ASSISTIVE ROBOTIC WHEELCHAIR USING VOICE AND BLUETOOTH CONTROL

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ABSTRACT
This project describes a wheelchair which can be controlled using the user’s voice, android based phone or a computer. Our goal is to design the a robotic wheelchair system which is intended to provide a general purpose navigational assistance with the use of an android based phone, computer and voice control, which will allow its user to travel efficiently and with greater ease. The systems is made up of interactive servo motors, NXT intelligent brick, Lego sound sensor, USB cable, RJ 12 cable and are connected as: The interactive servo motor was connected to the NXT intelligent brick via the RJ 12 signal cable. The NXT intelligent brick was connected to the computer to program the robot via the USB cable. The Lego parts were also used for the structural construction of the robot. The NXT intelligent brick was then programmed to move forward, backward, left, right etc. using an android based program and a computer program that was connected wirelessly for the mobility of the robot. The Lego sound sensor was connected to the NXT intelligent brick. Tests conducted shows that for android base phones and computer, using the basic movements which include forward, backward, left and right, the commands are sent to the robot through Bluetooth from an android based phone or a computer. For the voice control, the commands include go, stop, turn left and turn right. These commands are responded accordingly by the robot when the commands are issued. In conclusion, we have been able to develop a robotic wheelchair that uses android based phones and computer system with Bluetooth and the user’s voice to control the wheelchair which tends to ease the lives of many disabled people, particularly those with walking problems, by increasing their range of mobility.

I. INTRODUCTION
A wheelchair is a chair with wheels, designed to be a replacement for walking. A wheelchair is a device used for mobility by people for whom walking is difficult or impossible, due to illness or disability. In rehabilitation, a wheelchair is not just a chair but a home for the disabled. The device comes in variations where it is propelled by motors or by the user turning the rear wheels by hands. Often there are handles behind the seat for someone else to do the pushing. In 6th Century A.D, the earliest recording of a wheelchair was a Chinese engraving picturing a man in a chair with three wheels.

Fig. 1.1 Chinese engraving picturing a man on a chair with three wheels [1]
We cannot talk about wheelchair without making reference to two men who first design a wheelchair. Harry Jennings and his disabled friend Herbert Everest, both mechanical engineers, invented the first lightweight, steel, collapsible wheelchair in 1933. Mr. Everest had broken his back in a mining accident; the two saw the business potential of the invention and went on to become the first mass-manufacturers. [1]

II. TYPES OF WHEELCHAIR

**Manual wheelchair:** Manual wheelchairs are those that require human power to move them. Many manual wheelchairs can be folded for storage or placement into a vehicle.

**Powered wheelchair:** An electric-powered wheelchair is a wheelchair that is moved via the means of an electric motor and navigational controls, usually a small joystick mounted on the armrest, rather than manual power wheelchair mounted on the armrest.

Robotics is the branch of technology that deals with the design, construction, operation and application of robots and computer systems for their control, sensory feedback, and information processing. [3]

Robotic technology have the potential to improve the lifestyle of people suffering from one or more disabilities related developments are often grouped under the terms Rehabilitation Technologies; they attempt to restore human abilities that have been reduced or lost due to disease, accident or old age. [4]

Several studies have shown that both children and adults benefits substantially from access to means of independent mobility, this include scooters, walkers, manual wheelchair, power wheelchair and of course robotic wheelchair. [5-6]

For young children, independent mobility serves as the foundation for much early learning. [1]. For adults, independent mobility is an important aspect of self-esteem and plays a pivotal role in “aging in place.” For example, if older people find it increasingly difficult to walk or wheel themselves to the commode, they may do so less often or they may drink less fluid to reduce the frequency of urination. If they become unable to walk or wheel themselves to the commode and help is not routinely available in the home when needed, a move to a more enabling environment (e.g., assisted living) may be necessary. Independent mobility increases vocational and educational opportunities, reduces dependences on care givers and family members, and promotes feelings of self-reliance[5].

Robotic wheelchairs extend the capabilities of traditionally powered devices by introducing control and navigational intelligence. This research describes a wheelchair which can be controlled using the user’s voice, android based phone or a computer. One of the major problem associated with the usage of the manually controlled wheelchair is one’s inability or difficulty to multi-task. Usually, the wheelchair user’s focus is mainly directed toward using his strength to propel the wheels to cause a motion. The power wheelchair control interface currently still not enough to provide truly independent mobility for substantial number of persons with disabilities.

Our goal is to design a robotic wheelchair system which is intended to provide a general purpose navigational assistance with the use of an android based phone, computer and voice control, which will allow its user to travel efficiently and with greater ease.
III. MATERIALS AND METHODOLOGY

Materials
The materials used to construct the robotic wheelchair includes:
- Interactive servo motor, Nxt intelligent brick, Lego sound sensor, NXC and NXG programming software, USB cable, RJ 12 signal cable

**NXT Intelligent brick**
The NXT Intelligent Brick is the robot’s “brain”. It features a powerful 32-bit microprocessor and Flash memory, with support for Bluetooth and USB 2.0. The NXT intelligent Brick includes:
- 32-bit ARM7 microprocessor,
- Support for Bluetooth wireless communication,
- USB 2.0 port,
- 4 input ports,
- 3 output ports,
- Powered by 6 AA (1.5v) Batteries,
- the brick has a 100x64 pixel monochrome LCD display and four buttons that can be used to navigate a user interface using hierarchical menus. It also has a speaker and can play sound files at sampling rates.

**Lego sound sensor**
The Sound Sensor can detect both decibels [dB] and adjusted decibel [dBA]. A decibel is a measurement of sound pressure.

DBA: in detecting adjusted decibels, the sensitivity of the sensor is adapted to the sensitivity of the human ear. In other words, these are the sounds that your ears are able to hear.

DB: in detecting standard [unadjusted] decibels, all sounds are measured with equal sensitivity. Thus, these sounds may include some that are too high or too low for the human ear to hear.

The Sound Sensor can measure sound pressure levels up to 90 dB – about the level of a lawnmower.

**RJ 12 signal cable**
RJ12 is a 6P6C wiring standard. This means that there are also 6 wires that are terminated in the connector, occupying all the available slots. Its purpose is to carry data signal to/from both input and output to/from the NXT Intelligent Brick.

**USB cable**
The USB cable is used to transfer software from the computer to the NXT Brick.
**NXC and NXG as programming language for the nxt brick.**

NXT-G is the programming software and editor used in programming the NXT Intelligent Brick. It features an interactive drag-and-drop environment. NXT-G is based on Lab VIEW graphical programming, an industry standard in programming. Lab VIEW uses data flow programming to create a virtual instrument.

**Methodology flowchart**

This flow chart below describes the sequence that was taken to construct the robotic wheelchair.

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The interactive servo motor was connected to the NXT intelligent brick via the RJ 12 signal cable. The NXT intelligent brick was connected to the computer to program the robot via the USB cable. The Lego parts are the small parts used for the structural construction of the robot. The NXT intelligent brick was then programmed to move forward, backward, left, right etc. using an android based programmed a computer program that was connected wirelessly for the mobility of the robot. The Lego sound sensor was connected to the NXT intelligent brick.

**Block diagram showing the operation of the robot**

This block diagram below describes the working principle of the robotic wheelchair when being used by the user.
For the voice control, the user’s voice is sent in input which is detected by the Lego sound sensor, the signal is sent to the NXT intelligent brick which gives the command to the interactive servo motor to either go, stop, turn left or turn right. For the computer system and android phone control, the user establishes connection between the NXT intelligent bricks and the phone or computer via Bluetooth pairing. Then the NXT remote control downloaded on the phone or computer system is used to give control to wheelchair, these command signals is received by the intelligent bricks and sent down to the interactive servo motor to either forward, reverse, spin left, spin right, turn left-forward, turn left-reverse etc.

Dimensions
The dimensions of the robot was measured and written as follows: Height: 19.5cm, Length: 16.3cm, Breath: 15.7cm, the speed of the robot is 1.769cm/s or 0.01769m/s and the Bluetooth frequency of the NXT intelligent brick is 26MHZ

IV. RESULTS

<table>
<thead>
<tr>
<th>Android versions</th>
<th>Forward</th>
<th>Backward</th>
<th>Turn left</th>
<th>Turn right</th>
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<tbody>
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<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>v.2.3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Result For the computer control, the table below shows the response to the remote control in the computer:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Forward</th>
<th>reverse</th>
<th>Spin left</th>
<th>Spin right</th>
<th>Turn-left-Forward</th>
<th>Turn-right-Forward</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Yes</td>
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<td>Yes</td>
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<td>yes</td>
<td>yes</td>
<td>Yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Result for the voice control, the table below shows the response of the robot in a noisy environment:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Go</th>
<th>Stop</th>
<th>Turn left</th>
<th>Turn right</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>yes</td>
</tr>
</tbody>
</table>
Result for the voice control, the table below show the response of the robot in a quiet environment:

<table>
<thead>
<tr>
<th>subject</th>
<th>Go</th>
<th>Stop</th>
<th>Turn right</th>
<th>Turn left</th>
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<td>No</td>
<td>Yes</td>
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<td>No</td>
</tr>
</tbody>
</table>

V. DISCUSSION
Here we are talking about the various functionality of each operating modes used for the control of the wheelchair. They are as follows:

Android based phone functionality: Using the android based phone for the control, we first tried with an HTC phone with an operating system of 2.1 we saw that all the commands didn’t respond as shown in the first row of the table above. Then we also tried with a Samsung galaxy 2 android Phone with an operating system of 2.3 and we got response to all the commands. That is to say that the control works properly with a higher version of android operating system.

Computer system functionality: The computer system has more commands as compare to phones. It also uses the same nxt remote control as the android phone. We got all the responses as shown on the table above.

Voice control functionality: There is a description of how each command should sound and it responds to four commands as listed below:

- Go
- Stop
- Turn Right
- Turn left

The “Go” command must be a short sound with no noise afterwards.

The only command that the robot understands when it is going forward is “Stop”. So, you must be stopped before doing any turns.

The “Turn Right” command must be said with “Right” louder than “Turn”, and a fairly normal speaking speed.

The “Turn left” command must be said with “Left” louder than “Turn”, and a brief pause between the two words (otherwise it will sound just like “Turn Right” to the program).

VI. CONCLUSION
Traditionally, manually operated wheelchairs are the most common type of wheelchair. However, these require extra hands to operate, making the users dependent on other people. Thus, this project was embarked to design and construct a robotic wheelchair with a great degree of versatility and manoeuvrability to assist the physically disabled people. The developed system allows the user to use voice control, android based phones or computer to navigate the wheelchair.

REFERENCES


