Fabrication of Voice Controlled Wheelchair System

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Abstract— This project opens a new hope to the physically challenged people. Freedom of mobility is the dream for every patient especially in the case of people suffering from cases such as quadriplegics and multiple sclerosis. Although many types of mobility equipment's are available for these types of patient there is no independent means of mobility device for these patients since they cannot drive a joystick or manual wheelchair. To aid these types of patients we are developing voice operated wheelchair. The movement of the wheelchair is controlled by the voice of the user. This wheelchair can be driven to the preferred direction with minimum effort. The user requires only less training to use this wheelchair. Technically this wheelchair is integrated with a voice recognition app to identify the voice, a microcontroller which can be programmed, other supporting hardware components to form the embedded system and worm gear motors to cause movements of the wheelchair. The proposed microcontroller-based voice operated wheelchair would bring more convenience for the disabled people. Two DC motors can be driven simultaneously, both in forward and reverse direction with the help of motor driver. Here we can control the motors to move Right, Left, Forward, Back and Stop. The goal of this system will allow certain people to live a life with less dependence on others for their movement as a daily need. Speech recognition technology is a key technology which will provide a new way of human interaction with machine or tools. Therefore, the problems that they face can be solved by using speech recognition technology for the movement of wheelchair.

Keywords: Voice Controlled Wheelchair, Physically Disabled People, quadriplegics, multiple sclerosis, Micro Controller

I. INTRODUCTION

The number of people, who need to move around with the help of some artificial means, whether through an illness or an accident, is continually increasing. This means, the number of disabled people is increasing by tragic accidents also, some victims of the accidents are suffering from abnormal life with serious spinal injuries. Freedom of mobility is a dream for every person with physical disabilities.

Fig. 1: Statistics of Disabled person in the world

With the aid of technological evolution, in order to increase the quality of life for these people and facilitate their integration into the working world. In this way a contribution may be made to facilitating Wheelchair which is a widely used device by disabilities. While the needs of many individuals with disabilities can be satisfied with traditional, manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. Physically challenged people have either less mobility or no mobility. The various paralyses such as quadriplegia and Multiple sclerosis. Multiple sclerosis (MS), also known as disseminated sclerosis or encephalomyelitis disseminate, is an inflammatory disease in which the insulating covers of nerve cells in the brain and spinal cord are damaged. This damage disrupts the ability of parts of the nervous system to communicate, resulting in a wide range of signs and symptoms, including physical, mental and sometimes psychiatric problems.

The aim of this research project is to fabricate a motorized wheelchair control system with a voice command system. With this system most of the disabled people can move independently is the real moto of the project.

II. LITERATURE SURVEY

This project concentrates and focuses on the implementation of a voice-controlled motorized wheelchair. With all the available methods in the ongoing researches, definitely, the daily lifestyle of the disabled people will be improved. The introduction of the motorized wheelchair increases their independency and mobility in performing their daily social life activities. Different researches on wheelchair were done by worldwide renowned universities and researchers are discussed below:

1) Satish Kumar et.al. [1] Explained the importance of mobility and also designed the wheelchair based on both mechanical and electronic combinations to make it easier for the users to operate it.
2) Vignesh S.N et.al. [2] Designed a wheelchair in such a way that includes an accelerometer (sensor) which detects the movement of head and the controller will process the signal and will transmit to the wheel chair for its navigation.
3) Mr. Vijendra P. Meshram et.al. [3] Used the accelerometer device called the ADXL535 based transmitter. This device is placed on the person's head which detects the head gestures in various directions.
4) Colleen Nelson et.al. [4] Worked on a robotic wheelchair using eye blink sensors and accelerometer provided with home appliance control. In this case, an RF transmitter and receiver were also used in order to control the various devices or objects in close vicinity of the user of the wheelchair.
5) Narender Kumar et.al. [5] Wrote a research paper which introduces the design and implementation of a novel

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hands-free control system for intelligent wheel chair. This is achievement for those whose limbs are not working and who are blind because it works with the movement of head.

6) Monika Jain, et.al. [6] Worked on the wheelchair based on the eyeball motion-controlled wheelchair using IR sensors. There are three Proximity Infrared (IR) sensor modules are mounted on an eye frame to trace the movement of the iris.
7) Snehalata Yadav et.al. [7] Explains the various methods that are used or have been used or incorporated in the making and functioning of the wheel chairs made so far for the disabled.
8) Sandeep et.al. [8] Gives a briefing of gesture-controlled wheelchair. The purpose of this study was to present the reliable means of human-computer interfacing based on hand gestures made in three dimensions.
9) Gowthaman A et.al. [9] Explains in his paper, the accelerations of a hand in motion in three perpendicular directions are detected by a MEMS accelerometer and transmitted to a PC via Bluetooth wireless protocol.

III. OBJECTIVES

1) To design and fabricate a motorized wheelchair that would carry approximately a person of 70 kg.
2) To run a wheelchair with a battery powered and control it with voice of the user.
3) To design an embedded system which makes the wheelchair to operate wireless.
4) To develop an android app through which we can operate the movement of wheelchair using android devise.

IV. MATERIALS AND METHODOLOGY

A. Material used

To innovate a realistic voice controlled wheelchair, various kinds of equipment are necessary. Mainly wheelchair is made mechanically or by the installation of mechanical equipment/parts. The electrical equipment components are designed for using in the wheelchair and after installing these in the mechanical wheelchair, the mechanical wheelchair now is turned to an electrical wheelchair. Therefore some of the thoughts worked useful about the equipment/components used to construct the wheelchair and their installation.

1) Hardware Requirements

1) Wheel chair chassis: The wheel chair Main frame is made of Mild Steel, L angles and square pipe cut diagonally and welded together to make the frames of the Wheel chair. The seat is made up of wood which is bolted to the frame. Bicycle wheels have been used as driving boost (Rear wheels) and are coupled to the motors. The wheel diameter of the Rear wheels is 22 inches. Caster wheels are been used in the front having a diameter of 2 inches.

Fig. 2: Wheel Chair chassis

2) DC Motor: Motors are arguably one of the most important parts of a mobile robotics platform. Overpowered motors cause waste the already limited supply of power and inefficiency from the on-board batteries. At critical times undersized motors could be short on torque. The available speed range as well as the optimal rotation speed of the motor must also be taken into consideration. Too high of an output rpm from the motor shaft will cause the wheelchair to operate at a fast, uncontrollable speed. Too low of an output and the wheelchair will not be able to attain a speed and the available speed range of the motor must also be considered To meet the user's needs it is low of an output and the wheelchair will not be able to attain a suitable speed. The torque is the output of the motor plays a role in the performance because locomotion may not occur in certain situations. Therefore, the selection of the proper motor for the platform is very important. There is many shapes and sizes of motors. Figure shows the 12V DC motor use in wheelchair.

Fig. 3: DC worm gear motor of 12 volts 60rpm

3) Relay: Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized. Relays are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps.

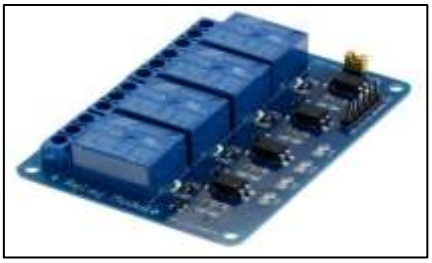

Fig. 4: Relay Module of 4 channel 5 volts

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4) Microcontroller: A microcontroller is a small working system on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. By decreasing the size and price between the design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.
5) Node MCU: Node MCU is an open source firmware for which open source prototyping board designs are available. The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits. The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The design was initially was based on the ESP12 module of the ESP8266, which is a WiFi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications.

Fig. 5: Node MCU Wi-Fi Module

6) Android Mobile: Any android mobile can be used. It is used as an input device as it receives the voice command from the handicapped user and converts this speech signal into text with the help of an android application developed from MIT APP INVENTOR. This then transfers this text to Node MCU Wi-Fi module with the help of Wi-Fi wirelessly giving signals to the microcontroller to perform operations.

Fig. 6: Android Mobile

7) Battery: The battery used in this work is 12 volts, DC 7.7AH. To create electrical energy the chemical reaction between lead and sulphuric acid which is to be used is wet batteries. There is need filling with distilled water to the batteries, wheelchair battery does have a higher maintenance rate, but are lighter than AGM (Absorbed Glass Mat) or Gel batteries.

Fig. 7: Battery (12 volts, DC 7.7AH)

2) *Software Requirements*

1) Arduino IDE software: Arduino is the hardware platform used to teach the C programming language as Arduino boards are available worldwide and contain the popular AVR microcontrollers from Atmel. It is a full featured integrated development environment (IDE) that uses the GCC C software tools for AVR microcontrollers and is free to download.
2) Android App developed from MIT APP INVENTOR: MIT App Inventor is a web application integrated development environment originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It allows newcomers to computer programming to create application software (apps) for two operating systems (OS): Android, and iOS, which, as of 8 July 2019, is in final beta testing.

It uses a graphical user interface (GUI) very similar to the programming languages Scratch (programming language) and the Star Logo, which allows users to drag and drop visual objects to create an application that can run on android devices.

Fig. 8: MIT App Inventor

B. Methodology

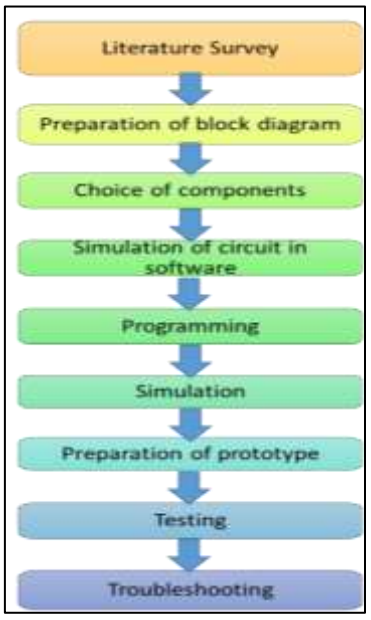

Fig. 9: Flowchart of the research work

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1) Working of the voice-controlled wheel chair:

The input is taken from the android mobile; speech signal is converted into the text with the help of an android application. This text is transferred to the Node MCU Microcontroller which controls the movement and direction of wheel chair via a Wi-Fi module wirelessly. Node MCU Microcontroller decides the operation of the two DC motors depending on the text received. Driver Circuit is a dual full bridge driver IC which is used for driving purpose of DC motors.

The wheel chair directions and movement possible are as given below:

1) Forward: Motor1 moves in the clockwise direction. Similarly, Motor2 moves in the clockwise direction and the tires of the wheelchair moves in forward direction.
2) Back: Motor1 moves in counter clockwise direction. Similarly, Motor2 moves in the counter clockwise direction and the tires of the wheelchair moves in backward direction.
3) Left: Motor1 or the left tire moves in the counter clockwise direction and simultaneously Motor2 or the right tire moves in the clockwise direction and the wheelchair moves in left direction.
4) Right: Motor2 or the right tire moves in the counter clockwise direction and simultaneously Motor1 or the left tire moves in the clockwise direction and the wheelchair moves in right direction.
5) Stop: This command terminates any operating control mode and stops the wheelchair immediately. After the stop command is given the voice recognition process performs a self-test and restarts in a neutral mode.

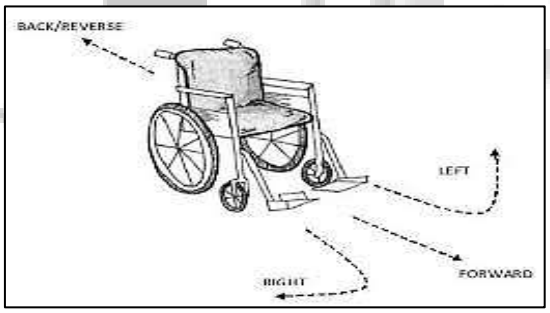

Fig. 10: Wheel chair path movements

V. PROPOSED SYSTEM:

In this work, voice recognition module is used as user interface. This wheelchair is driven and fully controlled by using voice commands. In which the voice commands of the user are recognized by the voice identification app. The output obtained from the voice recognition app is used to drive a microcontroller-based control circuit. The microcontroller is programmed in such a way to produce the required output for the corresponding voice commands. The output of the microcontroller is given to motor driver, which can control a set of 2 dc motors simultaneously in any direction. The system consists of Voice-recognition app, Microcontroller – Node MCU, Relays, Voltage regulator, Worm gear Motor (DC) and Battery.

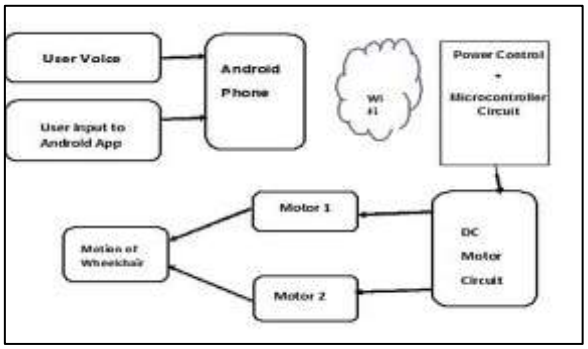

Fig. 11: Block diagram of the system

VI. RESULTS AND DISCUSSIONS

The project was tested for the movement of the wheel chair using trained voice after the design and development of the self-automated wheel chair with its various interfacing units. On the basis of important aspects, firstly the voice recognition system will be tested in a quiet room with only one single user. Every word was correctly recognized.

- For a next time, we tested it with a different user on whom the system was not trained. For example, words like "right" were recognized as "write" in this way about 5% errors occurred in this case.
- This was because the recognizer heard a different pronunciation. However, after the user had to speak the word a number of times the system had enough examples and properly determined what pronunciation the user speak of the word.
- After this system was tested in a noisy room by turning on some music in that room. There was no problem in correctly recognizing the words when the music was light but the recognizer found it difficult to recognize the user's voice when we turned the volume high and often took commands from what it heard in the song.

Voice command	(a)Result in silent area						(b) Result in noisy area					
	Experiment Trials					Total Response	Experiment Trials					Total Response
	1	2	3	4	5		1	2	3	4	5	
Reverse	1	1	1	1	1	5	1	1	1	1	0	4
Forward	1	0	1	1	1	4	1	1	1	0	0	3
Right	1	1	0	1	1	4	1	1	0	0	0	2
Left	1	1	1	1	1	5	1	1	0	1	0	3
Stop	1	0	1	1	1	4	0	1	1	0	1	3

Table 1: Accuracy of Wheelchair in Noisy and Silent Area

This experiment was conducted in a room which is in silent condition to observe the result of the experiment. The use of the experiment is to find out the accuracy of the wheel chair in response to the speech (voice) in different conditions.

1) Condition 1: In silent place Five trials of experiments were done with the new design based on the commands listed in table there are 4 over 5 commands were recognized by the speech recognition circuit to move the wheel chair. The percentage of the correctness of the wheel chair in silentcondition is Accuracy = 4.8/5 X100= 96%.
2) Condition 2: In noisy area the testing is done outside the silent room where it is considered as natural environment. From this experiment, the output is obtained as per the Table 1. From the table, there are 3 over 5 commands recognized by the trained speech

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recognition circuit. The percentage of the accuracy of speech Recognition circuit in noisy area is 60%. This is calculated as, Accuracy = 3/5 X100 = 60%.

A. Snapshots of Our Project

VII. CONCLUSION

This project elaborates the design and construction of voice controlled wheelchair system with the help of Wi-Fi setup. The circuit works properly to move as the command given by the user. The voice recognition system worked for most of the commands (over 95%). Only when a word was not properly vocalized, the system did not recognize it. After designing this the circuit enables physically disabled to control their wheel using an android application in their smartphones. This project contributes to the self-dependency of differently abled and older people.

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