Accelerometer Technology Based Helmet to Control the Movement of Wheel Chair for Handicapped Persons

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Abstract - **This paper introduces a "Human Computer Interfacing Device ", A system/helmet to control the motor rotation of a wheel chair based on the head movement of a physically challenged person. In order to obtain the movement of the physically challenged person an accelerometer (ADXL335) based transmitter is fitted on persons head using a helmet. Based on the head movements the transmitter will generate command signals which will be received by receiver fitted on the wheel chair wirelessly. This receiver after receiving signal will drive the motor fitted to the wheel chair. The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs, all on a single IC. The wheel chair supports the four directions i.e. left, right, forward, back. The wheelchair is controlled by a PIC16F877A microcontroller. The system also contains obstacle detection to detect various kind of obstacle comes in the path of wheel chair.**

Keywords: **Human Computer Interfacing Device, Micro Controller, Accelerometer**

I.INTRODUCTION

In the current era, computers are being integrated into every aspect of our lives. Making it essential to move away from the conventional methods of interacting with the computers and other appliances around us. such devices being tools designed to aid humans, it is in our best interests if we can make them adapt to our natural communication patterns rather than otherwise. To exploit gestures in Human Computer Interfacing, it is necessary to provide the means by which they can be interpreted by computers.

A Wheel Chair is a device designed for shifting patients, moving physically challenged people from one place to another with the help of attender or by means of self-propelling. The wheel chair is divided into two different types based on the power used for mobility:

1. Manually powered wheelchairs.
2. Electrically powered wheelchairs.

Manual powered wheelchairs are driven by manual power which is again classified into foldable and non-foldable with or without commode design. Electrically powered wheel chairs runs with electric power and operation of chair depend upon the instruction given by the patients head movement or any other mechanism.

Here we are mainly concentrated on electrically powered wheel chair. In these wheel chairs the motor for the movement of the wheel chair is electrically powered by some power source like battery .The movements of the system is controlled by the direction of the movement of the accelerometer/helmet.

II. RELEVANCE AND OBJECTIVE

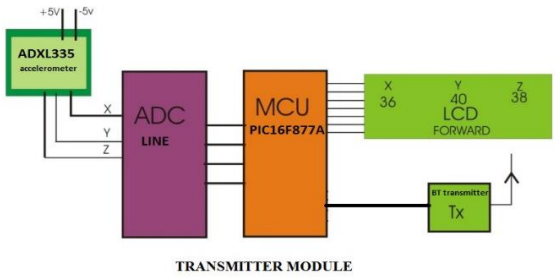
The Goal of this work is to design and build a wheel chair for handicapped persons for their independent movement without the help of other persons. The main Idea behind this work is to control motor rotation of the wheel chair based on the head movement of handicapped person. In order to preserve this purpose of the independent movement, an accelerometer device based transmitter is fitted on the helmet which worn by the physically challenged person. Based on the head movements the transmitter will generate electrical command signals which will be received by receiver fitted on the wheel chair. This receiver after receiving signal will drive the motor fitted to the wheel chair. The wheel chair can be driven in any of the four directions .The physically challenged persons can activate and deactivate the movement of the wheel by using micro switches which are situated on the foot pad of the wheel chair. The wheel chair is based on simple electronic control system and the mechanical arrangement that is controlled by a PIC16F877A Microcontroller. This automatic wheel chair is designed to help people who have various other disabilities to sit on the chair and just hold the accelerometer in the form of a glove or a joy stick and to control the vehicle movements. There are IR sensors on the side of the wheel chair for the purpose of obstacle detection.

III. BASE DESIGN

This work is based on the wireless technique with 3-axis motion. In this work two circuits are mainly used. One is transmitter circuit and second is receiver circuit. In the transmitter circuit use 3 Axis accelerometer base circuit and at the receiver end we use a small wheel chair with Bluetooth receiver circuit.

1. Transmitter Module

In the transmitter circuit measure the value of 3Axis accelerometer based on the movement of the helmet and converted into digital with the help of an Analog to Digital convertor ADC line of microcontroller. ADC converts the data from sensor and proceeds to the microcontroller for further conversion. Microcontroller gets the hex data from the accelerometer and converted into ASCII code for LCD display for the ease of the person using the system. LCD display the X—Y—Z values and display the values on the LCD. At the same time microcontroller gets the data and compare inside with pre-defined variables. As we change the position of hand, values are change automatically and change values are also shown on the LCD.



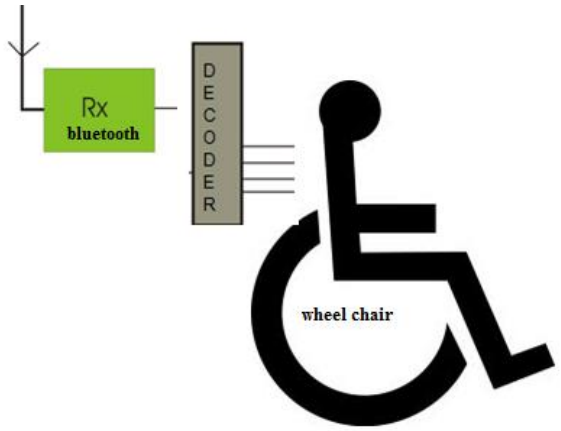
TRANSMITTER MODULE

Then these readings of accelerometer are taken for wheel chair movements. It uses one Bluetooth transmitter circuit with the microcontroller circuit for wireless transmission. Then specify four variables for the wheel chair motion. As the position of Helmet change, data from the controller is also changes automatically. There is a four output from the controller. Output from microcontroller is connected to the Bluetooth transmitter module. Then finally signal get transmitted.

2. Receiver Module

In the receiver circuit there is a blue tooth receiver module, decoder circuit and motor

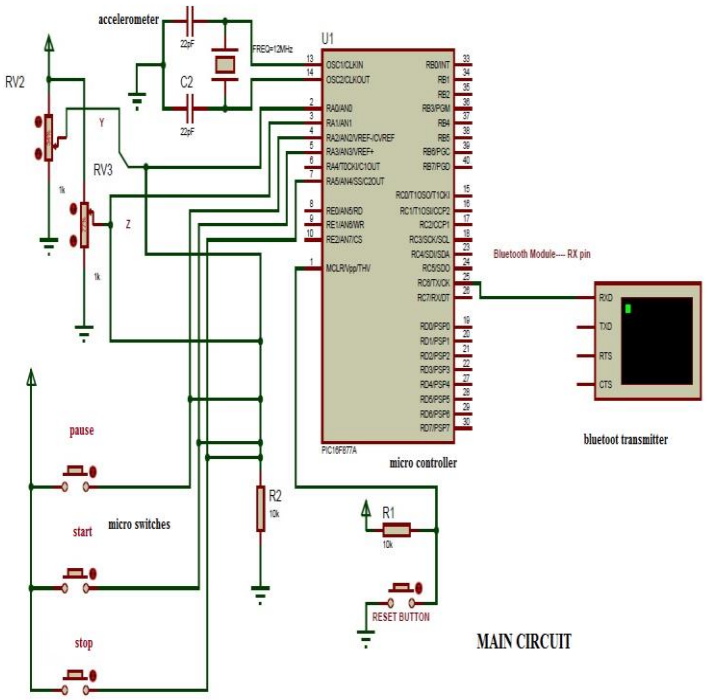
driving circuit. Receiver receives Bluetooth packets transmitted from the transmitter and sends this signal to the packet decoder circuit. Output from the decoder circuit send commands to motor driver circuits. H-Bridge is used to drive the motors of the wheel chair. Direction of the chair movement is depended upon the received signal. Depending upon the movement of the helmet wheel chair moves in four directions like- forward, backward, left and right.



RECEIVER MODULE

3. Main Module

The brain of the system is a Microcontroller PIC16F877A as CPU to control the overall functionality of the work .A DC gear motor is used to control the motion of the chair, LCD display for displaying X, Y, Z coordinates value, Decoder chip to decode the signal messages, bluetooth transmitter and receiver, IR sensor for obstacle detection and most important component is 3 axis accelerometer which is heart of this system.



This is based on the wireless technique with 3-axis motion. For wireless communication use two circuits. One is transmitter and second is receiver circuit. In the transmitter circuit uses 3 Axis accelerometer base circuit and at the receiver end uses a small wheel chair with blue tooth receiver circuit. In the transmitter circuit we measure the value of 3 Axis accelerometer and converted into digital with the help of ADC line. ADC converts the data from sensor and proceeds to the microcontroller for further conversion. Microcontroller gets the hex data from the accelerometer and converted into ASCII code for LCD display. LCD display the X—Y—Z values and display the values on the LCD. At the same time microcontroller gets data and compare inside with pre-defined variables. As patient change the position of the helmet values are changed automatically and changed values are also shown on the LCD. System uses the readings of accelerometer for wheel chair movements. System use one transmitter circuit with the microcontroller circuit for wireless

transmission. It is specified four variables for the wheel chair motion. As the position of accelerometer change, data from the controller is also changes automatically. System gets a four output from the accelerometer. This values are given as input to the microcontroller. Data from the microcontroller is connected to blue tooth transmitter module. BT transmitter modules get the signal from the controller and transmitted.

We use 2 by 16 LCD with port 1. Pin no 30 of microcontroller is connected to the positive supply and pin no 20 is connected to the negative voltage. Pin no 13, 14 is connected to the external crystal oscillator for external clock pulse. ADC converts the Accelerometer data into digital signal one by one. Three micro switches are connected to pin 4, 5 and 7 for the purpose pause, start and stop of the accelerometer. These micro switches are situated at the foot rest of the wheel chair.

IV. COMPONENT SECTION

1. The Human-End

The human wear the helmet that are fitted with the accelerometer module and the micro switches are placed in the foot rest of the wheel chair. This means that mere movements of the head/helmet will translate into corresponding movement of the wheel chair.

2. Accelerometer (ADXL335)

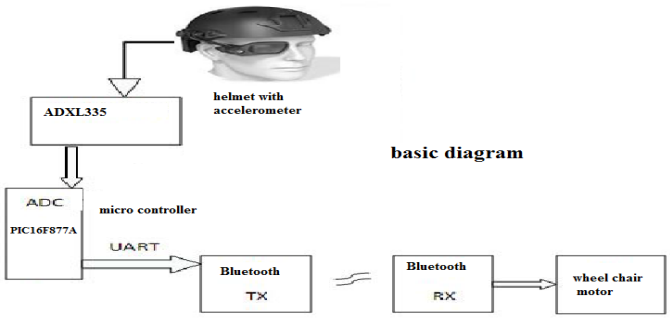
This is a 3D accelerometer which generate voltage according to the movement of the head. An accelerometer is a device that measures proper acceleration. The accelerometer sees the acceleration associated with the phenomenon of weight experienced by any test mass at rest in the frame of reference of the accelerometer device.

The accelerometer is the device which will generate corresponding electrical signals to control the wheel chair. The accelerometer used here is the 3-Axis Accelerometer with an easy analog interface and running at a supply voltage of 3.5V, which makes it ideal for handheld battery powered electronics.

The accelerometer will experience acceleration in the range of +1g to -1g as the device is tilted from -90 degrees to +90 degrees. In order to determine the angle of tilt, θ, the A/D values from the accelerometer are sampled by the ADC channel on the microcontroller. The acceleration is compared to the zero-g offset to determine if it is a positive or negative acceleration. This value is then passed to the tilt algorithm. When applied to all three axis, we are able to calculate the orientation of helmet in three dimensional space.

3. Microcontroller (PIC16F877A)

The function of the microcontroller in this application is to act as an interpreter between the head movement and the wheel chair movement. The ADC Port converts analog signals coming in from the accelerometer into corresponding 16-bit digital values. It then shifts out the result through the UART line to the device to be controlled. The PIC16F877A along with having all these features achieves throughputs approaching 1 MIPS per MHz by executing powerful instructions in a single clock cycle, allowing the system engineer/designer to optimize power consumption versus processing.



4. Bluetooth Module

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4to 2.485 GHz from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994,it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization. Both transmitter and receiver used here.

5. Micro Switches

A miniature snap-action switch, also trademarked and frequently known as a micro switch, is an electric switch that is actuated by very little physical force, through the use of a tipping-point mechanism, sometimes called an "over-center" mechanism. Switching happens reliably at specific and repeatable positions of the actuator, which is not necessarily true of other mechanisms. These switches are used for the purpose of start , stop and pause of the accelerometer.

6. Infrared (IR) sensors

Infrared sensors / IR sensors used here for detecting the obstacles on the way of the wheel chair. Some IR sensors are placed around the sides, bottom of the wheel chair so that they can detect the obstacles by infrared detection technology.

V. INTERFACING ISSUES AND SOLUTIONS

Various problems arose during the development phase while interfacing. Some of them are listed below along with their solutions.

- The major issues faced while interfacing included data communication between the microcontroller and the accelerometer and calibration of the on movements of the rotors to the input received via the blue tooth.
- Selection of components had to be made keeping in mind the balance between the application requirements and the need for minimizing power consumption as well as weight, as the device was to be equipped on the user's helmet.
- Selecting the right data type for carrying information was of utmost importance as it influences the entire data transfer process as well as transfer speeds. This was resolved by designating one data packet as four 16-bit frames. The frames contain button/click information, X Axis Voltage, Y Axis Voltage and Z Axis Voltage in that order.
- Another issue of great importance was security and reliability of communication and interference. The selection of the Bluetooth with capability for device identification resolves this issue.
- Selecting the correct sampling rate of data to attain optimum sensitivity and accuracy as well as to avoid picking up stray natural motions/vibrations of the head/helmet is important. This issue was resolved by selecting an appropriate data transfer rate as well as putting in microcontroller checks to resolve the problem of stray natural motion.

VI. CONCLUSIONS AND APPLICATIONS

This helmet controlled wheelchair is valuable research for the people with disabilities. Some of example of different

categories of physically challenged people is listed below

1. People with Weak or Poorly Controlled Upper Bodies using standard joystick.
2. People with Little or No Upper Body Movement, using special quad controls.
3. Amputees, Missing Legs and/or Arms but with active upper bodies.
4. Paralyzed Small People - Children and Adults in special seats.
5. Paraplegics - Healthy, Fit & Active are typically the safest users of manual, power-assisted, and fully powered wheelchairs.

VII. FUTURE WORK

Much future work is to be completed before commercialization of this work. This includes further development of hardware and software. It also includes the full testing of the system. The system can be redesigned and rebuild as per the patients requirement. It is planned wide range of activities that will be useful to evaluate system.

Further to better optimization and battery level indication some other modification in this work are required. Like Anti falling system and Ramp detection for forward movement. In Anti falling system there will be a sensor system that will find the edges and corners and will raise the command for stop movement. For this modification we can use accelerometer as well as Infrared sensors.

In Ramp detection system there will be a sensor system that will find the Ramp edges and corners and will raise the command for stop movement. For this modification use accelerometer, accelerometer again measure the tilt angle and will stop the backward movement of the wheelchair but forward movement will be continued.

VIII. REFERENCES

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