disabled person needs a way to control their wheelchair that meets their specific needs.

The primary goal of our prototype is to design a smart wheelchair that will aid in the development of an automated navigation system for physically challenged people, as well as to improve the existing wheelchair in terms of daily usage. It examines the wheelchair in terms of human factors engineering and material selection.

Finally, the report includes a reference list citing the sources used, which provide additional details on the evaluated tools, performance assessment results, and data collection forms and worksheets.

II. LITERATURE SURVEY

This section gives an overview of the approaches used in the recent years. There have been a number of strategies put out, however they all differ significantly. Below is a summary of the many methodologies and categorization strategies used in recent years.

“Human–machine interface based on muscular and brain signals applied to a robotic wheelchair [1]” The Human-Machine Interface (HMI) described in this work is based on signals produced by eye blinks or brain activity. The capture and processing of signals, as well as the system structure, are displayed. The signals employed in this study are either the brain signal associated with processing visual information or the signal associated with the muscular activity corresponding to an eye blink. The feature that is taken from these signals to determine the user's intent is variance. A variance threshold that is empirically defined for each user during the training step is used to do the classification. The user is shown the command options on a PDA's (Personal Digital Assistant) screen that will be delivered to the commanded device. In the trials described here, the object being controlled is a robotic wheelchair.

"EEG Controlled Smart Wheelchair for Disabled People [2]" Worldwide, millions of people experience mobility issues. People with mobility issues require new gadgets with advanced technologies to assist them in comfortable mobility. Mobility-impaired wheelchair users encounter severe movement and functional restrictions. Many patients are unable to operate a powered wheelchair with a conventional interface, and they are also thought to be unsafe drivers. For people who are unable to use a powered wheelchair due to motor, sensory, perceptual, or cognitive impairments, a brain controlled wheelchair is currently being developed. The potential for creating a sophisticated wheelchair is enormous thanks to developments in robotics, sensor technology, and artificial intelligence. Systems called brain computer interfaces (BCIs) translate various patterns of brain activity into commands in real time, allowing for communication between the human brain and physical objects. Traditional EEG sensors are expensive, and only hospitals and research facilities use them. To make it easier to read signals, conductive gel must be applied to the skin around the electrodes of EEG sensors. The benefit of using a portable EEG brainwave headset is that it reads brain electric activity using a dry active sensor technology. The Neurosky headsets are ready to use in just a few seconds, unlike conventional gel-based EEGs that can take up to 30 minutes to begin collecting data. Because of this, headsets based on Neurosky technology are affordable and simple to use.

"Android phone controlled Voice, Gesture and Touch screen Smart Wheelchair [3]" Wheelchairs are utilized by the general population who can't scroll because of physical sickness, damage or other incapacity. In the present day's advancement guarantees a wide degree in creating savvy wheelchair. This paper is to portray a wise wheelchair utilizing advanced mobile phone is creating to control the revolution of wheel seat in light of voice and signal development for the physically tested people. In construct voice and motion capacity are utilized to control the wheelchair and additionally by utilizing advanced mobile phone perusing SMS, E-mail, News. The sensors utilized are 8 in which 2 of them are IR sensors the remaining are for temperature, smoke identification and light recognition sensors. This framework allows the client to interact with the wheelchair in a heartfelt manner at several degrees of control and detection. The framework is divided into three main sections: voice recognition via Android, gesture recognition via Android, and motor control via flag moulding. An android phone equipped with an AVR small scale controller and sensors is required by the framework.

"Finger-Gesture Controlled Wheelchair with Enabling IoT [4]" Due to their high costs, technical constraints, and safety concerns, modern wheelchairs with advanced and robotic technologies are unable to improve the quality of life for millions of disabled people. In order to solve these issues, this paper suggests a gesture-controlled smart wheelchair system with an IoT-enabled fall detection mechanism. Convolutional Neural Network (CNN) model and computer vision algorithms are used to recognize gestures, which can then be used to automatically control the wheelchair. By using IoT-based emergency messaging systems to perform fall detection, it keeps users safe. The overall system's development cost was under USD 300 and is reasonable. Therefore, it is anticipated that the suggested smart wheelchair will be accessible, secure, and useful for helping people with physical disabilities move around independently.

"Low-cost smart electric wheelchair with destination mapping and intelligent control features [5]" For those who are physically disabled, wheelchairs have a significant impact because they offer mobility with relative ease. However, there is a need for automated electric wheelchairs, which are very expensive, in situations like severe disability or seeking relief from physical exertion. The robust and user-friendly smart electric wheelchair is designed and implemented in an innovative manner in this paper, with the product cost minimized while taking into account the affordability of a sizable population. The proposed system's "Destination Mapping" function, by which the smart wheelchair learns the locations visited by the user and then arrives at those locations on its own using speech recognition, is a noteworthy aspect. Additionally, there are numerous intelligent features that guarantee a safe and comfortable ride, including slope and obstacle detection, torque adjustments, and rough surface detection. The suggested system receives input from a microphone, joystick, rotary encoders, and sonar sensors, processes it using a microcontroller, and then uses a motor driver to drive the motors. Windshield wiper motors were chosen after extensive research into the selection of appropriate motors for implementation because they produce adequate torque at low rpm and are readily available as recycled parts locally. 50 disabled people of various ages participated in an experiment, and over the course of a year, improvements were made in response to their feedback. Results were satisfactory, suggesting that the suggested wheelchair can actually help those who are physically disabled and be a smart, affordable alternative. This has a significant potential social impact.

"Intelligent Wheelchair Using Voice, Touch and Gesture Control By Smart Phone [6]" In this study, we created an intelligent wheelchair that can be controlled by voice, touch, and gestures on a smartphone. People who are unable to walk due to a medical condition, injury, or other impairment use wheelchairs. The current state of progress promises a lot of room for creating intelligent wheelchairs. In order to build and control the direction and rotation of the wheelchair's DC motor based on voice touch and gesture movement for physically challenged people, this article will explain a smart wheelchair operated using an Android phone. The wheelchair is controlled utilising speech, touch, and gesture features created by an android software. The smart wheelchair may be strongly interacted with by the physically challenged individual in this paper at various levels of control and sensing. There are three primary components to this system: touch control for Android, gesture control for Android, and voice control for Android. An Android phone, an Arduino UNO microcontroller, and a Bluetooth device make up the system.

III. PROPOSED SYSTEM

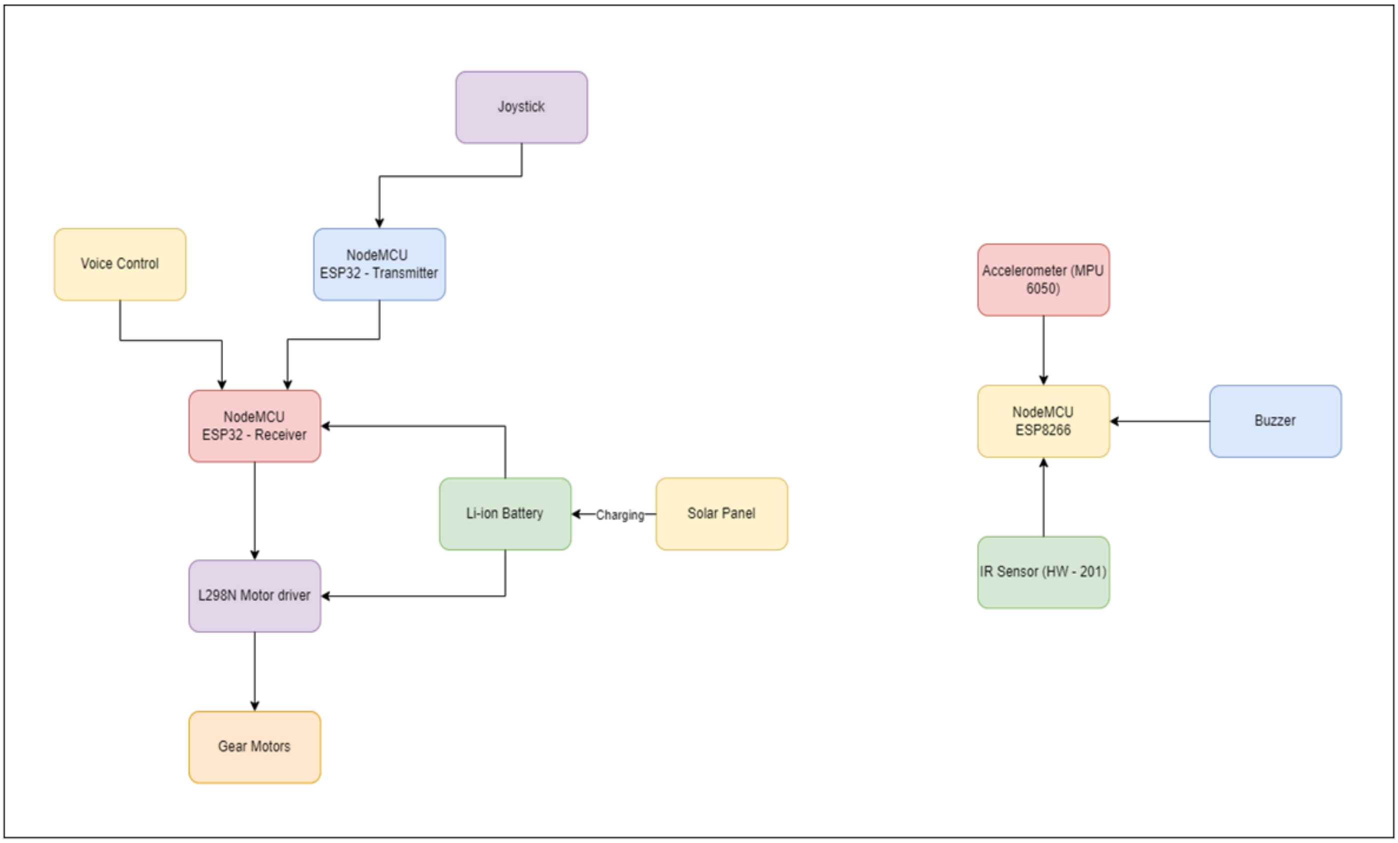

Fig 1 Block Diagram

This model uses two NodeMCU ESP32 microcontrollers. One ESP32 is used as a transmitter and the other ESP32 is used as a receiver. Both microcontrollers are coded using C++ language in Arduino IDE. The receiver uses transmitter's MAC address for sending signal. A joystick module is used to control the wheelchair in forward, backward, right, or left direction.

The transmitter ESP32 is connected to a L298n motor driver which controls the two gear motors on the back. The motors can move the wheelchair in front, back, right, or left direction depending upon the signals received from the transmitter. This whole setup is powered using two 1200 mAh Li-ion cells. These cells can also be recharged via Solar panels connected to the back of the wheelchair. This will reduce the efforts required to continuously change the batteries. The wheelchair can also be controlled via voice control using the "Dabble" mobile app available on both IOS and Android operating systems.

An ESP8266 microcontroller is used with the wheelchair for obstacle detection. This circuit consists of a ESP8266 connected to a IR sensor (HW-201) and a buzzer. The IR sensor is also coded in C++ language on the Arduino IDE. This sensor can sense any obstacle in the range of 2-30cm in front of the wheelchair. This range can also be extended by using ultrasonic sensor instead of IR sensor. If the sensor detects any obstacle in its path, the sensor sends this data to the microcontroller and this causes the buzzer to beep, which will alert the person sitting on the wheelchair.

A. Components Used

Table 1 Components Used

Items	Quantity
NodeMCU ESP8266	1
NodeMCU ESP32	2
L298n Motor Driver	1
Gear Motors	2
Wheels	3
Jumper Wires	10-15

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Accelerometer	1
IR Sensor (HW-201)	1
Solar Panel	1
Buzzer	1
Joystick	1

- *The above Components were used to Build the Smart Wheelchair.*

B. Software

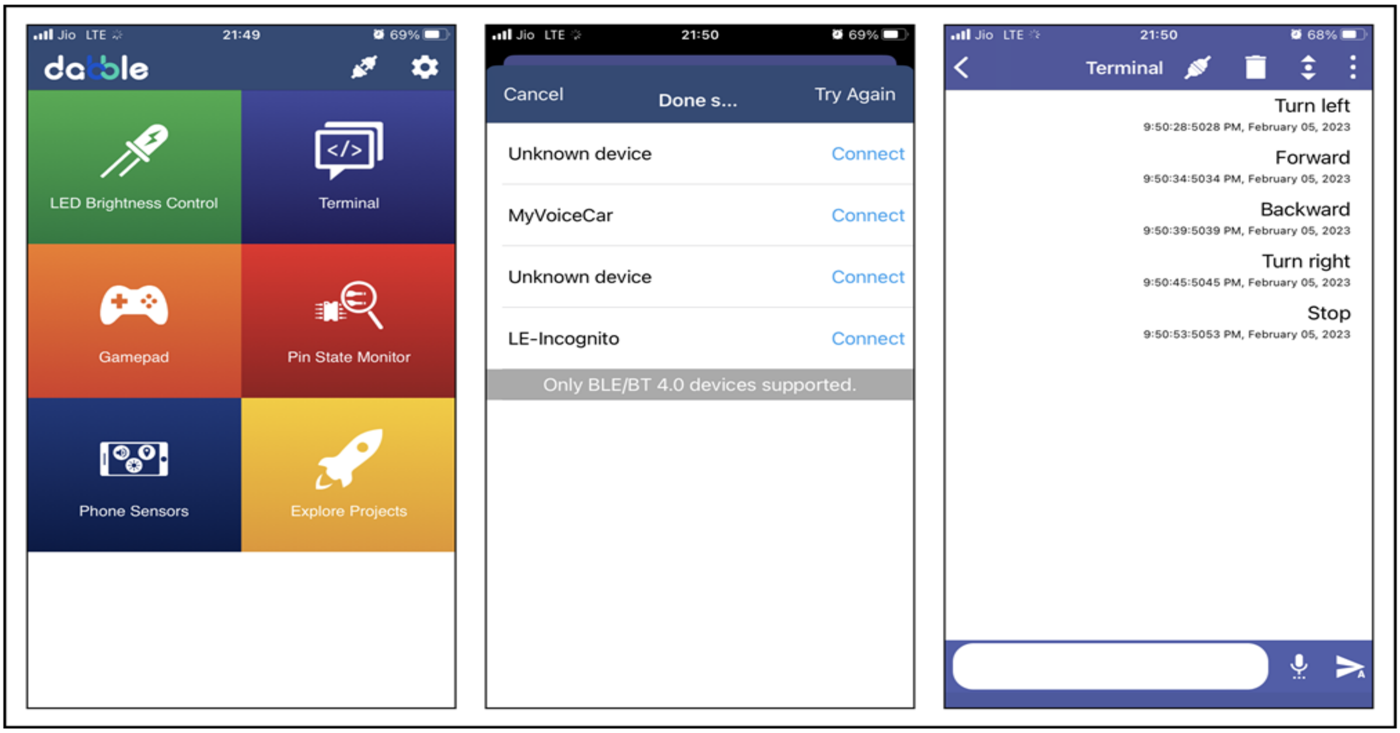

Fig 2 Dabble Mobile Application

The person sitting in the wheelchair could also control the wheelchair with their voice. This is accomplished through the "Dabble" app. Dabble App allows you to control hardware via Bluetooth, communicate with it, and access sensors such as accelerometer, GPS, proximity, and other Smartphone features. Dabble employs Bluetooth to control microcontrollers such as the Arduino Uno-Mega-Nano and ESP32.

The wheelchair's NodeMCU ESP32 transmitter communicates with the user's smartphone via Bluetooth. Once connected, the user can send commands to the wheelchair using either the microphone or the textbox. To control the wheelchair, the user can use commands such as "forward", "backward", "turn right", "turn left" and "stop". The "speed (number)" command can be used to change the wheelchair's speed.

IV. PROTOTYPE

Certainly. Figure 3 provides a comprehensive visual narrative of the developmental journey undertaken by the team, illustrating the meticulous progression from a rudimentary wireless setup to a fully functional smart wheelchair prototype. The initial depiction captures the project's inception, where a fundamental model of the wheelchair is wirelessly operated using an ESP32 microcontroller connected to a joystick. This wireless communication system forms the backbone of the prototype, enabling seamless control of the wheelchair's movements. The integration of the ESP32 and joystick signifies the project's innovative approach, leveraging advanced technology to redefine mobility solutions for individuals with disabilities.

As the iterations advance, the subsequent images showcase the refinement and enhancement of the prototype. The strategic placement of the joystick on the right arm of the wheelchair stands out as a thoughtful ergonomic choice, ensuring that users can intuitively control their movements with precision. Simultaneously, the integration of motors, a receiver module, and an obstacle detection system at the base of the wheelchair highlights the project's commitment to functionality and safety. The synchronized motors empower the wheelchair with smooth and efficient mobility, enhancing the user experience significantly. Moreover, the incorporation of an obstacle detection system exemplifies a user-centered design approach, prioritizing the safety of users by enabling the wheelchair to identify and navigate around obstacles autonomously.

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In essence, Figure 3 encapsulates the project's evolution from a conceptual idea to a tangible, user-oriented solution. It showcases the team's dedication to leveraging cutting-edge technology to create a smart wheelchair that not only provides enhanced mobility but also prioritizes user comfort and safety. This iterative development process serves as a testament to the team's commitment to pushing the boundaries of innovation, ultimately revolutionizing the way individuals with disabilities experience and interact with mobility devices.

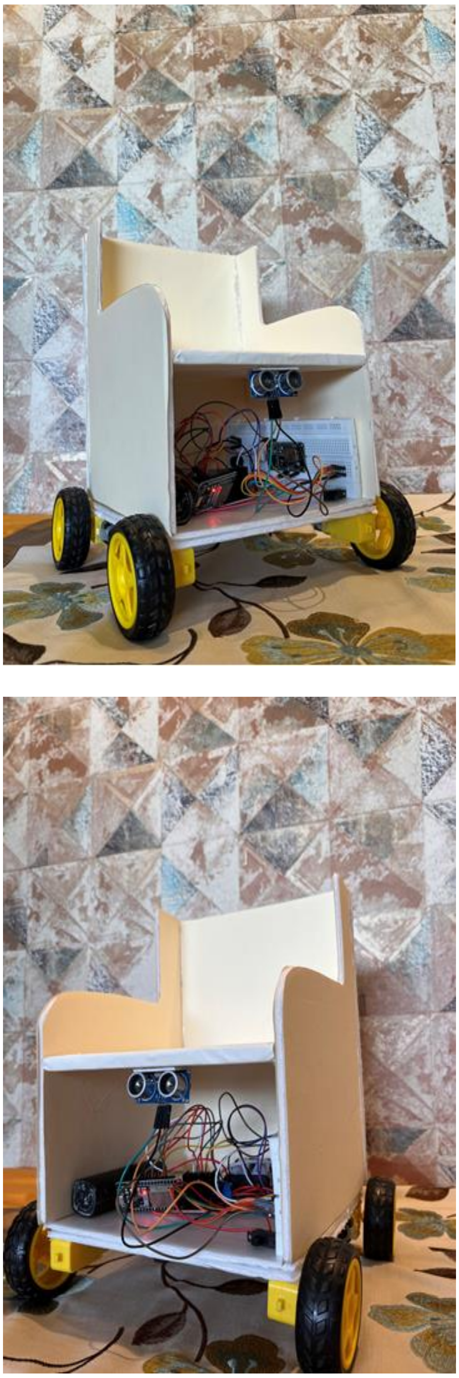

Fig 3 Cutting-Edge Technology to Create a Smart Wheelchair

Electronic smart wheelchairs are transformative devices that enhance the lives of people with disabilities in several ways. They offer a user-friendly interface, promoting independence and confidence among users. These wheelchairs significantly increase mobility and maneuverability, allowing users to navigate various terrains with ease and conserving their physical energy. Moreover, the motorized functionality reduces the strain on users and caregivers, ensuring a safer and more comfortable experience. By providing enhanced mobility, these wheelchairs open doors to increased employment opportunities, enabling individuals with disabilities to participate actively in the workforce. Additionally, these devices foster independent living by eliminating the constant need for a guardian or caregiver. Their versatility allows implementation in diverse settings, making them indispensable tools for promoting inclusivity and accessibility in society.

V. CONCLUSION

The initiative to develop wheelchairs tailored for the elderly or disabled individuals addresses a critical gap in research and technology. Existing commercially available wheelchairs often pose significant challenges. They are not only prohibitively expensive, placing a heavy financial burden on individuals and their families, but they are also typically large and cumbersome, making maneuverability difficult. Furthermore, the reliance on caretakers for basic movement exacerbates the situation, both in terms of cost and the need for constant supervision. This reality highlights the pressing need for innovative solutions that are not only affordable but also empower the user, reducing their dependence on others and promoting a sense of autonomy and dignity.

The project's vision to create a swift, affordable, portable, and easy-to-build wheelchair represents a significant breakthrough. By integrating electric operation, the wheelchair minimizes the user's dependence on a caretaker, allowing for self-directed mobility. This newfound independence is crucial for the individual's mental and emotional well-being, fostering a sense of control over their own lives. Moreover, the incorporation of sensors that gather environmental data and respond accordingly is a remarkable advancement. These sensors not only enhance the safety of the patient but also safeguard the wheelchair itself, ensuring a secure and reliable mode of transportation.

The ingenious design choice to construct the wheelchair's chassis in several pieces adds another layer of practicality. This modular approach not only facilitates easy assembly and disassembly, allowing for quick deployment and storage, but also simplifies transportation. Portability is a key factor often overlooked in traditional wheelchair designs. By addressing this aspect, the project ensures that the wheelchair can seamlessly fit into various environments, whether at home or during travel, making it a versatile and indispensable assistive device. In summary, this innovative wheelchair project not only fills a crucial gap in accessibility and affordability but also redefines the standards of usability, independence, and safety for individuals with mobility challenges.

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