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Development of Smart Wheel Chair with Dual Control: Smart Phone and Hand Gesture

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Abstract
Physically challenged individuals with severe motor impairment face difficulty with the existing wheelchair as they cannot process command by means of conventional joystick. By, designing a semi-automatic wireless smart wheelchair which can adapt to be used indoor and outdoor those hassles can be eliminated. This also aids the user by minimizing the physical and cognitive load required in steering an electric wheelchair. MEMS sensor, an accelerometer sensor with three-axis measures the orientation of hand from the user and interprets the hand motion. Bluetooth module integrated with an android application recognizes the commands through various buttons in the smart phone pressed by the user, which has different set of values programmed for different direction including an emergency stop button. Arduino UNO is the microcontroller used to control the whole process of the system. The proposed system is efficient to reduce the effort taken by the individual to propel it manually. The future developments as GPS based voice navigation system, speed control system and safety belts make it highly advanced mobility solution for disabled individuals. These features in the prototype also makes it viable and safe to the user and environment.

Key words: wheelchair, accelerometer, MEMS sensor, Bluetooth module, microcontroller, Arduino UNO, smart phone.

1. INTRODUCTION

Wheelchairs are the assistive devices for the physically disabled individuals that enhances their personal mobility. The wheelchair is propelled by electric motors and battery. Traditional wheelchair requires a propulsive force either from user by their hands or from the caretaker pushing through the handles placed in the rear surface of the wheelchair. Traditional wheelchair has its own limitations such as mode of operation, flexibility, and limited functions [1]. Numerous methods are developed and incorporated in the wheelchair to improve the quality of life for the individuals with severe motor impairment. Joystick is the

most common control used in the conventional wheelchair for many years. Powered wheelchairs and smart wheelchairs are recently developed and their robustness has drastically enhanced the operation of wheelchair.Smart wheelchair is a powered chair the controls the system by augmenting or replacing user's control. This eliminates or reduces user's task in steering the wheelchair.

In this paper, we developed a semi-automatic smart wheelchair controlled by multi-input user interface: hand gesture where hand movements are recognized through accelerometer sensor and android application based via bluetooth module. The user can provide control command, the microcontroller processes the command and controls the operation [4]. The user's responsibility is heading the wheelchair in desired directions. This aids in mobility for the individuals with severe motor disability.

2. SYSTEM OVERVIEW

The proposed method consists of an accelerometer sensor, bluetooth module, relay, motor, battery and Arduino UNO microcontroller. MEMS sensor, a three-axis accelerometer sensor measures the hand orientation and recognizes the movements of hand through which the user's input on desired direction is directed in heading the wheelchair. It is highly sensitive accelerometer sensor that can detect acceleration, inclination and vibration by measuring the motion in x-, y- and z-axis simultaneously [5]. The acceleration is measured by the change in resistance in the piezo material. HC-05 is bluetooth module with serial port protocol which can be operated either as master or slave mode. An android application is programmed with various buttons where each button is programmed with each direction. Bluetooth module integrated with android application to transmit the user's input data to the microcontroller for operating the wheelchair. Fig. 1 demonstrates the block diagram of proposed system.

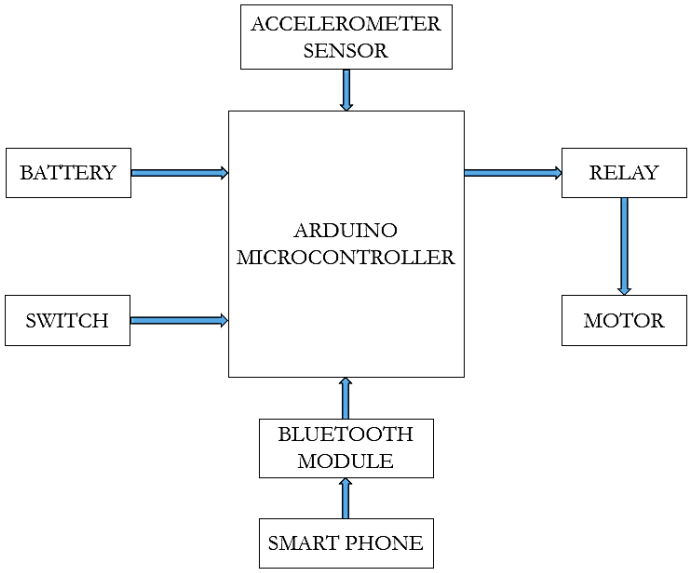

Fig. 1. Block diagram of the proposed system

3. METHODOLOGY

The proposed system comprises of two units hand gesture control and smart phone control via bluetooth module and android application. Fig.2 illustrates the working of proposed system and is explained in detail as follows:

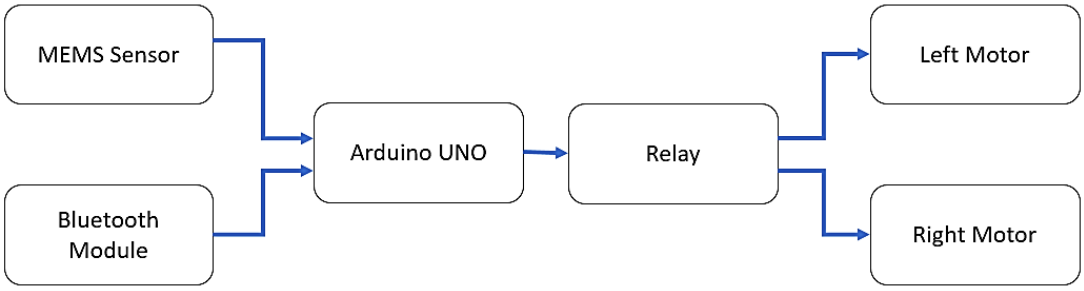

Fig.2. Working of proposed system

A. HAND GESTURE CONTROL

In our project, 'FAR-S2AB' series, a three-axis on single chip accelerometer measure the tilting angles along x-, y- and z axis respectively. Here, the values along x and y axis from the accelerometer sensor are used for the wheelchair operation. The accelerometer sensor is mounted on the hand glove that can be worn by the user [2]. The hand glove will be easy, flexible and comfortable to wear for any physically challenged individual [3]. According to the orientation of hand, there will a change in voltage according to the change in resistance in the accelerometer sensor. Depending upon the voltage values, the threshold value is calculated along each directional motion, forward, backward, left and right. When the user moves his/her hand beyond the threshold value along certain direction, the microcontroller drives the DC motor following the direction provided by the user [7].Fig. 3 explains the processing of data from accelerometer by the microcontroller. The accelerometer sensor transmits the sensed values as encoded data to the microcontroller that processes and sends the control signals to the relay which in turn produce actions in wheelchair movement.

Fig. 3. Processing of data from accelerometer sensor by Arduino

B. SMART PHONE CONTROL

'Serial Port Terminal' is an android application interfaced with bluetooth module for transmission of data. An android application consists of button such as "FWD" for forward direction, "BWD" for backward/reverse direction, "LEFT" for left direction, "RIGHT" for right direction, and "STOP" for emergency stop [6]. The user commands through the directional buttons incorporated in the app, bluetooth module interfaced with Arduino processes the user's input and operates the movement of the wheelchair accordingly. Fig. 4

illustrates the interfacing of smart phone via bluetooth module with Arduino.

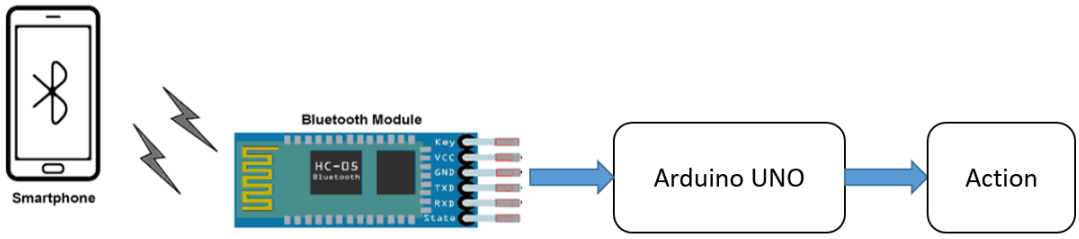

Fig. 4. Interfacing of smart phone via bluetooth module with Arduino

4. HARDWARE PROTOTYPE

The basic working prototype for the proposed system is illustrated in Fig. 5. DC motors are mounted on the wheels of a small chair. Relay is connected to the motors which drives the motor in desired direction as directed by the user. The proposed system executes the user's command rapidly and more precisely. The system is evaluated in both indoor and outdoor environment.

Fig. 5. Prototype model

5. CONCLUSION

This paper presents a comprehensive overview of the design and validation of the wheelchair. The proposed system is efficient to reduce the effort taken by the individual to propel it manually. The proposed smart wheelchair is cost effective, viable and highly adaptable can be used both indoors and outdoors. Future developments includesGPS based Voice navigation system, speed control system and safety features like seat belt, advanced braking system with anti-rollback mechanism, and ergonomic chair design and development.

REFERENCES

1. Prof. Vishal V. Pande, Nikita S.Ubale, Darshana P. Masurkar, Nikita R. Ingole, Pragati P. Mane, "Hand Gesture Based Wheelchair Movement Control for Disabled Person Using MEMS", *International Journal of Engineering Research and Applications*, 2014, pp.152-158.
2. Sudipta Chatterjee, Sahadev Roy, "A low-cost assistive wheelchair for handicapped & elderly people", *Elsevier*, 2021, pp. 3835–3841.
3. Mohd Razali Md Tomaria, Yoshinori Kobayashia, Yoshinori Kunoa, "Development of Smart Wheelchair System for a User with Severe Motor Impairment", *Elsevier*, 2012.
4. Mohd Razali Md Tomari, Yoshinori Kobayashi, Yoshinori Kuno, "Development of Smart Wheelchair System for a User with Severe Motor Impairment", *Elsevier*,2012, pp. 538 – 546.
5. Diksha Goyal and Dr. S.P.S. Saini, "Accelerometer Based Hand Gesture Controlled Wheelchair", *International Journal on Emerging Technologies*, 2013, pp. 15 – 20.
6. Dineshkumar M , Nikhil A U, Yashaswini S, Ashwathanarayana Reddy , "Android phone controlled Voice, Gesture and Touch screen Smart Wheelchair ", *International Research Journal of Engineering and Technology*, 2017, pp. 3481 – 3484.
7. Abu Tayab Noman, Md. Salman Khan, Mohammad Emdadul Islam, Humayun Rashid, "A New Design Approach for Gesture Controlled Smart Wheelchair Utilizing Microcontroller", *International Conference on Innovations in Science, Engineering and Technology*, 2018.