Voice Controlled Artificial Intelligent Smart Wheelchair

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***Abstract*—An artificially intelligent wheelchair controlled by voice has been presented in this paper. A smartphone is used as an interface for implementing and automating the voice recognition process by the movement control system. The presented voice-controlled gadget is well suited for some disabled people who are unable to employ the customary joystick-operated wheelchair. The Arduino utilizes DC motors and the microcontroller circuit for supervising the wheelchair's movement. The voice of the patient that controls the movement of the chair is recognized using graphical commands. The key attribute of this graphical commands control method is that it enables the handicapped patient to steer the wheelchair with a varying speed much the same as a standard joystick. This voice-controlled artificial intelligent wheelchair has shown good results when tried out on actual patients and also has low-performance costs.**

Keywords—Arduino, Voice Recognition, HC-05 Bluetooth Module, Voice Controlled Wheelchair, Android App Interface, Wireless Control.

I. Introduction

The percentage of people with disabilities has been increasing drastically due to accidents, elderliness, and diseases such as spastic paralysis and medulla spinalis injuries. The number has now reached 1 billion, representing 15% of the worldwide population [1]. It can be found in various studies within the literature that the independent mobility of powered wheelchairs and also manual wheelchairs allow all people with disabilities to access his or her advantages. Independent mobility increases opportunities for work and education reduces reliance on other members and promotes feelings of autonomy and integrity [2]. Independent is a crucial aspect of self-esteem and features a crucial role [3]. Impaired mobility often results in reduced opportunities to possess socialized policies, making the individual end up in social isolation, and can cause many mental problems. While the wants of the various individuals with disabilities are often satisfied with traditional manual or self-automated wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently [4]. The impaired include individuals with poor vision, a decrease in visual area, spasticity, trembling, and cognitive disability. Several researchers have originally developed technologies for the utilization of power roller chains to accommodate this population in various ways, including collision-free transportation, assistance to the performance of special tasks (e.g., browsing doorways), and also the independent transportation of the buyer between places [4]. Many disabled people do not have the power required to drive an electrical wheelchair joystick [6]. There are many ups and downs for developing a conveniently helpful wheelchair. It had always been very difficult to implement voice in any system. Because the system may fail to acknowledge user's input voice and no navigation system was used [7]. The amount of time for any command that could move the chair was being limited. But another problem arises because the short-lived commands could cause collisions in crowded area [8]. One of the main problems of voice control was its limited bandwidth. It had been almost impossible to perform frequent small adjustments to the wheelchair's velocity. Fortunately, navigation assistance using sensors can be used to avoid obstacles [9]. Three sorts of commands alongside verification command can be used to control the wheelchair with a voice recognition rate above 90% [10]. Several techniques like Joystick, Direction Button and voice command etc were integrated together. Fast Mode/Slow Mode is introduced, and an Emergency SMS alert is featured in [11]. Easy minimal assistance and cost-effective wheelchair with an impression system supporting a microcontroller using simple head movements for controlling directions such as right, left, front, and back is performed in [12] by Micro-electromechanical (MEMS) tech systems.

Recently, a head gesture identification method accompanied by an acceleration sensor has been employed for recognizing head movements. Therefore, the RF module has been employed for intelligent wireless control [13]. Then, a sensible wheelchair with the ultrasonic sensor is developed, supporting a micro-controller with different user head movements for detecting obstacles [14]. A wheelchair controlled with a joystick and using a micro-controller to process all the commands have been proposed. The input needed to maneuver the wheelchair is shipped by the joystick [15].

This paper deals with the research activities of the user interaction voice-controlled wheelchair. The HC-05 Bluetooth Module is employed within this Wheelchair. The HC-05 is a Bluetooth module that gives a wireless two-way feature (full-duplex). This module can hook up or communicate with any Bluetooth device, like phone or laptop; between 2 microcontrollers like Arduino. To speak in smartphone with HC-05 Bluetooth module, a smartphone requires Bluetooth terminal application for transmitting and receiving data. Then, this data is transferred to the microcontroller and it sends this signal by using the transmitter side of the Radio-Frequency Module. The microcontroller is interfaced with BTS7960 Motor Driver Module. Then, the microcontroller sends signal to Motor Driver, and these signals are supported by the Signals received from the Radio-Frequency Module. The microcontroller sends an Interrupt signal to the pins of the Motor driver. This activates the motor and hence the wheelchair moves inconsistency with the voice.

II. METHODOLOGY

The suggested artificial intelligent wheelchair model includes two parts. One is the transmitting part and the other is the receiving part. The diagram of the proposed model comprising of the transmitter and receiver section has been presented in Fig. 1.

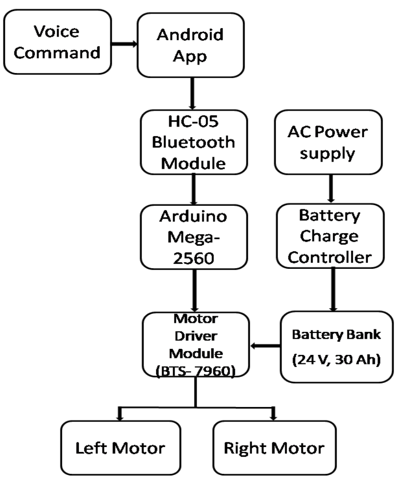

Fig. 1. Block Diagram of the System

A Bluetooth module is employed as the receiver and an Android app is employed as the transmitter. The android app is integrated into the Bluetooth Module with the Bluetooth frequency 2.4 GHz band. From Fig.1, it can be seen that a command signal is shipped through the Arduino mega2560 microcontroller by the module. Then the microcontroller triggers the BTS7960 driver and transfers the position by voice order. the driving force rotates to the proper way by following the app-driven voice command. The Google API for the corresponding Bluetooth waveband translates the voice signal in our Android app. The Android App Interface model is shown in Fig.2. When a command is applied within the application, the Android application is meant to transmit serial data to the Bluetooth module. The Arduino Bluetooth module receives information and sends it to the Arduino via the Bluetooth module's TX pin (connected to RX pin of Arduino). Most of those messages are translated into ASCI code and decoded. Therefore, motors connected to the facility are converted to a requirement-based linear motion. For these linear motions, all DC motors are furnished with 5V. The BTS7960 motor driver drives DC motors. For mobility, the battery is attached.

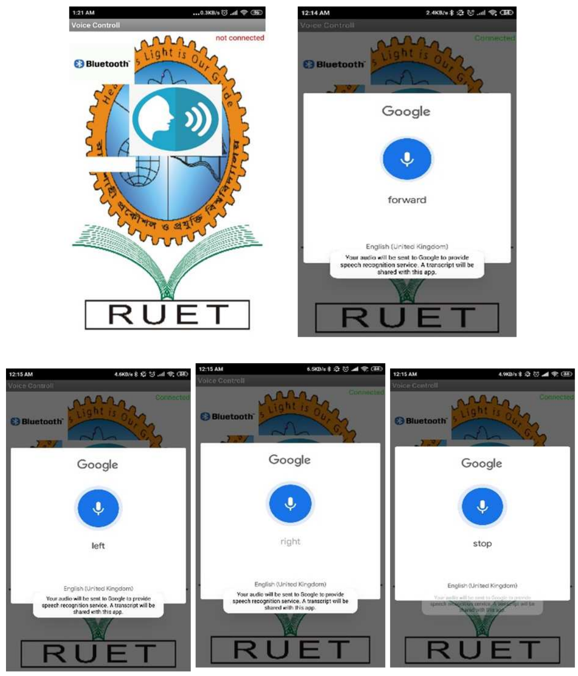

Fig. 2: Android App Interface for the proposed wheelchair

For the proposed wheelchair, there are four different choices for easy movement control. The subsequent is often defined as four conditions of the wheelchair:

- Moving Forward
- Moving Right
- Moving Left
- Stop

The layout of the proposed model is shown in Fig.3. This layout shows that each of the components functions correctly. This layout apparently shapes the entire work system idea.

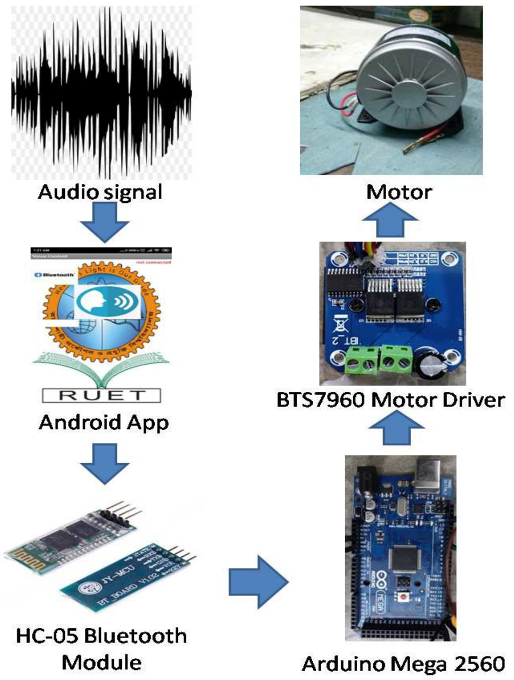

Fig. 3. Layout of the System

The layout focuses on how a voice signal is transmitted to the Arduino via the Android app. The voice commands are recognized by the Google Voice Assistance application Interface. Afterward, the Arduino processes the info and changes the motor direction as programmed earlier via the motor driver.

In essence, this Android app works with Google to detect the voice order. The Android app sends the signal to HC-05 module via Bluetooth's phone after the command is detected. Then the module HC-05 sends the Arduino signal. It had been working on four commands and they are "Forward", "Left", "Right" and "Stop". The algorithm of programme is shown in figure 4.

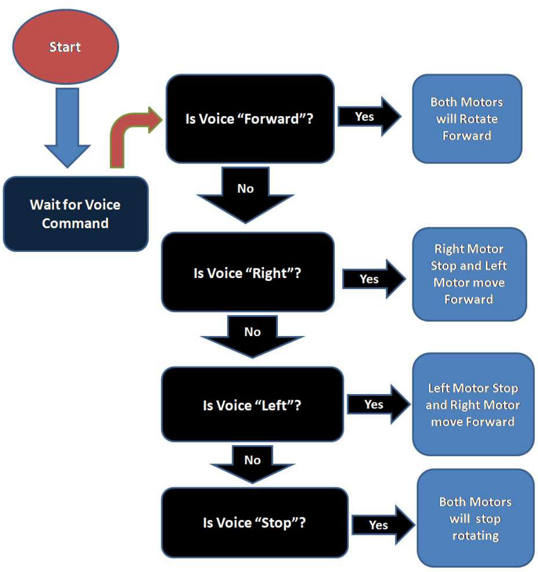

Fig 4: Flow Chart

III. Experimental Application

The frame is composed of stainless-steel pipes. The front wheel in this diagram is the Caster wheel and the cycle wheel is designated for the back wheel. But for the important parts, a more powerful battery, and some upgraded motor and motor driver modules are used. Fig.5 shows the simplified diagram.

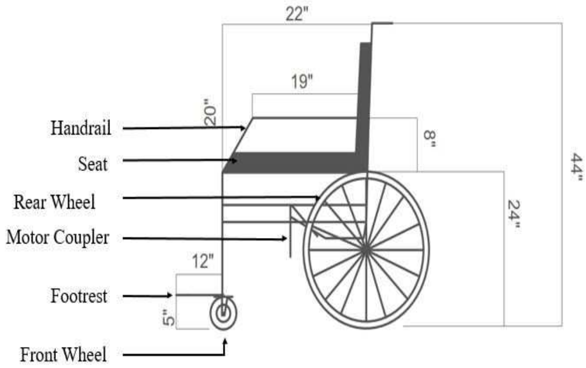

Fig. 5 Structure design of real wheelchair

This figure is the structural arrangement of the proposed model which shows the wheelchair's side view and illustrates the hardware application of the project. At the back of the wheelchair, two rear wheels with a large diameter of 24'' are attached. Cantilever brake, which is employed within the wheelchair is shown in Fig 6. Generally, the rim brakes are the most powerful and therefore, the most common brakes used for a few years. Without an excessive amount of maintenance, they have ample braking power.

Fig. 6: Cantilever Brake

The regulation is completed employing a hand lever that is fixed with a cable to the brake. The cab shifts the brakes and two pads, one on one side, when the rider pulls on the lever and the rim is pushed to hamper the wheel. It has two different arms on either side of the fork and remains on all sides of the seat. The frame and therefore the gate must be armored to accommodate the bolts. These brakes are usually used on mountain bikes, which require extra power while descending. They are also not as wet as other brakes and have the advantage not only of thin tires but also of being unable to cross them. The receiver section is shown in Fig. 7.

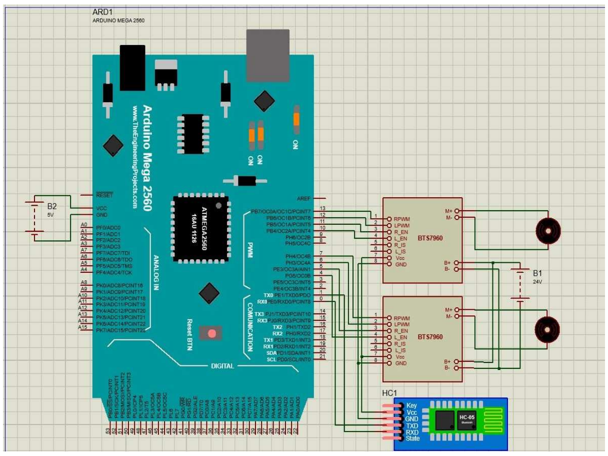

Fig. 7: Schematic diagram of the receiving circuit for real wheelchair

Table 1 shows the listing of components that are used for the real wheelchair.

Table 1: List of Components used for real wheelchair

SL No.	ITEMS
1	Wheel (24")- No.-2
2	Stainless Steel frame
3	Led Acid Battery (12V) – No.-2
4	DC Motor (24V, 250 Watt) – No.-2
5	BTS7960 Motor driver – No.-2
6	Joystick module– No.-1
7	Arduino mega2560– No.-1
8	HC-05 Bluetooth Module – No.-1

IV. RESULT & DISCUSSION

All the components as well as the android application which is integrated with Google API have operated properly while testing within the lab.

Fig. 8: Experimental Model of the Wheelchair

The real model of a chair in Fig.8. The motors were powered by a 24V battery. The 9V battery is employed to power the Arduino. There is a caster wheel ahead of the chair for free of charge motions.

Table 2: Voice Recognition Accuracy of the system

Command	No. of Trials	Number of Correctly Recognized Command	Number of Correctly Recognized Command in Noisy Environment	Average Accuracy (%)
forward	100	89	83	86
Right	100	84	80	82
Left	100	88	`81	84.5
Stop	100	89	84	86.5

Voice recognition rate by the Google API which is integrated with the dedicated android application is shown in Table III. Four commands such as forward, Right, Left and stop are tested respectively. This voice recognition rate is better than most of voice recognition systems.

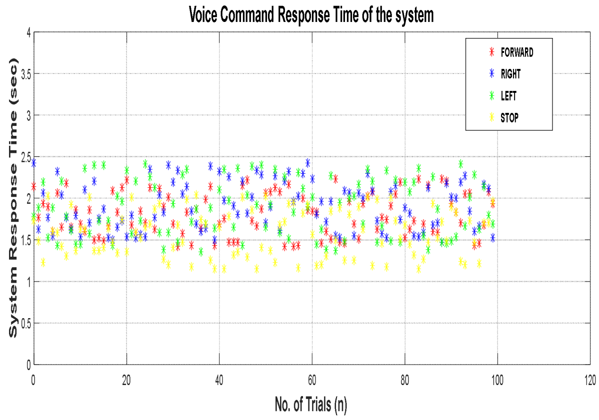

Fig. 9: Response Time of the System

In Fig. 9 the response time for each of the four command of the system has been shown. The average Response time of each command is less than two seconds which is given below by a bar diagram.

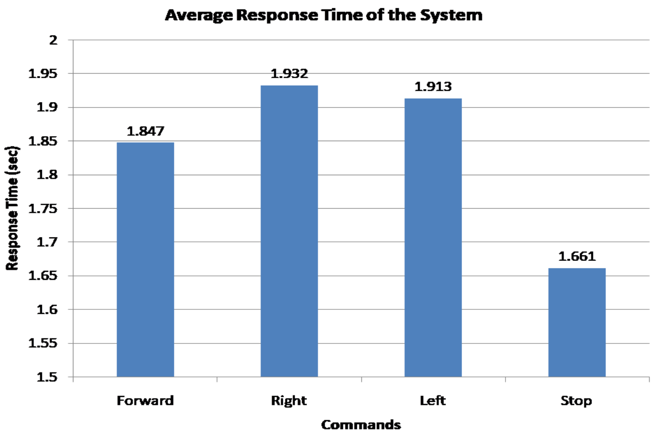

Fig. 10: Response Time Bar Graph

The motor's speed is slowly increased to gain smoothness. It has been discovered after obtaining numerous readings that the typical time required for succeeding in its maximum speed is 3.8 seconds and a velocity of 4.8 km/h for a fixed distance of 2 meters. The total cost of the chair is 40,100/- taka which is equivalent to $500. This price is excluding the labor cost which is reasonable compared to the availability of the chair in the market.

V. CONCLUSION

In this paper, It was tried to create a voice controlled intelligent wheelchair that was successful in guiding an individual with a disability everyday. Casic components used in this project, was economical because the second hand interface control device and Bluetooth module integrated with Google API were employed. The Motor was powerful and all other parts are user-friendly and easy to reach. The overall voice recognition rate was 87.5% which was suitable but it might be improved. During the detection of “RIGHT” command some difficulties had been faced because it was recognized as “WRITE” by the Google API. Object dectection system might be implemented to smooth its movement.

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