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Smart Electronic Wheelchair Using Arduino and Bluetooth Module

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Abstract- This paper describes the design of a smart, motorized, voice controlled wheelchair using embedded system. Proposed design supports voice activation system for physically differently abled persons incorporating manual operation. This paper represents the "Voice-controlled Wheel chair" for the physically differently abled person where the voice command controls the movements of the wheelchair. The voice command is given through a cellular device having Bluetooth and the command is transferred and converted to string by the BT Voice Control for Arduino and is transferred to the Bluetooth Module SR-04connected to the Arduino board for the control of the Wheelchair. For example, when the user says 'Go' then chair will move in forward direction and when he says 'Back' then the chair will move in backward direction and similarly 'Left', 'Right' for rotating it in left and right directions respectively and 'Stop' for making it stop. This system was designed and developed to save cost, time and energy of the patient. Ultrasonic sensor is also made a part of the design and it helps to detect obstacles lying ahead in the way of the wheelchair that can hinder the passage of the wheelchair.

Keywords: Arduino Uno, Wheelchair, Voice Recognition.

I. INTRODUCTION

This paper is conceived as an idea to ease the lives of those among us who are unfortunate enough to have lost the ability to move their legs due to a significant amount of paralysis, accident or due to old age. Many differently abled people usually depend on others in their daily life especially in moving from one place to another. For the wheelchair users, they need continuously someone to help them in getting the wheelchair moving. Their lives are made difficult by the fact that there is lack of an intuitive control system for their wheelchairs that allows moving independently. Using an electrical wheelchair leads to a large amount of independence for persons with a physical disability who can neither walk nor operate a mechanical wheelchair alone as it requires great effort and help of

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other people [1]. The problem is that in some cases the disability causes someone to lose the ability to use his hands, therefore in this case, the way of controlling a power wheelchair can be done using speech commands for hands-free patients leading to an interesting and promising outcome. But, still the availability of the smart wheelchair solutions is often limited due to the high costs and not-so-friendly operation. By the proposed approach, described in this paper, the low-cost, simple and friendly solution for the voice controlled platform will be presented that is user friendly, fully-customizable according to the language spoken by the user and will help in enhancement of user's independent mobility. Using a Smartphone as the "brain" of a robot is already an active research field with several open opportunities and promising possibilities [2]. Another recent and very successful technology, Bluetooth has changed how people use digital device at home or office, and has transferred traditional wired digital devices into wireless devices [3]. This research is based on Voice-controlled Wheelchair design based on mobile platforms, by means of Bluetooth technology, design and implementation of wireless remote control solutions. The project also incorporates use of ultrasonic sensors to detect obstacles within range of 4 metres and notifies the system and stop the wheelchair till further command. In this work, Smart Wheelchair control using Arduino Uno microcontroller and Bluetooth Module via android application is presented. The rest of this paper is organized as follows: Section 2 specializes to display the related most recent works. Section 3 concerns with the Flowchart of the project and application instruction. Section 4 discusses the result. The last section is dedicated to the main conclusions.

II. RELATED WORKS

The objective of this research project is to equip the present motorized wheelchair control system with a voice command system at low-price and friendly operation. By having these features, differently abled people especially with a severe disability who are unable to move like normal people will be able to move independently. Prototypes of several smart wheelchairs have been developed, based on advanced technology to help the differently abed. In 2012, Megalingam, Rajesh Kannan,et al, proposed a system that uses a small camera mounted very close to the user's hand, which tracks the small movements of their fingers to understand the direction of movement of the wheelchair. A gesture recognition system which identifies the gesture is then interfaced to the wheelchair control system inorder move it to the desired location [4]. In 2014, Andrej Škraba et al, presented a prototype speech controlled cloud based wheelchair platform. The control of the platform is implemented using low-cost available speech WebKit in the cloud. Besides the voice control, the GUI is implemented which works in the web browser as well as on the mobile devices providing live video stream [5]. In 2014, Sobia, M. Carmel et al, proposed a wheelchair command interface that does not require the other's hands. It includes 3 major modules. They are face detection, facial expression recognition and command generation. The software contains digital image processing for face detection, principal component analysis for facial expression recognition and generating a command signals for interfacing the wheelchair [6]. In 2014, Klabi I. et al, presented controlled the movement of wheelchair in different directions by monitoring voice commands and also the simple movement of the patient's face. Automatic obstacle detection and avoidance had been done using ultrasonic and infrared sensors which helps the patient to apply a temporary brake in case any obstacle suddenly comes in the way of the wheelchair. Also wall tracking and target tracking algorithms had been developed in the wheelchair [7]. Each one of the works above has its drawbacks and weakness. In this project, simple package with very cheap electronics that would not intricate the wheelchair and with high efficiency voice recognizer that could achieve sometimes to 100% of recognition rate, is used to build an effective voice-controlled smart wheelchair.

III. SYSTEM DESCRIPTION

The system has two parts, namely; hardware and software. The hardware architecture consists of an embedded system that is based on Arduino Uno board, a Bluetooth Module, Motor Driver and an Android phone. The Bluetooth Module provides the communication media between the user through the android phone and the system by means of voice command given to the android phone. The user speaks the desired command to the "BT Voice Control for Arduino voice (AMR Voice Application)" software application installed in the android phone that is connected through Bluetooth with Bluetooth Module SR-04. The voice command is converted to an array of string and the string is passed to Arduino Uno connected to it. Once the Bluetooth Module receives the message, the command sent will be extracted and executed by the microcontroller attached to it and depending on the commands fed to the Motor Driver, the motors will function accordingly. The system will interpret the commands and control the Wheelchair accordingly via android application. Meanwhile, the ultrasonic sensor works while the circuit is on

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and makes sure the path has no obstacle and if any obstacle occurs it notifies the Arduino and stops wheelchair till further command is obtained from the user.

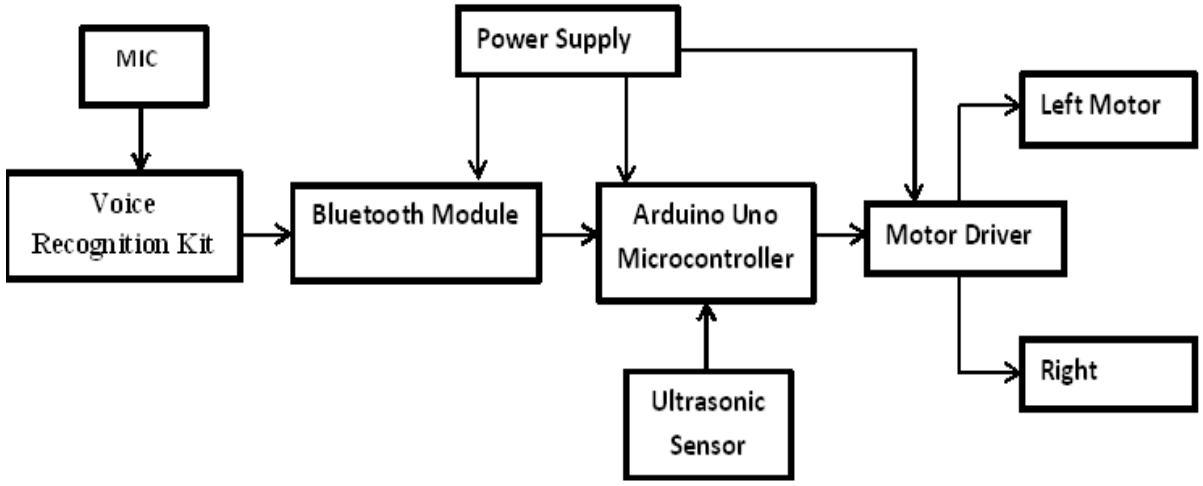

Figure 1: *Block Diagram of the Project*

APPLICATION INSTRUCTION

The different directions of motions possible are: forward, backward, left, right and stop. In achieving the task the controller is loaded with program using the arduino programming language and arduino development environment.

- First make sure Bluetooth module is paired with the android mobile. The default password for pairing is "1234" or "0000".
- When the user says "GO", AMR Voice application sends the data in form of string "*GO#" to Bluetooth module connected to the circuit. When microcontroller detects "GO", the motor attached to the wheelchair moves FORWORD.
- When the user says "BACK" AMR Voice application sends the data in form of string "*BACK#" to Bluetooth module connected to the circuit. When microcontroller detects "BACK", the motor attached to the wheelchair moves REVERSE.
- When the user says "LEFT" AMR Voice application sends the data in form of string in form of string "*LEFT#" to Bluetooth module connected to the circuit. When microcontroller detects "LEFT" the moves the motor attached to the wheelchair LEFT side.
- When the user says "RIGHT" AMR Voice application sends the data in form of string "*RIGHT#" to Bluetooth module connected to the circuit. When microcontroller detects "RIGHT" the moves the motor attached to the wheelchair RIGHT side.
- When the user says "STOP" button which is in the Centre of remote the AMR Voice application sends the data in form of string "*STOP#" to the Bluetooth module connected to the circuit. When microcontroller detects "STOP" the wheelchair gets stopped.
- Click on "DISCONNECT" icon to disconnect the paired Bluetooth module.

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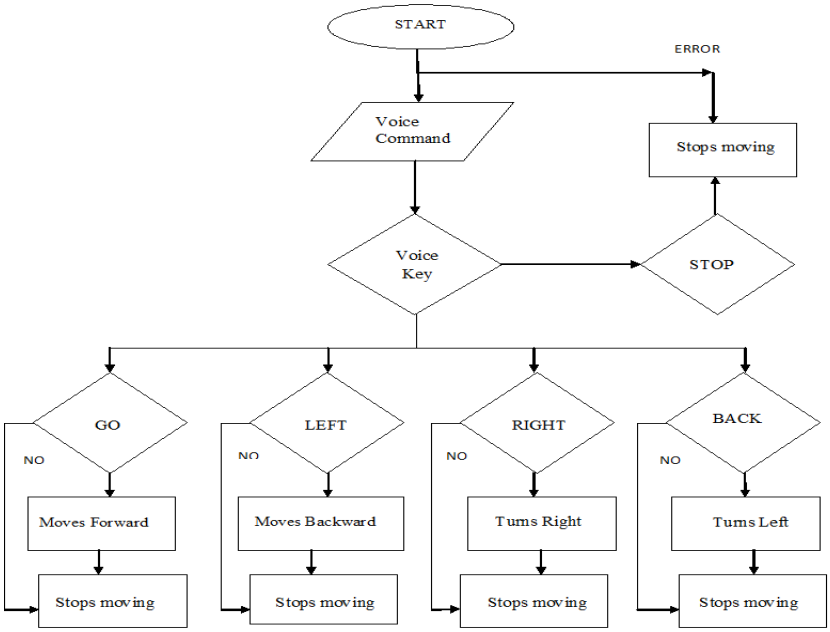

Figure 2: *Flowchart of the Project*

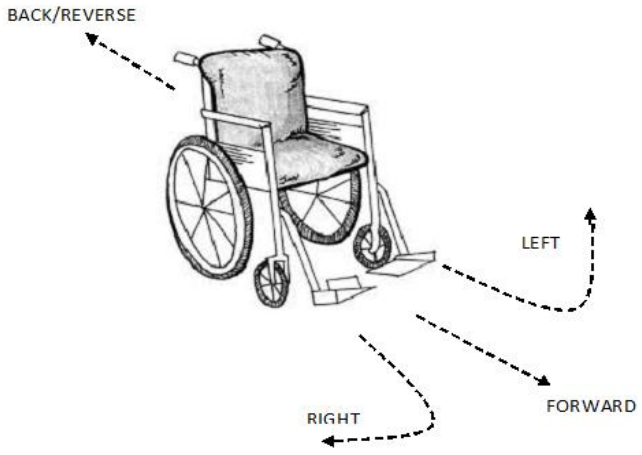

Figure 3: *Wheelchair Movement Paths*

Table 1: *Common Words and its Operations*

Common Words	**Operation**
GO	Moves forward
BACK	Moves backward
LEFT	Moves left
RIGHT	Moves right
STOP	Stops moving

IV. RESULTS AND DISCUSSION

In order to evaluate the performance of the presented speech recognition system to drive the wheelchair following test done to test the effectiveness of the Voice-recognition to drive the wheelchair. The recognition rate of each Keyword word programmed to operate when spoken by the user is calculated by the following equation:

RR% = Number of Recognized Words *divided by* Number of Tested Words

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In order to test the accuracy and effectiveness of the project, four volunteers were asked to become a part of testing of the project. Each volunteer was asked to give 10 commands and based on how many the commands are followed will give the result. The test was carried in silent and noisy environment by both male and female users. This test will determine the accuracy and effectiveness of the project.

Table 2: Test Results based on Voice Commands given and followed

Volunteer	Number of commands spoken	Number of times the command is followed	Accuracy
A(Male) Silent Environment	10	10	100%
B(Female) Silent Environment	10	10	100%
C(Male) Noisy Environment	10	9	90%
D(Female) Noisy Environment	10	9	90%

There is a maximum of 1 word wrong every 10 times repeating words leading to an error of 10% i.e. recognition rate not less than 90%. This percentage might reach 100% if the test is done in clear environment with good pronunciation of words with moderate time. This test proved that there is no big difference in RR if the speaker is male or female. The voice commands are interpreted and translated to string and provided to the Arduino that in turn produces and actuates the wheelchair accordingly as shown in Table 5.

Table 5: Voice and String Commands Action

Voice Command	**Condition**	**String command**	**Left/Right Motor**
GO	Moves Forward	*Go#	On/On Forward
BACK	Moves Backward	*BACK#	On/On Backward
LEFT	Moves Left	*LEFT#	Off/On Forward
RIGHT	Moves Right	*RIGHT#	On/Off Forward
STOP	Stops	*STOP#	Off/Off

Designing a simple and efficient automatic speech recognition system for isolated command words to satisfy the motion control of an electric motorized wheelchair for differently abled persons is the interest of this project. The processing units (the speech kit and the microcontroller) are directly attached to the wheelchair in one package that made the design representing a complete autonomous and smart wheelchair. The speech recognizer is tested to prove its performance to generate exact movement of the chair. It proved a recognition rate of above 90%.

V. CONCLUSION

This project elaborates the design and construction of Smart Electronic Wheelchair with the help of Bluetooth Module. The circuit works properly to move as the command given by the user. After designing the circuit that enables physically disabled to control their wheel using an android application in their smartphones and it has also been tested and validated. The detection of any obstacle is successfully controlled by the microcontroller. As the person switches on the circuit and starts moving, any obstacle which is expected to lie within a range of 4 metres will be detected by the Ultrasonic sensor. This proposed system contributes to the self-dependency of differently abled and older people.

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