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Adaptive Hand Gesture Controlled Wireless Wheelchair using ZigBee Protocol

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Abstract: ***These The proposed technique is intended as a solution to the conventional wheelchairs which involve strenuous hand movement. This technology allows the user to control the direction of a Wheel Chair by hand gesture movements. The hand gesture movement drives the sensors in the designed circuit to control the direction of the wheelchair. The control unit uses a Motor Driver IC to drive the DC Motors. The wireless transmission is employed using ZigBee Technology, a secured communication technique popular for low data rate applications. The accelerometer sensor senses the hand gesture and the output is fed to the microcontroller which processes this data and provides a digital output to the ZigBee module at the transmitter section. The ZigBee module at the receiver section receives the transmitted signal which is then processed using microcontroller & employed to control the Motors using Motor Driver circuit.***

Keywords: hand gesture; ZigBee; Accelerometer; data rate (key words)

1. Introduction

This paper involves the implementation of an automated adaptive wheelchair based on the pattern recognition of human hand gesture movements. The intended design proves to be an integrated and modularized approach for tracking, sensor based 'real time detection' and recognition of hand gesture movements which is supposedly used as a man-machine interaction interface for the intelligent wheelchair. It is based on the principle that finger movement and hand gestures can be effectively translated using Accelerometers into computer interpreted signals. For recognition of a gesture the accelerometer data needs to be calibrated and filtered. The magnitude and direction of gravity in addition to the acceleration induced by movement is measured. Calibration is done by the rotation of the device's sensitivity axis with respect to gravity and using the resultant signal as an absolute measure.

ZigBee Technology

ZigBee is a technology of data transfer in wireless communication networks. The name comes from erratic pattern of bees between flowers which symbolizes communication between nodes in a mesh network. It is designed for wireless control and connectivity between small packet switch devices.
Zigbee technology follows 3 topologies:

- Star
- Cluster tree
- Mesh

In star topology there is one coordinator and several end devices or nodes. In this topology, the end device communicates only with the coordinator. Any exchange of packet between end devices should go through the coordinator.

In tree topology, the network consists of a central node or root tree which acts as a coordinator, several routers, and end devices. The function of the router is to extend the network coverage. The end nodes which are connected to the coordinator are called children. Only the coordinator and routers can have children, therefore, these are the only devices that can be parents. A cluster tree technology is a special case where the parent along with the children forms a cluster. Mesh topology also known as peer-to-peer network consisting of one coordinator, several routers, and end devices.

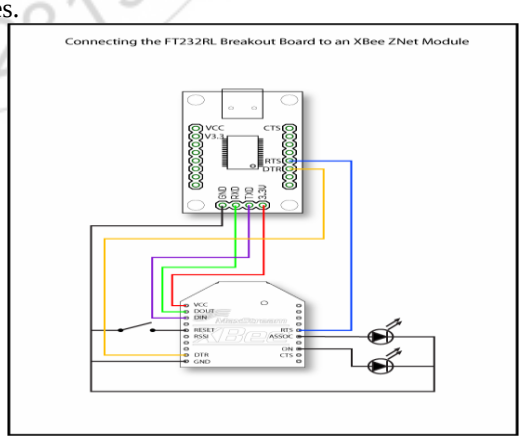

Figure 1: Connection of FT232RL breakout board to an Xbee Zetnet module

2. Proposed Design

In this system an Accelerometer Sensor is used to recognize the hand gestures. According to the tilt in Sensor, it gives the analog output with respect to the acceleration due to gravity.

The Sensor interfaced with the ADC peripheral of the ATmega16 AVR Microcontroller. So, the analog value is converted into digital and which is used for further processing.

According to these digital values, the Microcontroller gets to know which direction the wheelchair should move and thus it sends data to the Zigbee, correspondingly the Zigbee transmits wirelessly to the receiver module. At the receiver side, the Zigbee receives the data and feeds it to the Microcontroller. By sensing this data, Microcontroller decides to drive the motors in the desired direction by giving output to Motor Driver IC. Thus the wheel chair moves.

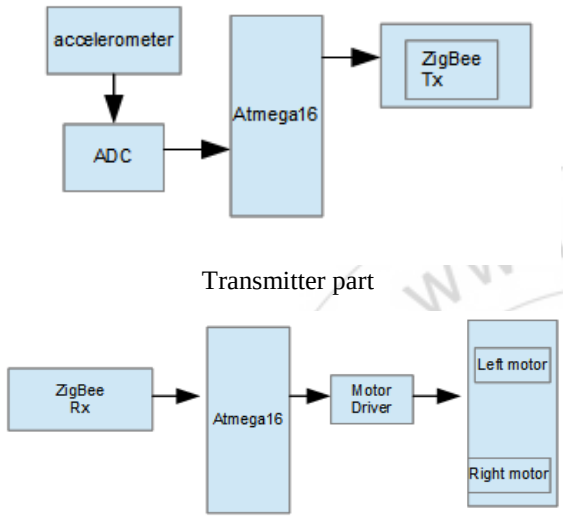

Figure 2: Block Diagram

Accelerometer

The ADXL335 is a low power, complete 3-axis accelerometer with signal conditioned voltage output. This circuit measures acceleration with a minimum full-scale range of ±3 g. It can measure both the static as well as dynamic acceleration resulting from motion, vibration and shock.

Figure 3: ADXL335 module

The Accelerometer having 6 pins-

1) VDD- We will give the +5volt to this pin
2) GND- This pin is connected to the ground for biasing
3) X- On this pin the analog data will be received for x direction movement.
4) Y- On this pin we will receive the analog data for y direction movement.
5) Z- On this pin we will receive the analog data for z direction movement.
6) 6-ST- this pin is use to set the sensitivity of the accelerometer.

Atmega 16

AVR was developed in 1996 by Atmel corporation. It stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller. AVR microcontroller is used because it executes most of the instructions in single execution cycle and are about 4 times faster than PICs, it consumes less power and can be operated in different power saving modes. In this paper Atmega 16 microcontroller is used which is a 40 pin chip and belongs to the AVR family.

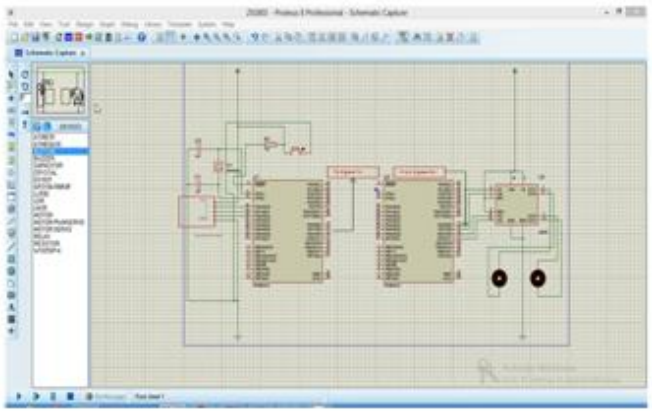

Figure 4: Schematic of Proposed Design

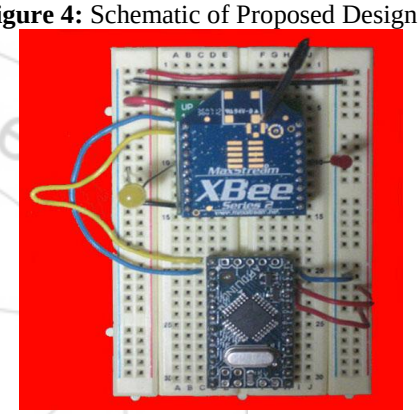

Figure5: Implementation of ZigBee module

Figure 6: Hardware Implementation of proposed circuit

Figure 7: Fully functional prototype of proposed model

3. Conclusion

The proposed design of the wheel chair caters to the needs of the orthopedically challenged section of the society making it more economical . The viability of the design is based on the fact that the communication protocol used, i.e. ZigBee provides a more secured, dedicated, performance optimized and user friendly mode of communication.

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Author Profile

Sushree Swayamsiddha has passed her B.Tech degree from Indira Gandhi Institute of Tecnology, Sarang, 2013 in the field of Electronics and Telecommunication Engineering. Currently she is persuing her Masters in VLSI from KIIT University. Her areas of active research includes alcohol detection using gsm modules, implementation of ZigBee and other communication protocols to real life systems. She works in active collaboration with third author Joy Chowdhury.