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Voice Controlled Wheelchair for Physically Disabled People

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Abstract: The proposed system aims at assisting people with physical disabilities and old aged people who are not able to move independently because of their weakness. The proposed system allows the handicapped people to live their life independently to an extent. Voice recognition technology is a new way of human interaction with machine. This project uses voice recognition for the controlling of wheelchair. It uses the voice recognition module which is interfaced with motors to take input commands from the user and move the wheelchair. Also, the proposed system is interfaced to control the wheelchair using the android app which is used in smartphone. An Arduino microcontroller circuit and DC motors are used for the movement of wheel chair and IR Sensors to detect any obstacles present in the way of direction.
Keywords: Wheel chair; Physically Challenged; IR Sensors; Voice Command; Arduino Micro-controller;

I. INTRODUCTION

A wheelchair is used when it is hard or impossible to walk due to physical illness, injuries or disabilities. There are various kinds of wheelchairs to meet the various needs of their users. Several studies have concluded that for independent mobility to all the disabled human beings powered wheel chair, manual wheelchair and walker access the benefit. Independent mobility increases many educational opportunities, promotes feelings of self-reliance and reduces dependency on others.

As per the "World Report on Disability" there are 70 million people who are handicapped. Unfortunately, day by day the number of handicapped people is increasing due to road accidents and disease like paralysis, Quadriplegics, etc. Among all the disabilities percentage of physically handicapped people. In India 120 million people are disabled out of which 41.23% are physically disabled. The lack of ability to explore and control can often result in deprivation and lack of motivation that leads to helplessness. For elderly, independent movement is an important aspect of self-esteem. Mobility difficulties leads to the problem of activities of daily living because of the need to move around to accomplish many activities. The impaired mobility often results in reduced opportunities, which leads to social isolation, and many mental problems. While the needs of many people with physical disabilities can be satisfied with traditional manual or self-automated wheelchairs, a portion of the disabled community finds it difficult or impossible to use wheelchairs independently. People with Quadriplegics, Multiple sclerosis have severe disabilities and hence cannot drive joystick operated traditional Wheelchairs.

Traditionally wheelchair has their own limitations with reference of its flexibility, bulkiness and limited function. The wheelchair may include individualized user controls, and may be specific or referred to particular activities, as seen with sports wheelchairs and beach wheelchairs. The most widely work recognized is between powered wheelchairs, where propulsion is provided by batteries and electric motors, and manually propelled wheelchairs, where the propulsive force is provided either by the wheelchair user pushing the wheelchair by hand or by using an attendant pushing from the rear.

The proposed system describes a wheelchair which can be can be controlled using the voice commands from the user as well as smart phone. It is used to facilitate the movement of physically disabled people and elderly people who cannot move properly. So, with this aspect in mind we can help them to lead a better life. Voice recognition is a key technology which provide human interaction with machines for controlling wheelchairs. This project includes two parts, which is the software and hardware. Arduino kit (Atmega 382) is used as a controller for the movement of wheelchair. The five basic movements of the wheelchair are described as following:

A. Moving it forward
B. Moving it backwards
C. Turning it to the righ
D. Stop condition

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II. METHODOLOGY

The main part of the design is to control all the motions of the wheelchair as per the user commands. The forward command moves the wheelchair forward until the obstacle is detected. Similarly, the reverse command for the reverse direction, to run the opposite movement of wheel rotation. The left command will make right wheel move forward and left wheel moves backward. The right command makes left wheel move forward and right wheel backward. For the stop command rotation of the both motors will stop.

The system development majorly has four sections. First one is to develop an electronic circuit for voice recognition, second one is on developing an interfacing circuit, third one is designing the circuit for controlling the direction of the motor forth one is developing a modified manual wheelchair and interface with the control circuit.

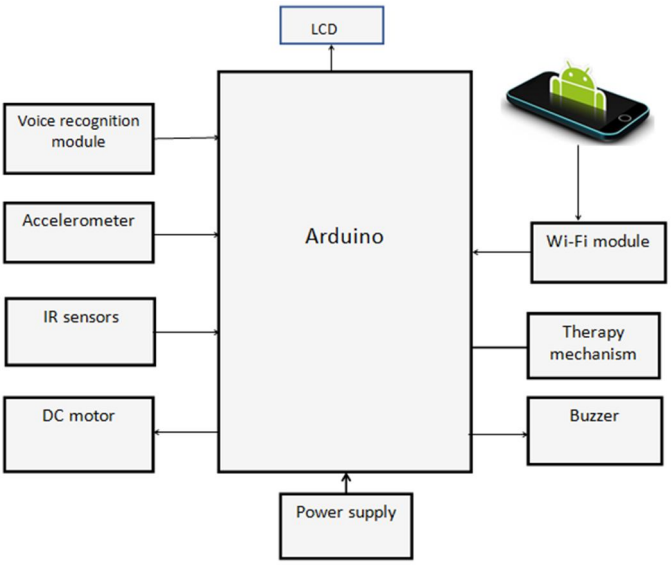

Figure 1, Block diagram for voice-controlled wheelchair.

A. *Hardware Requirements*

1) Voice recognition module
2) Microphone
3) Accelerometer
4) IR Sensor
5) Arduino
6) Wi-Fi module
7) DC Motor
8) Motor Driver
9) Buzzer
10) LCD
11) Vibrators

B. *Software Requirements*

1) Arduino suit
2) Embedded C

A microphone receives voice instructions from the user and is sent to the voice-recognition module in turn to run the smart wheel chair. Voice recognition module V3 is used wherein it supports 80 voice commands in all and maximum of 7 voice commands to work at the same time. Any sound or words of any language can be trained to this module. This works at an input voltage range of 4.5 to 5 volts which is provided by the Arduino board.

A microcontroller is mounted within an Arduino board and hence it holds the instruction to be followed within its code. The Arduino board is equipped with its own digital and analog input/output pins that maybe interfaced with others circuits and components such as IR sensors, Accelerometer, LCD, etc. The operating voltage of Arduino board is 5 volts and it has 14 digital

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input/output pins of which 6 provide PWM output. This operates at a clock speed of 16 MHz and provides 32KB Flash Memory,2KB SRAM and 1KB EEPROM. As the Arduino consists of both physical circuit and a piece of software or IDE (Integrated Development Environment) that runs on the computer hence helping to write and upload code to the physical board. The board can be powered directly from AC mains power supply by connecting it to the barrel jack. As Arduino board are relatively inexpensive, has a cross platform, easy to use programming environment and an open source extensible software and hardware it is choose over the other controllers.

In the system an accelerometer is used to detect if the person on the wheelchair falls down. This is detected by measuring the acceleration, Inclination and vibrations according to the movements. These readings are taken with respect to X, Y and Z coordinates. As soon as person falls down it is detected and alerted using a buzzer which is connected to it. For the faster recovery of the numbness of the body parts vibration therapy has been incorporated in the proposed system. So, the vibrators are used to provide simple vibrations stimulate muscles for a faster recovery while sitting on the wheel chair. While the wheel chair is moving and the IR sensor senses an obstacle, immediately it alerts the user. This is done by sending IR energy by the transmitter present in it and looks for reflected IR energy if any obstacle is present in the path of the wheel chair as shown in Figure 2. Thus, stopping the movement of the wheel chair.

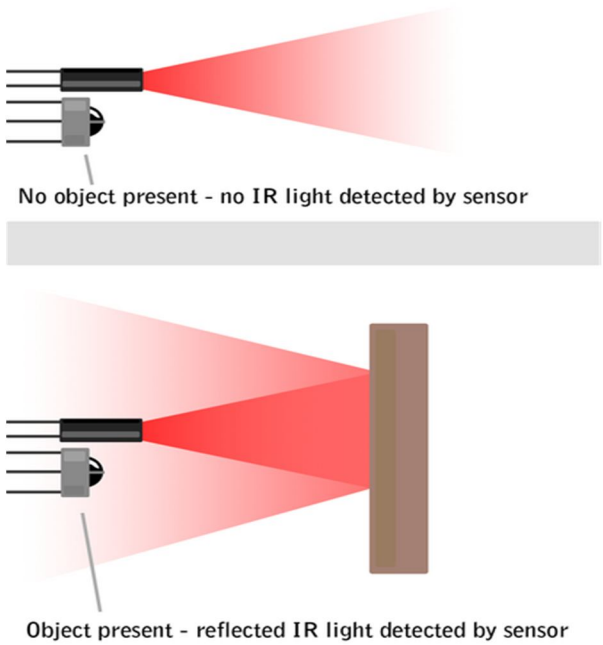

Figure 2, Working of IR sensor

DC motor converts the direct current electrical energy into the mechanical energy in turn driving the wheel chair.

The Arduino board provides a voltage of 5 volts whereas a DC motor requires 12 volts for it to rotate. Thus, a motor driver acts as amplifier and ESP 8266 WIFI module can be simply hooked up to the Arduino and as well interface between these smartphone and microcontroller for operating the wheel chair using a smartphone.

III. IMPLEMENTATION

Using the procedure hardware setup is done and the interfacing of Android Smart phone and the wheelchair is shown. The system continuously checks for the input and compares it with the previously stored commands. The program that includes threshold values of the sensors is loaded into the Arduino board through Arduino software. If the input matches, motor rotates according to the input in turn the wheelchair moves.

The IR is stored with the value zero, if the value matches it indicates the presence of an obstacle and stops the motors. If the value doesn't match then motor continues to run according to the input. This flow is maintained as the flow chart shown in the figure 3.

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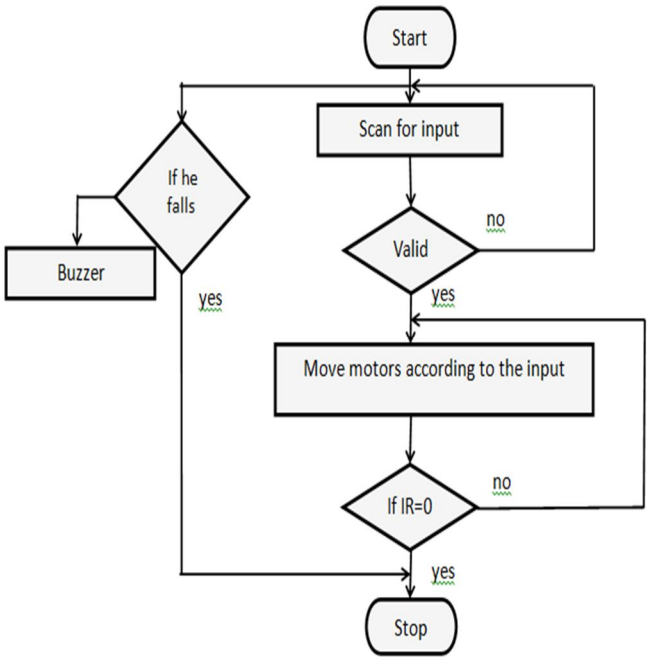

Figure 3, Flowchart

Simultaneously the accelerometer continuously compares the coordinates value with the stored one. The sensors start continuously monitoring the wheelchair to fetch the sensed information and is compared with the threshold value program in the microcontroller. Accelerometers are fixed on Neck, spinal cord. The outputs of these accelerometers are given to the ADC unit of the microcontroller. If value doesn't match, it indicates the fall of the wheelchair and alerts through buzzer.

IV.RESULTS AND DISCUSSION

This work elaborates the design and construction of wheelchair with voice recognition module to control all the movements of the wheelchair. The wheelchair can also be operated by the help of an android application which can easily be downloaded in smartphones.

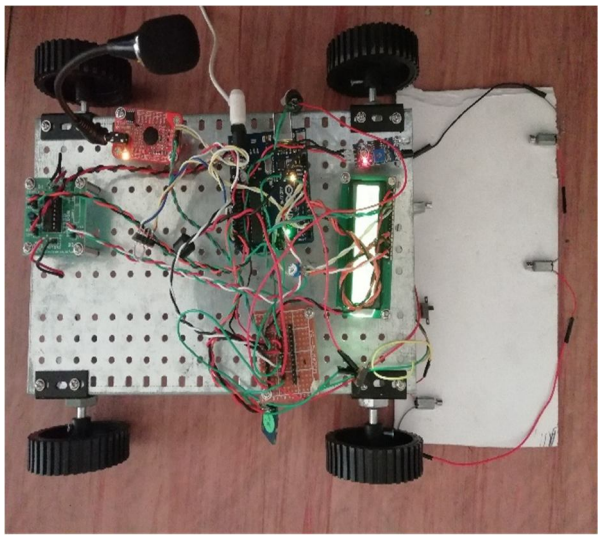

Figure 4, Hardware setup of the smart wheelchair

The above figure 4 shows the wheelchair prototype which is controlled using a voice recognition module from which takes the voice inputs from user.

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A Wi-Fi module is connected to the Arduino which can be used to control the wheelchair using smartphone. The wheelchair also consists of an LCD screen which displays the command given to the system. An IR sensor is also included which detects any obstacles on the path. There are also vibrators connected to the end of the wheelchair wherein it provides the vibration therapy.

VOICE COMMANDS	SMART PHONE COMMANDS	DIRECTION
One	$A	Forward
Two	$B	Reverse
Three	$C	Right
Four	$D	Left
Five	$E	Stop

Table 1, Table of commands

The above table represents the commands given to the smart wheelchair by the user voice commands and by the smartphone via the Wi-Fi module.

Figure 5, Connection enabling and commands given through a smartphone.

The above figure 5 shows the connection establishment from the WIFI module to the smart wheelchair to control. Commands are given such as $A for forward, $B moves the wheelchair in reverse direction, $C for moving in right direction, $D for moving in left direction and $E for the command stop.

V. CONCLUSION

The wheelchair is controlled by the commands from the user as well as by the using a smartphone which is connected through the Wi-Fi module. This helps the disabled or the elderly people to move independently and thus eliminating the enslavement. Alerts are given if the person falls down from the wheelchair and stops when an obstacle is detected. The wheelchair also provides vibration therapy for faster recovery of the patient.

The efficiency of voice command-based wheelchair can be improved by neural based algorithm.

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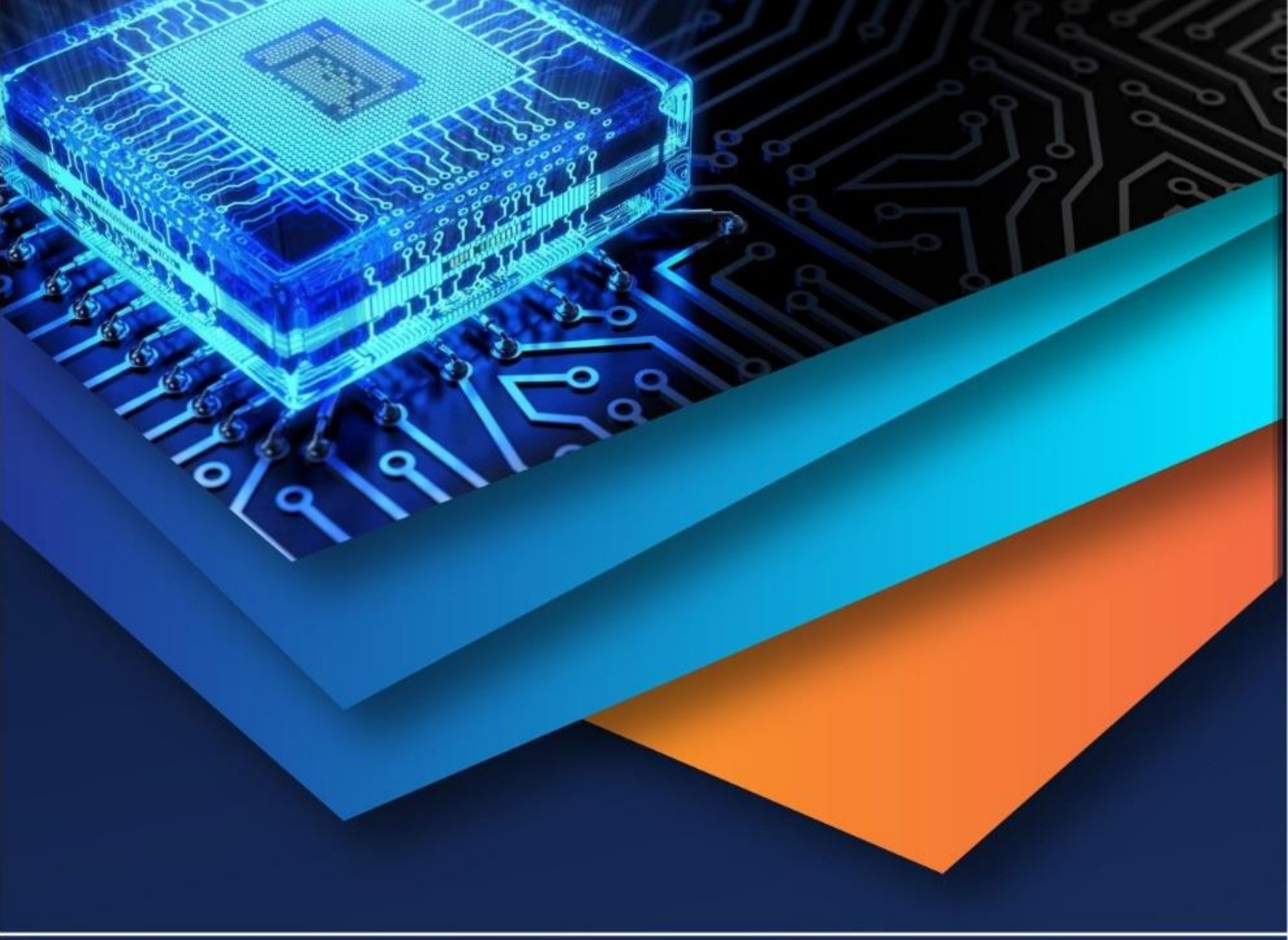

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