Smart wheel chair for physically handicapped people using tilt sensor and IEEE 802.15.4 standard protocol

Puneet Dobhal
[1]*B.Tech EE,4th*
University of petroleum and Energy studies, Dehradun, INDIA
Puneet271178@rediffmail.com

Nishant Singh Bisht
[2]*B.Tech AVE , 4th year*
University of petroleum and Energy studies, Dehradun, INDIA
Nbisht07@gmail.com

Rajesh Singh
[3]*Associate Prof. & HOD DEPT. of ECE Baddi university of emerging sciences and technology Baddi, Himachal Pradesh*
rajesh.singh@baddiuniv.ac.in

Bhupendra Singh
[4]*Schemantics Microelectronics Dehradun*
itsbhupendrasingh@gmail.com

Shubham Murari
[5]B.Tech EE,3rd
University of petroleum and Energy studies, Dehradun, INDIA
anshumurari@gmail.com

Abstract

Approximately 6 million people in the world face the problem of disability due to paralysis of various degrees. Paralysis is caused by impairment of nervous system disabling the people from performing various common functions. This paper provides a wireless system that can be used by disabled people to control the motion of the wheelchair by elementary motion of their hand or head. The system comprises of a Transmitter mounted on operator's hand; employing a MEMS Accelerometer which transmits control signals to the Receiver. The receiver is mounted on the wheelchair and controls its motion based on control signals. The control signals are transmitted and received wirelessly using Wireless Radio Frequency Module.

Keywords: Paralysis, Wheelchair, wireless, MEMS Accelerometer, Wireless Radio Frequency Module,.

1 Introduction:

According to a study conducted by Christopher & Dana Reeve Foundation, nearly every 1 person in 50 is suffering from paralysis due to damaging of nervous system. This figure approximates to 6 million people worldwide and has increased by 33 percent from previous estimation[6]. The causes of Paralysis are mainly due to spinal cord injury stated in the figure. We are using accelerometer in our system, accelerometers are also used earlier to monitor patients physical activities and their posture. [2]

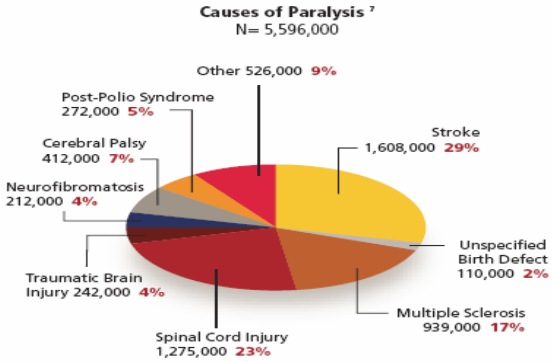

Figure 1.0: Pie chart showing cause of paralysis

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A similar wired system has been developed to assist the physically challenged people suffering from Quadriplegia to control the motion of wheelchair motors by head movements [1]. This paper proposes a system that can assist the disabled people to control the motion of their wheelchair by the hand movements wirelessly. The system proposed can be mounted on primary functioning body part to control the wheelchair movement i.e. hand, head.

The system consists of a Transmitter which acts as a wireless remote that can be mounted on hand or head. Transmitter end consists of a microcontroller development board employing MEMS accelerometer which senses the tilt of the platform it is mounted on. The system having positioning of an accelerometer on upper side hand to detect roll (fig. 1) and pitch (fig. 2) angle.

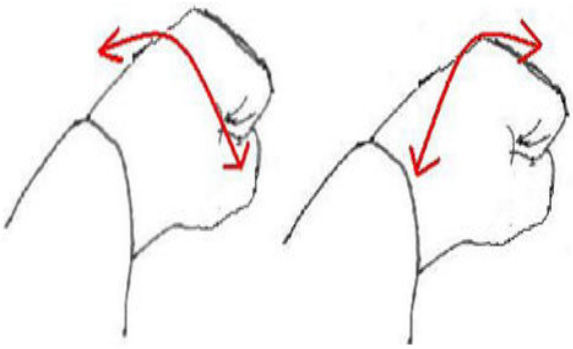

Figure 1.1: A view of hand movement for controlling

In accordance with these tilt readings microcontroller issues control signals which are wirelessly transmitted through wireless RF module to the receiver. The Receiver is mounted on the wheelchair which controls the DC motors of the wheelchair on the basis of control signals received through RF module. Furthermore the operator can also control the speed of the wheelchair as we are using concept of PWM(Pulse Width Modulation) speed of wheel chair is controlled with amount of tilt of transmitter as the tilt increases speed of wheel chair is increasing and vice versa. The block diagram of Transmitting and receiving end is shown respectively in fig (1.2) and (1.3).

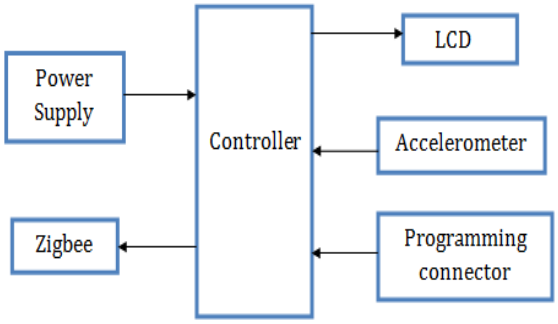

Figure 1.2: Block diagram of transmitting end

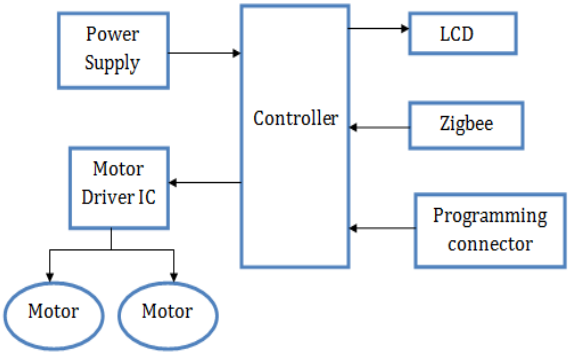

Figure 1.3: Block diagram of receiving end

2 Hardware Development

2.1 ATmega 8:

The ATmega8 is a low-power CMOS 8-bit microcontroller configured on the basis of AVR RISC architecture. ATmega8 is capable of executing powerful instructions in a single clock cycle; this enables ATmega8 to achieve throughputs approaching 1 MIPS per MHz. This allows the system designed to optimize power consumption versus processing speed.

Current consumption: 500mA

Operating Voltage: 5 V

2.2 Tilt Sensor/vibration sensor:

Acceleration is a vector force which has direction and magnitude and is measured in meter per second. As we know Earth produces gravitational acceleration on all objects on earth. Hence by monitoring the three axis acceleration one can measure the level of tilt of any platform on which the device is mounted.

Current consumption: 1mA

Operating Voltage: 3.3 V

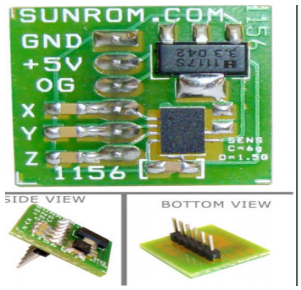

Figure 2.0: A view of tilt sensor

2.3 Motor Driver:

This IC is high voltage, high current four channel driver designed to accept DTL or TTL logic. This can provide 600mA output current capability per channel and providing 1.2 peak output current (non repetitive) per channel and also have internal over temperature protection. It consists of a Half H Bridge to provide high current in order to drive motors.

2.4 Transmitting module (RF Modem, 9600 bps Serial RS232 Level)

It is a low power and low cost 2.4 GHz transceiver designed for wireless applications. The Zigbee is designed for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. This provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio. The main operating parameters and the 64-byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In a typical system, the CC2500 will be used together with a microcontroller and a few additional passive components. [3]

Key Features of Zigbee module is

- ✓ 13.3 mA in receiving mode, 250 kB is baud rate.
- ✓ data rate (Programmable at 1.2 to 500 k Baud)
- ✓ Frequency range is of 2400 – 2483.5 MHz it supported to OOK, 2-FSK, GFSK, and MSK.
- ✓ SLEEP mode current consumption is 400 nA.
- ✓ SLEEP to RX start up time is 240 us or in TX mode measured on EM design.
- ✓ Automatic low-power Receiving (RX) polling for Wake-on-radio operation.
- ✓ FIFO buffer of 64-byte for receiving data and 64-byte for Transmitting data by enabling burst mode data transmission.

2.5 Motor:

Motor receives power from your Motor driver IC. This power is utilized to do physical works, for example move the Wheel chair. DC motor orientation, speed and operation can be controlled with microcontroller. We can start it, stop it or make it go either in clockwise or anti clock wise direction. The speed of the Motor is controlled by the help of PWM (pulse width modulation).

3 Software Development

The programming of designed system is with the help of a high level language i.e. embedded C language in order to write the program , AVR Studio 4 is a software for writing program for any AVR series of microcontroller's based on RISC architecture on windows platform .After writing the program we have to compile it with the help of AVR gcc (compiler) and AVR-gdb (debugger) and if there is no error it converts high level language to machine level language in the form of 0's and 1's and generates a hex file with extension '.hex'. This hex file is used to burn inside the microcontroller flash memory with the help of a programmer; the program memory has limited life time for AVR microcontroller family it may be reprogrammed up to 10 thousand times.[4]

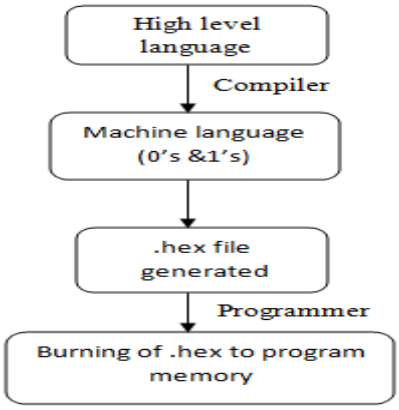

Figure 3.0: Block diagram of Software Development

In order to Burn the program into program memory we can use serial programmer, parallel programmer or USB programmer, we are using Robokits AVR 1.3 USB programmer to burn the program. If the system performs as desired by the user and performs all the tasks efficiently and effectively the software development phase is over and the project is ready to be installed in any of the industrial sites otherwise we have to repeat this process in order to achieve desired output.

The complete flow chart of Transmitting and receiving side system is explained below respectively :

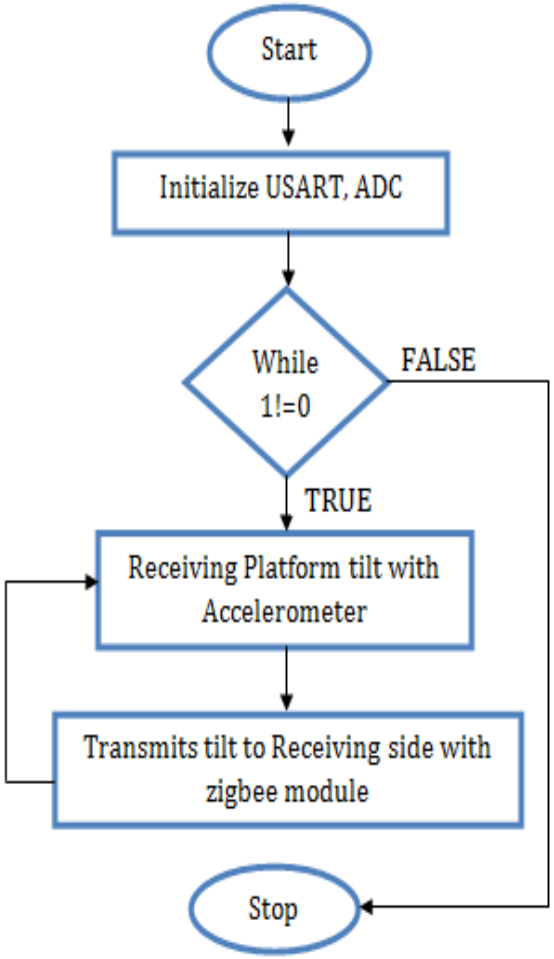

Figure 3.1: Flow diagram of transmitting end

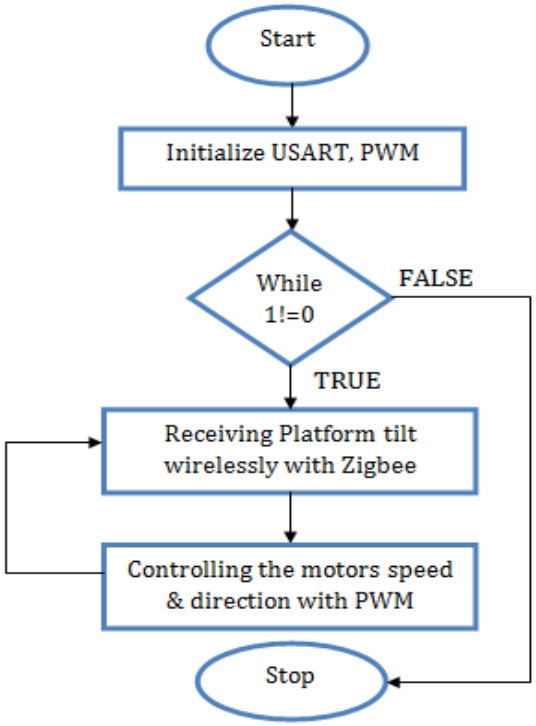

Figure 3.2: Flow diagram of Receiving end

4. Conclusion & Result

In this paper a wirelessly controlled wheel chair is proposed with the help of accelerometer and Zigbee module whose demo model is already designed for physically handicapped people so that they can control their chair themselves and the wireless communication provides an extra advantage if wheel chair is not with them then they can control chair.

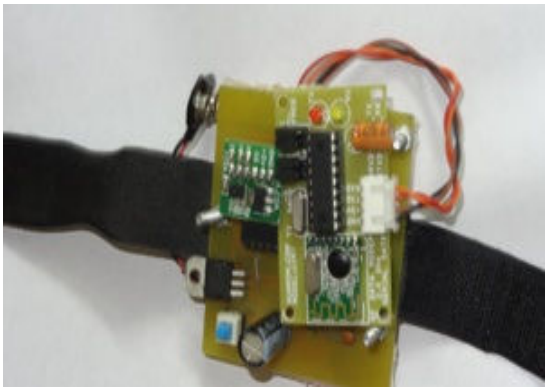

Figure 4.0: Transmitting side control band which is to be mounted on hand /head

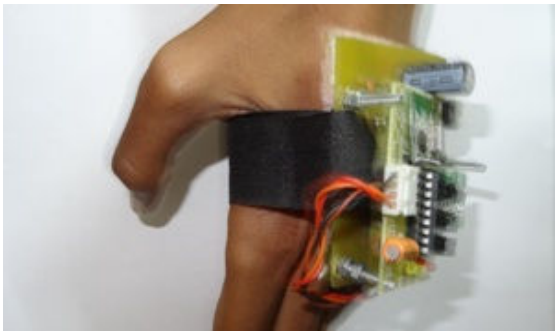

Figure 4.1: Transmitting side control band which is to be mounted on hand /head

References

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