

Development of Android Based Powered Intelligent Wheelchair for Quadriplegic Persons

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Abstract: Several surveys give us the view that both children and adults benefit substantially from access towards independent mobility. With the inventions of technology, no individuals are satisfied with traditional manual operated machines. To accommodate population, researchers are using technology, originally developed for mobile robots to create 'intelligent wheelchairs'. It's a major challenge for quadriplegic persons as they really find it difficult to manipulate powered wheelchair during the activities of their daily living. As the Smartphone era has evolved with innovative android based applications, engineers are improving and trying to make such machines simple and cheap to the next level. In this paper, we present a development of android based powered intelligent wheelchair to assist the quadriplegic person by making them self sufficient in controlling the wheelchair. The wheels of the chair can be controlled by the voice or gesture movement or by touching the screen of the android app by the challenged persons. The system uses the Bluetooth communication to interface the microcontroller and the inbuilt sensors in the android Smartphone. According to the commands received from android phone, the kinematics of the wheels are controlled.

Keywords: Android application software, Bluetooth wireless communication, microcontroller, personal area network, serial communication

1. INTRODUCTION

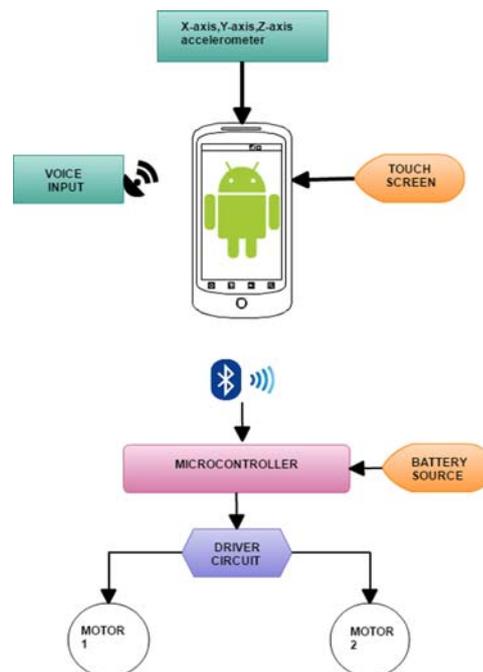
Embedded wireless system has been widely used for tele-monitoring and tele-control in the different process control applications [1-4]. The development of Android based powered Intelligent wheelchair for quadriplegic persons has been presented in this paper. Presently, the smart phones are playing vital role in human life. They are cost effective, promising and durable device that helps in performing daily tasks using the android application software (App) [5-7]. The main objective of this paper is to improve quality of life of the quadriplegic person. It facilitates the subject by assisting them in controlling the wheelchair as per their required directions by using voice commands, touch screen or gesture movement send from the android application software using Bluetooth wireless communication. The user-friendly android application software is customized in the Massachusetts Institute of Technology (MIT) App inventor 2 software [8]. The designed application is interfaced with Google Now for speech processing. The Bluetooth machine address (MAC) of the user PDA is made to be paired with the android application Software which enables in the creating of personal area network [9].



Based upon voice driven command send from user PDA to the Bluetooth interfaced microcontroller at the receiving end, the wheels are controlled as per the desired directions. The designed application can also control the wheelchair through touch screen remote android control and through gesture movement.

The paper is organized as follows: Block diagram of the system, Methodology, Working, Application Instruction, APP behavior, Results, Conclusion and Future Scope.

2. BLOCK DIAGRAM OF THE SYSTEM



3. METHODOLOGY

The main contributions of this work are three-fold. First, we use the voice recognition through android. Second the touch screen remote based control of wheelchair. Third, the gesture recognition through android. The system is based on the Arduino platform and works on the technology of wireless communication. Communication plays a crucial role in today's globe and can be used as a better tool in controlling systems. Among the wireless connections, Bluetooth technology is most preferred and implemented.

4. WORKING

We have used two DC motors [10] fitted with the wheels of the powered wheelchair because DC motors are high in efficiency, silent operation, compact, reliability and low maintenance. Android is the software core for mobile devices which basically has three-fold-OS, middleware & key applications. It offers connectivity through Wi-Fi, Bluetooth and wireless data over cellular connection.

The voice recognition app receives the voice command and send it to the Bluetooth serial module (here we have used HC-05) which in turn convert the recognized voice as string. Now

the microcontroller (Atmega328p) receives the command voice. Now it compares with its predefined conditions in base. If condition is satisfied then signal is sent to the driver circuit which in turn converts output pulse signal from microcontroller to electrical signal (voltage) to drive the wheel.

If the person wants to change the direction of the wheel through the touch screen android app, it is designed such that by pressing finger against the various quadrants on app which is programmed with different values for different directions as given in Table1.

In the third proposed method, the input to the application is usually given by the inbuilt and void accelerometer through the movement of hand of the user which is basically analog in nature. The android app codes it digitally and sends it to the microcontroller by HC-05 Bluetooth module. The signal now goes to the digital pins of microcontroller. We know microcontroller (Atmega328P) has inbuilt DA/AD converter of 8 bit. Based on the data received microcontroller process the data and transmit it to the driver circuit to manipulate the wheel in such a way the kinematics work according to the direction of persons hand.

Table-I. Different keywords for controlling the powered intelligent wheelchair

Direction control keys	Speech keywords for control	Action Performed
1.	“FORWARD”	Forward direction
2.	“LEFT”	Left direction
3.	“STOP”	Stop
4.	“RIGHT”	Right direction
5.	“BACKWARD”	Backward direction

5. APPLICATION INSTRUCTION

- HC-05 Bluetooth module is paired with android mobile.
- Default password is ‘1234’ for pairing
- Click on the Bluetooth icon to search the Bluetooth module and pair it.

6. APP BEHAVIOR

The android applications are developed on **MIT App inventor 2** Software. Three android apps have been developed.



Fig. 1-Indicates the voice control app

When the microcontroller is connected to the android phone through Bluetooth the status of the app changes to 'Connected'. Before giving any command we need to press the microphone button. It uses Google Now for speech recognition. This app deal with the conversion of received voice commands to text and transfers the next to the connected Bluetooth module. The microcontroller receives the text and stores it as a string. Only one voice command can be processed at a given time.



Fig.2- Indicates the direction control app or touch screen remote control app

When the phone is connected to the microcontroller through Bluetooth the status of the app changes to 'Connected'. Now if the up arrow is touched the wheelchair moves in forward

direction and similarly with the other buttons desired directions can be obtained. To stop the vehicle the Red Cross button is pressed.

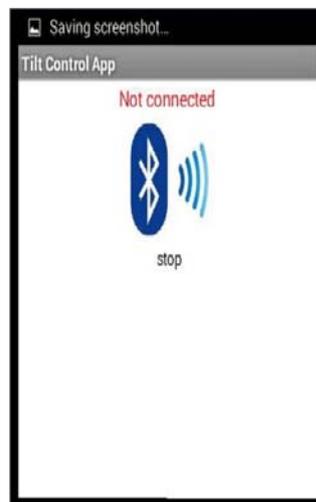
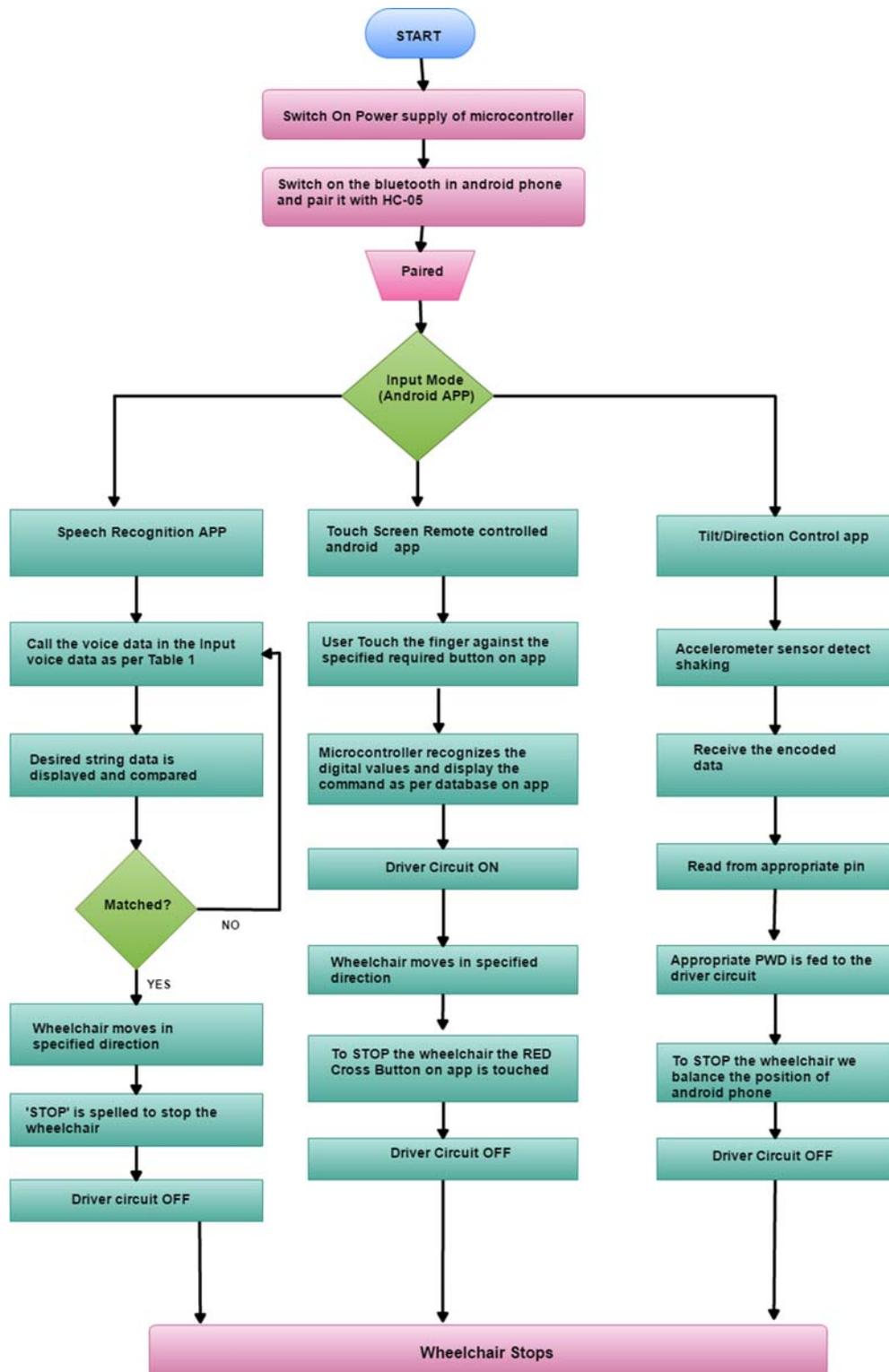


Fig. 3- Indicates the gesture control app.

This app use the inbuilt and void accelerometer sensor within the android device to detect shaking and measure acceleration in dimensions (x, y, zAccel) using SI unit m/s^2 . When the android phone is parallel to ground the wheelchair is in static position. On tilting the phone left the wheelchair moves left and other desired directions can be obtained by tilting the phone accordingly. To stop the wheelchair again we have to make the phone parallel to the ground.

7. FLOWDIAGRAM



8. RESULTS

The System is tested and trained to give voice based commands as shown in Table I as well as further tested through direction control & tilt control app.

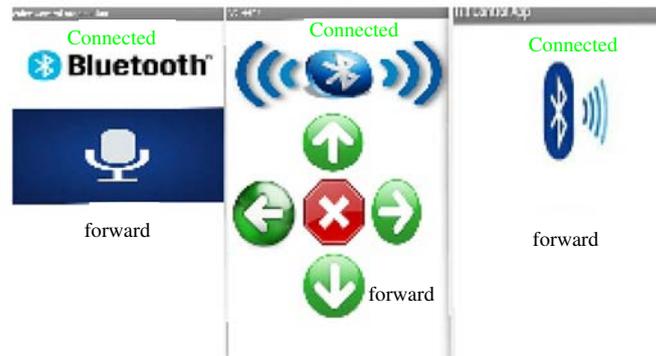


Fig.4: Android app operation for the wheelchair

9. CONCLUSION

The system is very simple and easy to use as it is communicating with the subject in real time using the Android application software from the android based personal digital assistant devices which are widely used throughout the world. The proposed system has made it easy for quadriplegic person to navigate within the house or hospital without the external help. As the system uses smart phone so the accuracy is increased. However, by experimenting we have observed the gesture control method has the highest response compared to others. Touch screen control has comparatively high response and accuracy than voice recognition system.

10. FUTURE SCOPE

- The wheelchair can be further improved by neural based algorithm for BCI applications.
- Sensors can be attached to wheelchair to avoid all kind of collisions
- The limitation of Google Now which only recognizes character in English can be overcome by making a substantial system which has its own speech algorithm.
- Tongue operated assistive technology can be used to access the wheelchair through android app using Bluetooth link.
- To control the kinematic of wheelchair eye retina using optical sensor can be used.

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