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Voice Automated Smart Wheel-Chair

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***Abstract*— Being independent is crucial to surviving in today's environment. For persons with physical disabilities, this is regrettably not feasible. They require help to move about freely and are reliant on it continuously. These individuals benefit from the suggested system since it enables them to handle their everyday tasks on their own. This system makes use of an embedded Wi-Fi module in the ESP32 microcontroller. This eliminates the need for any help by allowing the user to maneuver the wheelchair using voice instructions through an app. Also, while the wheelchair is in use, the user's gadget, such as a smartphone, tablet, etc., may be charged.**

***Index Terms*— Physically disabled, Wheelchair, ESP-32, Voice-command.**

I. INTRODUCTION

It is estimated that 1.3 billion people, or roughly 16% of the world's population, are severely disabled. One in six people worldwide have serious disabilities. Additionally, the accessibility of transit facilities for people with disabilities is 15 times worse than it is for people without disabilities [1]. To solve this transit problem and reduce these people's dependence on help, a wheelchair is necessary. In developing countries like India, less than 10% of the populace has access to wheelchairs. More and more people find themselves having to utilise wheelchairs. A further 154 wheelchairs are required globally every hour of every day [2]. In order to handle the everyday transportation issue and meet the demand for cutting-edge features in a wheelchair, the suggested system has been developed using an ESP32 microcontroller to control and monitor the readings provided by numerous integrated sensors. ESP32, a line of reasonably priced, low-power microcontrollers with dual mode and integrated Wi-Fi. In order to collect data from the environment, warn the user when an obstruction is encountered, and operate the wheelchair using voice commands, Bluetooth [3] and ultrasonic sensors are used. Not all people with disabilities can move the chair manually; some may find it difficult because of their weaker limbs. The suggested system has a speech recognition component for voice commands to operate the device. Speech recognition technology is included into the "Dabble" software to ensure flawless operation, making it easier and more efficient for the user to provide voice instructions. The user of this software has the choice of speaking commands into the app or typing them in, in which case the chair will act as directed. The proposed technology adds a feature to the standard automatic wheelchairs that are currently on the market. Using two DC motors, a motor driver, and the chair, these components control its movement. The chair's wheels have dynamos installed. The wheels are connected to a generator to produce electricity, which is produced as the wheels spin. Because of this, the user is able to charge any rechargeable item, including mobile phones.

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II. LITERATURE REVIEW

These authors' works on the voice-controlled wheelchair are listed below: [1] In the ResearchGate article IoT based smart wheel chair for disabled people, we discuss a low-cost Smart Wheelchair based on Arduino Nano microcontroller and Internet of Things (IoT) technology that has a number of features to help disabled people, especially poor people who cannot afford an expensive Smart Wheelchair, get the assistance they need to complete daily tasks without assistance. This effort will enable more people with disabilities to use smart wheelchairs. The wheelchair control system will be powered by an Arduino Nano, an ESP-12e Wi-Fi module, an MPU6050 fall detection system with voice message warning using the IFTTT platform, an obstacle detection system with a buzzer and LED to function as threats, a speech recognition system and joysticks. [2] The purpose of this article, which was published by IJSDR, is to design and build an AI-powered smart wheelchair that can be controlled by voice commands and a virtual joystick. The newly created wheelchair is incredibly user-friendly and does not have a computer system to control it. As a result, it is easy to understand and process. The wheelchair can move in response to human orders thanks to two parts. If a patient is unable to move their hands, voice commands can be used to independently move the wheelchair. A phone that has been mounted to the wheelchair can be used to issue voice commands. The system offers various clever amenities and autonomous movement to the growing impaired population. [3] Voice controlled wheel chair for physically disabled people, Published by IJRASET, in this research, speech recognition is used to operate wheelchairs. It takes user input orders and moves the wheelchair using a speech recognition module that is connected to motors. Moreover, the proposed system includes a wheelchair control interface for an Android smartphone app. DC motor and an Arduino microcontroller circuit are utilized to propel the wheelchair, while IR sensors are employed to detect any obstructions in the path of travel. [4] Voice controlled smart wheel chair, Published by Journal of management information and decision science, The model demonstrated how simple a voice-controlled system like the wheelchair is. It illustrates how control elements may be achieved without the need of additional control devices like joysticks or catches. The devices may be endlessly automated by enhancing voice collection and triggering more commands. [5] Smart wheel chair, published by Peertechz, Finding the wheelchair system's speed is crucial. The distance and time are measured for velocity while the wheelchair is handled by speech. Two criteria need to be checked to determine the wheelchair's velocity. The speed is initially assessed in an empty state. A speed of 0.8 m/s is noted for the wheelchair, which is intended to move straight ahead. Second, a 15 kg weight was permitted to be carried by the wheelchair, and a velocity of 0.76 m/s was measured. Finally, a 78 kg guy sat down in the wheelchair. In order to do this, the voice-activated wheelchair has to move straight ahead. [6] The actual implementation of the hardware, the software interfacing, and testing are all included in this attempt to design, integrate, code, interface, and test a fully powered, gesture-controlled wheelchair. It is a component of the design and implementation of a smart wheelchair with Internet of Things (IoT) environment support. Research Square was the publisher of the article. The interactive cameras and sensors on this smart wheelchair are managed by a CPU unit that can handle the numerous duties it is designed to carry out. [7] "Artificial Intelligence Based Wireless Smart Wheelchair" is the title of an article that was published in the international publication of Emerging Technologies in Engineering Research (IJETER) publication. The major goal of this project was to develop an AI-powered, wireless smart wheelchair that could be moved by a patient's eye movements. The patient is seated just by staring directly at the camera, the wheel chair assembly may travel in three directions: left, right, and straight. Also, using ultrasonic sensors, the wheelchair will be able to recognize any obstructions or hurdles in its path. MATLAB programming is used to monitor the real-time camera signals. This study describes the creation, development, and application of an eye-controlled wireless wheelchair that is dependable in terms of practicality and has a straightforward design. [8] The CSE department published a paper on a voice-controlled chair. Power wheelchairs usually meet the needs of individuals with disabilities, however for certain people with impairments, using a standard power wheelchair is difficult or impossible. Assistive technology may be used in this project. It's to help people live more independently, productively, and happily. The project's background, objectives, issue descriptions, and scopes will all be covered in this chapter. [9] Voice controlled wheel chair, published by international journal of pure and applied mathematics, A voice recognition method for controlling the mobility wheelchair robot was created. The core acoustic modeling was completed using the HMM method, and more than three commands are built into the linguist database to increase or decrease the likelihood that the output words will occur. These improvements in accuracy are made possible by reading previously recognized words from the buffer. This system enables some people to live lives that are less dependent on others. [10] creating a voice-activated wheelchair for users who speak Persian In this study, They exhibited a voice-activated wheelchair for Persian speakers that was based on deep neural networks, and their work was published by a science publishing business under the heading The phrase "Using Deep Learning Networks with a Small Dataset." It has been discovered that deep learning works well for categorizing photos. They used one of the most cutting-edge deep networks, Inception-V3, to perform the categorization after converting the audio recordings to visuals. They constructed the database by capturing the voices of 15 men and 35 women because there was no existing database for Persian speakers. The performance of two algorithms, Incp-kSVM-RBF and Incp-SVM, is superior to other methods. The outcomes of the experiments show how effective their algorithm is. [11] IJSTE's voice-activated smart wheelchair for the disabled utilizing Android - International Journal of Science Technology & Engineering, this article will discuss an intelligent voice-activated motorized wheelchair for the disabled. Their objective is to gradually enable people with motor disabilities to use commonplace things. Simple speech commands may be used with a voice controller to operate it. a voice recognition program that connects to motors through a microcontroller. The Hidden Markov Model algorithm is being used (HMM). Based on the Embedded C system, this research proposes a novel approach for incorporating intelligence into a low-cost smart wheelchair. [12] IOT based smart wheel chair, published by Dogo Rangsang Research Journal, in particular, this project relates to the IOT system managing wheelchairs. It is advised to use the wheelchair System to operate a wheelchair online. The goal of this initiative is to make it easier for elderly persons who have trouble moving about and disabled or handicapped people to move around. As a result of this design, the exceptional individuals will be able to live a life with less need for other people. A new method of interacting between people and tools or machines may be possible with the use of IOT technologies. So, their problem might be remedied by using IOT to regulate the movement of a wheelchair. A power wheelchair that has several sensors, assistive technologies, and computers built into it is referred to as a "Smart Wheelchair". These features give the user with a disability, such as an impairment, a handicap, or a permanent injury, the mobility they need to move around freely and safely. [13] According to research published in the International Journal of Engineering and Advanced Technology (IJEAT), the autonomous wheelchair uses gesture recognition. Taking this action One acceleration sensor outputs two, which is the primary functioning principle of an autonomous wheelchair. Using a simple formula, we can calculate the amount of tilt and decide which direction to travel in response to tilt. Axis and acceleration sensors have outputs that vary depending on the acceleration applied to them. Sensor provides independent x- and y-axis outputs, which are supplied to the ADC and subsequently to the C, which determines whether or not to move based on the pulse width. Obstacle sensors will be fitted on the chair. There will be a total of 4 sensors fitted to detect walls and other obstructions in the forward, backward, left, and right directions. They are attempting to create a wheelchair that can be operated; the system will comprehend and carry out plain language motion directions like "Take a right." Such a system is created using several technologies. [14] The primary goal of this research is to construct a smart wheelchair whose movements are managed by an Android software that can recognize gestures. The International Journal for Research in Engineering Application & Management (IJREAM) published it. For those who are physically handicapped, this wheelchair is helpful. This Android program; Bluetooth is used to establish the connection after being developed and installed on the smartphone. There are three different ways the wheelchair may move: touch, speech, and accelerometer based. While in touch mode, the user must select the desired direction from one of the four quadrants on the touch screen of the smartphone in order to change direction. In the second mode, the user only needs to speak his desired direction, such as left, right, up, or down. The third mode, which uses an accelerometer, allows the smartphone to travel in a certain direction by tilting it up, down, left, or right. The wheelchair has IR sensors attached on it to look for obstructions in its route; if any are found, the wheelchair stops. [15] IJLTEMAS, the International Journal of Latest Technology in Engineering, Management, and Applied Science, published an article on an intelligent voice-activated wheelchair. A voice-controlled wheelchair is a portable wheelchair that can be maneuvered using spoken commands. The five voice commands "Run," "Stop," "Left," "Right," and "Back" can be recognized by speech recognition software on a computer when they are pronounced by a certain User. In order to control the wheelchair, this gadget reads the patient's settings.

III. Methodology

In this paper we have implemented (made) a voice-controlled car using ESP32 module, which has an inbuilt Bluetooth module. We have used a free dabble app to send voice commands to control the car or Bluetooth. This car can be controlled using an android as-well-as iPhone.

The components we used are: 2WD (wheel drive) car kit for this project. This kit comes with car-chassis, 2 gear motors, wheels connector and screws. (Figure 1)

A. We have also used ESP-32 module

Espressif Systems created the robust system-on-chip (SoC) microcontroller module known as the ESP32. It is the popular ESP8266 module's replacement and offers greater features and capabilities. Two Tensilica Xtensa LX6

Processors with a maximum clock frequency of 240 MHz, The ESP32 module comes with 4MB of flash memory and a total of 448 KB of RAM. The ESP32's built-in Bluetooth and Wi-Fi modules make it a great option for Internet of Things (IoT) applications. It is suited for a number of applications, including robotics, home automation, and industrial automation, and includes a wide range of peripheral interfaces, including SPI, I2C, UART, ADC, DAC, and more. Because of its low cost, adaptability, and good performance, the ESP32 module is frequently used in DIY electronics projects and is growing in popularity. (Figure 2)

B. L29 Motor driver module

An electronic circuit board called the I29 Motor driver module is used to regulate the direction and speed of tiny DC motors. To regulate the motion of wheels or other mechanical components, it is frequently used in robotics and do-it yourself projects. The module typically comprises an H bridge circuit that, depending on the input signal, enables the current to flow through the motor in either direction. It normally contains a power supply input, two input pins for regulating the motor's speed, and one input pin for controlling the motor's orientation. Programming motors using C++ and Python is simple thanks to the I29 motor driver module's compatibility with many microcontrollers, including Arduino and Raspberry Pi. Overall, engineers and hobbyists who need to control the motion of DC motors in their projects will find the I29 motor driver module to be a helpful and adaptable tool. 15v DC battery, Double sided tape and few jumper wires. (Figure 3)

C. ESP32

The ESP32 is a low-cost, low-power microcontroller that includes Bluetooth and Wi-Fi. (Figure 4)

D. Motor driver L293D IC

It is the most popular way to use a computer to operate several DC Motors bi-directionally. The figure below shows an H-Bridge motor driver as an example. Two tiny motors can be controlled simultaneously and, in both directions, using the L293D circuit motor driver. It is capable of driving two DC motors simultaneously in both forward and backward motion. Pins 2 and 7 and pins 10 and 15 are, respectively, the input logic inputs for this operation.

Figure *1. 2WD Kit*

Figure *2. ESP32 Module*

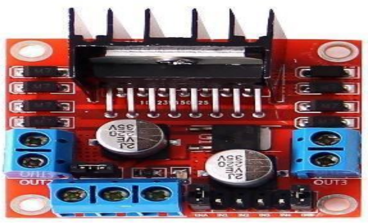

Figure *3. L29 Motor Driver Module*

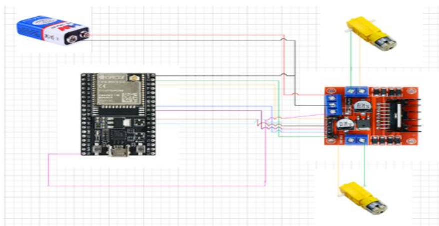

Figure *4. Circuit Diagram*

E. DC Motors

It is a basic motor that generates revolutions using power from a battery and a magnetic field. It consists of two opposite-polarity magnets and a coil that functions as an electromagnet. The magnets' electromagnetic forces of attraction and repulsion supply the torque needed to turn the DC motor. They are utilized as wheelchair wheels.

ESP is a single 40 nm TSMC power chip that combines 2.4GHz Wi-Fi and Bluetooth functionality. ESP32 is a line of inexpensive, low-power systems on a chip microcontroller that include built-in dual-mode Bluetooth and Wi-Fi.

F. Assembly

Firstly, we have assembled the car; we have soldered wires to gear motors to mount all gear motors on car chassis using connector and screw. Then we have attached the car-chassis plate using screws and we have made sure that it is tightened properly, so that we don't have any loose parts. Then we have joined red to red and black to black wires of DC-Motors on each side. Attach I298 and motor driver module on car chassis using double-sided tape.
We have connected the right side motor to the 1 and out 2 pins of the I298 motor driver module, then we have connected the left side motors to the 3 and out 4 pins of the motor driver modules. Then attached DC-battery power connectors to the motor driver module plus a 12-volt pin and Ground (GND) pin. Then we fixed the ESP-32 module on car-chass, using double sided tape. Now we have connected the I298 motor driver module to ESP32 pins. As per Table below.
We have taken plus 5 volts and Ground (GND) from I298 and the motor driver module and provided two ESP32 modules through 5volt and GND pins. After that, we attached the wheels to the car.
Coding Part: Firstly, we have installed ESP32 board using Arduino-Board manager for that, we have to go to file preferences and add ESP32 board link:
https://dl.espressif.com/dl/package_esp32_index.json
then select Tools, Board Manager, then look for and install ESP32.

TABLE I. PINS CONNECTION

ESP32 Pins	L298N Driver Pins	ESP32 Pins	L298N Driver Pins
IO22	enA	IO18	IN3
IO16	IN1	IO19	IN4
1017	IN2	IO23	enB

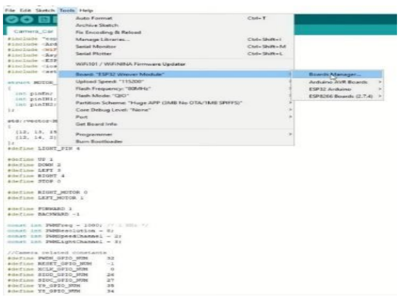

Figure 5. *Coding part 1*

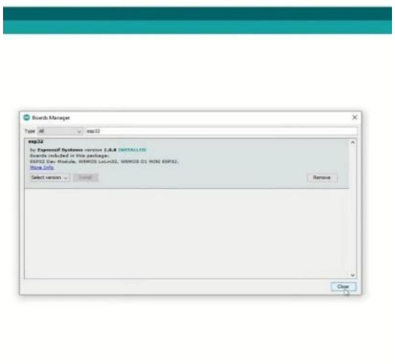

Figure 6. Coding part 2

Then we have installed the Dabble ESP32 library as well. For that, select Tools, Manage Libraries, then Search for and Install Dabble ESP32.
Now we have defined custom settings and included the terminal module, then we need to include the Dabble ESP32 library. We have designed the default motor speed as 200. We have also defined turning speed as 150, whose maximum value can be 255. Now we have assigned the right and left motor pins. We have set the PWM frequency resolution and channel for speed control. We also have created a variable to store the current speed of the car, we can change the car speed using voice commands. We have a car direction variable for the current direction. We have created a control with a voice function to control the car; inside this function, we will read the command sent for the mobile app over Bluetooth. We will read the command using the "dot read string" function, if the received command is forward, then it moves the car in forward direction by rotating both motors that too in forward direction. Similarly, if the command is received in reverse or backward direction then the other side motor moves in reverse direction, which makes the right turn

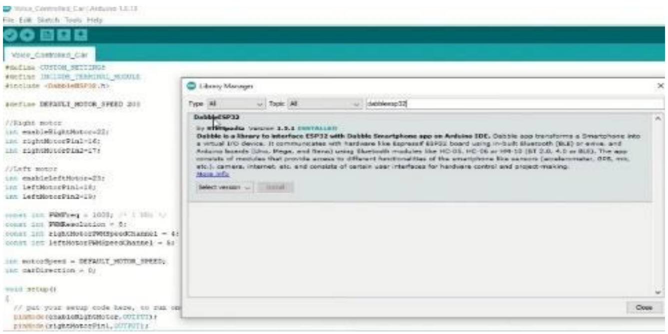

Figure 7. Coding part 3

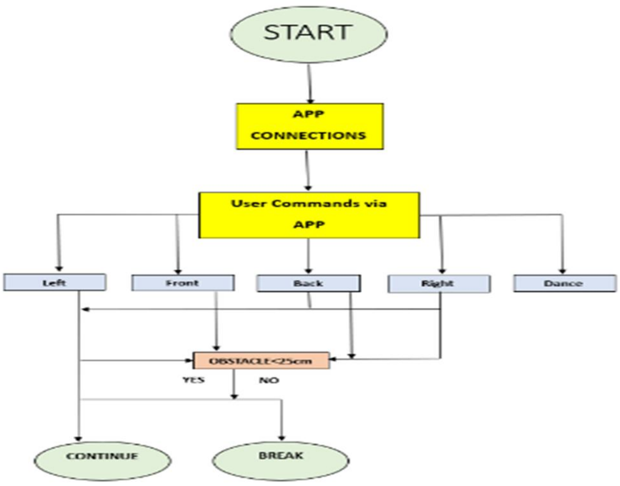

Figure 8. Flow Diagram

If the received command is left or states to turn in the left direction the car would rotate to the left. These commands are quick turn commands as, if the commands are rotated right or left, it will keep the car rotating continuously, unless and until the 'stopped' command is not given. If the command given is speed, the speed of the car is being set wherein the value of the speed of the car should be numerical. We can also make our car dance by giving a dance command. We have also created a rotate motor function which rotates the motor in a particular direction with particular speed given. Also, we have created a setup pin mode function to set up motor pins as output. It even sets the PWM channel for the speed control which initially stops all the motors inside. Then inside the loop function we need to call the dabble dot function to process the data, which is, it processes the input to receive the data. After these steps, we need to call control the voice function which controls the car.upload the code.
Now we connected the esp32 module to the laptop using a USB cable. then we select the esp32 Dev module and port. then hit upload. Now we connect the battery to the car.

At last, we need to download the dabble app for further use for commands. we need to go to the terminal module, connect it to our esp32 Bluetooth module which will be displayed as ‘my voice card’ in the Bluetooth device list. Now we can use this app to give voice commands.

The user must first integrate the model via the Dabble App before running in a wheelchair. The user will now be able to use their app to connect to the Bluetooth device with the name "MyVoiceCar" because we introduced the library DabbleESP32.h to the Arduino IDE. So, we can effectively connect our model with the app by adding Dabble.begin. The user will be able to send orders through the app, such as forward, backward, left, or right, after a successful connection. Wheels will rotate in accordance with the code, causing these orders to be carried out. If the wheelchair senses an obstruction less than 25 cm (9.84 in) away, it will halt automatically; otherwise, it will carry out the user's commands.

IV. Results & Discussion

The automated wheelchair system described provides users with a number of cutting-edge features and advantages. Since voice control is the foundation of its functioning, those with mobility issues can use it easily. Users may easily control the wheelchair's motions by speaking orders, which can substantially increase their independence and ease of movement. An ultrasonic sensor must be included as a vital safety element. The wheelchair is able to recognise obstacles in its route and, when spotting one, temporarily pauses to assess the situation and choose the best course of action for dodging the obstacle. The probability of crashes is greatly decreased and user safety is improved by this real-time obstacle identification and avoidance technique. By utilizing the Bluetooth capabilities of the ESP32 Microcontroller, the integration of the Dabble app provides users with a handy way to manage the wheelchair. Through the software, users can communicate with the wheelchair in a variety of ways by pressing buttons on the screen. Additionally, the system provides five instructions that let users carry out a variety of tasks, including moving ahead, carrying out prepared dance routines, turning right or left, and moving backward. These commands give users the flexibility to maneuver their wheelchair and modify it for various scenarios. The wheelchair's capacity to create power while in use is one of its unique features. The wheelchair can recharge its battery by using a dynamo to convert the wheel revolution into power. The wheelchair's operational range is increased thanks to this sustainable energy generation, which is also in line with environmental ideals. The electricity produced can also be used to recharge other electronic gadgets. The ability to recharge cell phones, tablets, and other necessary devices while using the wheelchair makes this function highly useful. Users are guaranteed constant access to their gadgets and connectivity throughout the day.

V. Conclusion

The suggested system's core component, the voice command, turns mobility for a physically impaired person into an autonomous endeavor and does away with the need for any type of outside support. By allowing the user to input voice commands to the ESP32 Microcontroller, which in turn controls the wheelchair, the "Dabble" app totally automates the procedure. Thus, the suggested solution is a voice-controlled wheelchair that also has a charging capability for mobile devices. The suggested approach introduces a fresh model to the already known automated wheelchair designs.

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