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Controlled Monitoring Of Wheeled Mobility Device powered by Android

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***Abstract*—Wheeled mobility devices such as wheelchairs are used by people who are not able to walk due to physical illness or inability to move on their own. Today's modern technology allows sophisticated use of wheelchairs like automated or manual transmissions and even wireless communication between the user and the smart device. The paper focuses on to develop a smart wheelchair that operates automatically by moving in all possible directions using voice and gesture functions provided by the smartphone. The sensors used are two IR sensors, one GPS sensor and one Accelerometer sensor. The IR sensor is used for obstacle detection. The Accelerometer sensor is used for fall detection. The system makes the user to vigorously interact with the wheelchair at different modules of control and sensing.**

***Index Terms*— Accelerometer sensor, GPS sensor, Gesture function, IR sensor, Smartphone, Voice function.**

I. INTRODUCTION

The Report given by World Health Organization (WHO) on disability confirms that all over the world over 70 million people are handicapped [9]. Day by Day the disability count starts increasing due to many reasons that include road accidents and diseases like paralysis [7]. According to this report the disability percentage is highly recorded on physically handicapped persons. If the person is handicapped then they are dependent on others for his/her day to day work like transport food etc.

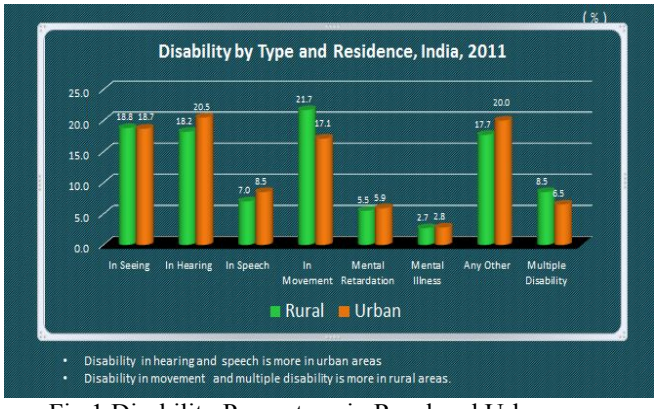

Fig.1 Disability Percentage in Rural and Urban areas

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In India, according to 2011 census report [2] 8.3% household has disable persons. The rate of disability in movement is more in rural areas compare to urban, in which 21.7% are physically disabled.

Fig.2 Percentage of Disabled Population to Total Population In movement

II. RELATED WORKS

The smartphone controlled wheelchair operates automatically by moving in all possible directions using voice and gesture provided. The traditional wheelchair has some extent of limitation in content to flexibility, size and limited functions.

A wheelchair is fitted with obstacle sensors, accelerometer sensors, and motors under smartphone, to help the driver achieve independent mobility. By just tilting the smart phone in any of the four directions the user can make the wheelchair move in that particular direction. The obstacle sensor takes over the responsibility of steering and avoiding objects until the user is able to handle the job. The accelerometer sensor helps detect the fall of the user and send error and emergency signals to their respective caretakers. This approach allows the user to use human voice, gesture and one smartphone and sync that with the movement of the wheelchair to provide the user with most comfort. In order to facilitate the quality of life for disabled people and to make the ease of use in to their working worlds, the evolution of technology will be an added advantage. [3]

The gesture recognition can be done in two methods. The first is Vision based gesture recognition in which the Robot was designed and the entire task is mobile controlled done by robots. The second method was Motion capture sensor recognition in which accelerometer was implemented for communication through wireless manner. [1]

The movement is measured by Accelerometer which is an electromechanical device used to measure the forces that occurs statically or dynamically. The static acceleration is caused by pulling and the dynamic acceleration is caused by moving or vibrating. The measurement of static acceleration helps to find out the angle in which the device is tilted. Dynamic acceleration is used to find out the movement of the device [4].

The voice and speech powered electronic wheel chair using ARM uses speech and gesture combination. For speech it uses hidden markov model and for recognizing the hand angle MEMS sensor is used [5].

The speed of the wheel chair is controlled by voice and touch screen based controls. The varying voltage is controlled by a speech programmable control circuit to make the controller work [8]. The medical assistance for the user is provided by a natural hand gesture system. It consists of three dynamic components and five static hand gestures for hand gesture vocabulary in the system. [6]

III. PROPOSED SYSTEM

In the proposed system, the movement of the wheel chair is controlled by using voice and gesture recognition through a smartphone. The wheelchair is equipped with voice and gesture functions, So that the disabled person, who is unable to walk, can drive the smart chair using the gesture movements and voice commands in the smartphone.

The core part is by using an accelerometer and GPS sensor by which a parameter value is detected and fall of a person is detected and an alert is made to the caretaker. The caretaker can also monitor the person in a timely basis by the GPS sensor.

The system is controlled by a PIC micro controller which also controls the IR, GPS, and Accelerometer. The DC motors are attached to the wheels of the wheelchair and hence rotation of motor direction of wheelchair will be easily controlled. Motors are interfaced with micro controller using motor drivers. The PIC micro controller is interfaced with smart phone through Bluetooth controller, depending on the user voice or gesture operation that is done.

The Accelerometer sensor in the phone is made use for the implementation of the fall detection in the smart wheelchair. The sensor when triggered by an axis change of 90^{o}, there would be an immediate reaction from the controller and an alert is made to the caretaker.

The PIC microcontroller and the given Bluetooth module are communicating over 9800bps via UART. The module works over a 3.5V power supply prototyped in a SMD package. The RX pin of microcontroller is used to send and receive data to the module in the profile. This is useful in making the device Bluetooth compatible.

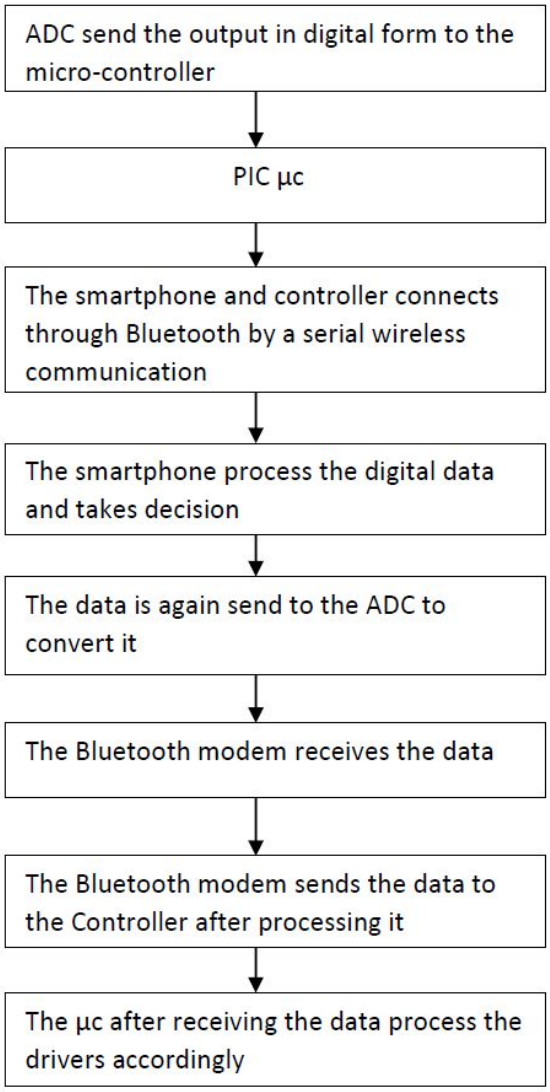

Fig.3 Flow of the entire operations

HC-05 Bluetooth module has 4 pins namely 5V, GND, TX and RX pins. The power supply pins are the 5V and GND pin and the serial wireless communication are implemented by TX and RX pin. The module sends the information using TX pin and receives the information using RX pin.

IV. SYSTEM ARCHITECTURE

A. Hardware Design:

In Hardware design, the microcontroller is designed with all the sensors attached. The sensors are categorized into obstacle detection sensor, fall detection sensor and real time sensing sensor. For obstacle section an IR sensor is used where the IR waves are being transmitted once the power supply is given. It reflects if an object is been detected and alerts in the smart phone.

The fall detection sensor is the accelerometer available in the smartphone. It operates in the sense that when there is a shift in the axis of the smart phone over a range of 90 degree, it automatically alerts the caretakers. The real time sensing

sensors is GPS sensor connected to the micro-controller. Its parameter value is detected which gives the latitude and longitude of the user.

A range limiting feature is being designed in the controller board. This feature work in the way that the disabled person when crosses the threshold parameter set by the caretaker, an automatic alert is been set to pass to the caretaker about the movement. The caretaker can either deny or allow the user to move beyond that limit.

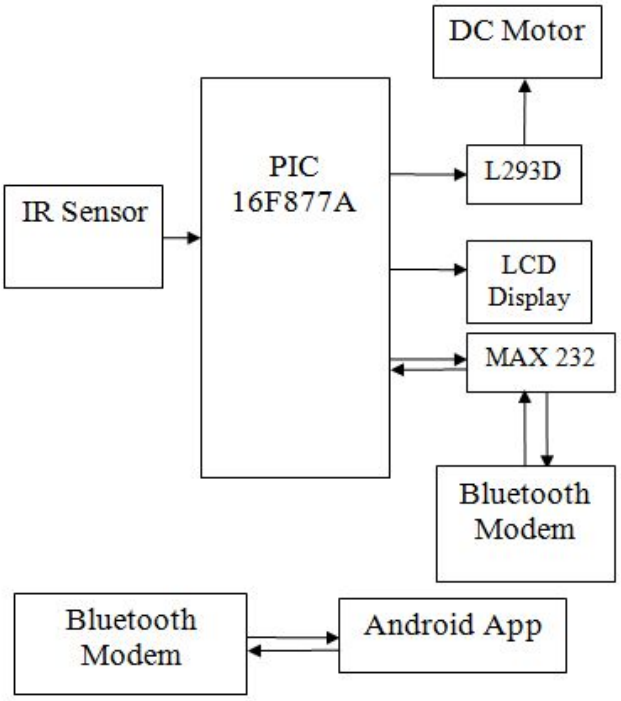

Fig.4 System Architecture

B. Mobile Application Design:

In Mobile Application design, the user interface for the control of the micro- controller is been designed. The Module is intervened by three phases. The phases are Touch screen, gesture and voice. The touch screen based is like a button control module. The interface is designed with buttons for movement of the wheel chair in all possible directions.

The second phase is gesture based control, in which the Smart phone's actions are being used to move the wheelchair. The movement of the smartphone would provide a three axis parameter value, which is recorded and passed to the controller at a loop. The third phase is voice based control in which the user's real time voice is passed to the microcontroller for movement of the wheelchair. Here a hidden markov model algorithm is used for speech processing of data.

The data received from the mobile phone is passed to the micro-controller using a Bluetooth module. The controller and the smart phone is first paired with each other and data's are being communicated in a serial way. The accelerometer available in the smartphone is used to detect the fall of a person and by alerting the caretaker. The range limiting value is being set by the smartphone in order to limit the disabled person not to move any further upon the request of the caretaker.

C. Wheelchair Deployment:

A model of wheelchair is developed in a miniature way. Two wheels are connected to a DC motor for its rotation. These rotational values are provided as an input to the controller. These rotational values are being controlled through the smartphone by using any of three phases of the interface that is been designed.

The overall setup is connected to the controller through a serial communication Bluetooth module. The Bluetooth module is then connected to the smartphone and the wheelchair. The Bluetooth module acts as both transmission and receiver device.

V. PERFORMANCE MEASURE

A. Experimental Setup:

In our experiment, the system is comprised of two models which interact with each other. The first part consists of a controller board which comprises of a Micro-Controller and the necessary sensor which are connected to the micro-controller board. The second part comprises of a Mobile Smart phone in which an Application is been developed to control the controller using a Bluetooth medium. The previous model consists of a WI-FI interface to control the controller, but Bluetooth interface is used for cost efficiency and quick response.

B. Experimental Result and Inference:

A Comparison experiment is conducted to validate whether the proposed algorithm is capable of dealing with various actions of the controller

(1) Touch-Based Control:

For every action issued from the phone, the controller responds. The response is depicted in the graph.

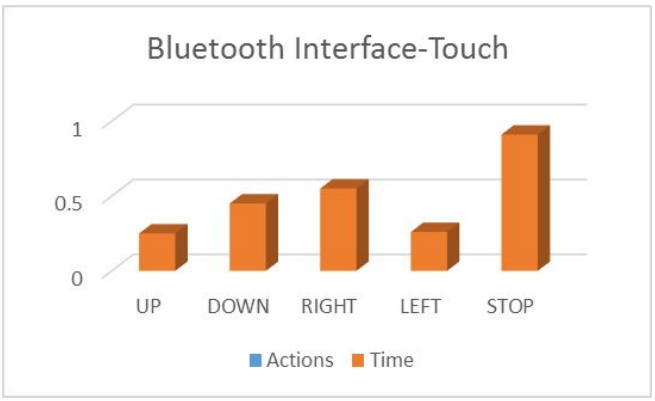

Fig.5 Touch-Based Control Via Bluetooth

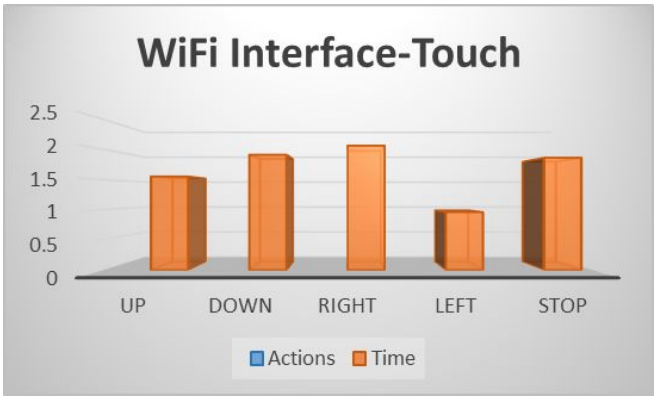

Fig.6 Touch-Based Control Via WiFi

(2) Gesture-based Control:

For every gesture issued from the phone, the controller responds. The response is depicted in the graph.

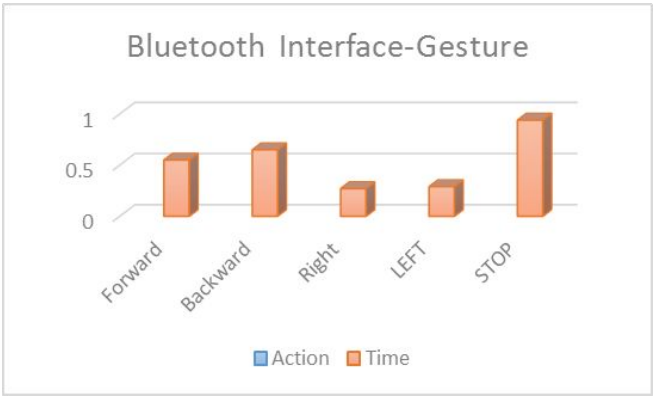

Fig.7 Gesture-Based Control Via Bluetooth

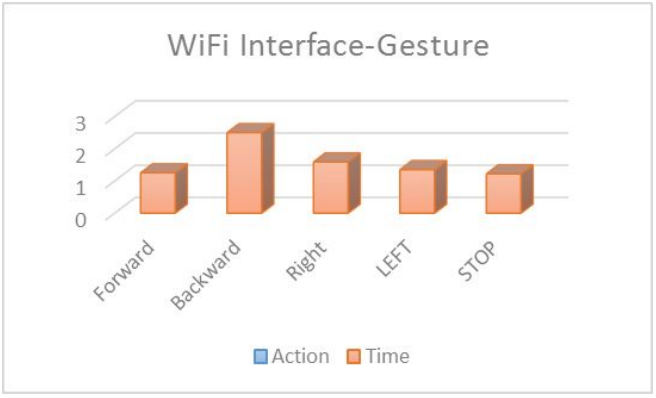

Fig.8 Gesture-Based Control Via Wi-Fi

VI. CONCLUSION

By using the proposed system, handicapped people would find it easier to move around the house or anywhere else without any external help. As the system use latest technologies the accuracy is increased. An IR sensor and camera module is used for obstacle detection and provides an alternative route.

VII. ACKNOWLEDGEMENT

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