DESIGN & IMPLEMENTATION OF A LOW COST BASED WIRELESS HCI SYSTEM FOR DISABLED PERSONS

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Abstract

The project focuses on design & development of a portable wireless Human Computer Interface (HCI) system to create a robust hands free interface for disabled people or peoples having upper limb motor paralysis. Early techniques mainly considered image processing, gaze tracking and cameras to synthesis the device. We propose a new mouse as an input device for a computer whose operation is based on measurement of movements of the user's head and detection of eye blinks. A tilt sensor (3-axis accelerometer) is used to detect both lateral and vertical head movements to navigate the mouse cursor position placed on a helmet. The IR based eye blink sensor is placed on a spec used to detect eye blink and in turns do clicking operation. The signals are sent to the micro-controller (Arduino Uno) for processing & do required operations. The wireless technology includes Bluetooth module (HC-05) used to send signals to the computer in use. A 'C' based program is developed for the mouse control operations & provides a flexible method for the disabled people to improve both personal & professional life quality.

CERTIFICATE FOR CORRECTNESS AND APPROVAL

It is certified that the work contained in the thesis for **DESIGN & IMPLEMENTATION OF A LOW COST BASED WIRELESS HCI SYSTEM FOR DISABLED PERSONS** Muhammad Awais, Ahmad Rehman, Shah Faisal and Ayoub Al-Bashir under the supervision of Asst. Prof. Dr. Mir Yasir Umair for partial fulfillment of Degree of Bachelor of Electrical Engineering is correct and approved.

Approved by

Asst. Prof. Dr. Mir Yasir Umair

Electrical Engineering Dept.
MCS

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DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

In the name of Allah, the Most Merciful, the Most Beneficent.
To our parents, without whose unflinching support and unstinting cooperation, a work of this magnitude would not have been possible.

ACKNOWLEDGEMENTS

We bow in gratitude to Allah Almighty for giving us strength and knowledge to accomplish this task as nothing happens without His will.

The group is indebted by the immense help and moral support given to us by our parents as it would not have been possible without their prayers.

The team also likes to thank our project supervisor Dr. Mir Yasir Umair, without his support and encouragement; it would not have been possible to complete this project.

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Chapter 1: Introduction

In the era of science & technology computers are an integral part of life that makes human life more comfortable. Human Computer Interface (HCI) is a technology used to incorporate the correlation between human and Computer. HCI device which uses information taken from the head area offer interaction methods that are more convenient, impulsive & direct compared to the traditional input devices like keyboard, or mouse. One of the most benefitted target groups is physically disabled people having spinal cord problem, motor paralysis & who cannot use their hands in the interaction. Additionally, as the number of people with disabilities is increasing drastically several researches have been going on for effective Human computer interaction.

1.1 Background

According to the users ability, systems like speech recognition, brain-computer interfaces (BCI) and infrared head-operated joysticks *etc.* may be involved for this purpose. However patients with several disabilities may not be able to speak and eye muscles are the only muscle they can control. Some prominent Eye-movement detection interfaces may be based on videooculography (VOG), image analysis, infraredoculography (IORG), electrooculography (EOG) and electromyography (EMG). Furthermore, this type of interface is not be limited to critically disabled Peoples and could be applicable to any one with enough eye-movement control.

EOG is a widely and successfully implemented technique that has proven reliable human–computer interfaces (HCI) where electrode-based device is designed to enable people with special needs to control a computer with their eyes but it leads to an uncomfortable way of act as several electrodes are placed on face near eye area.

Gaze tracking recommended as an alternative to traditional computer pointing mechanisms. However, the precision or accuracy limitations of gaze estimation algorithms and the fatigue imposed on users when overloading the visual perceptual channel with a motor control task have prevented the widespread adoption of gaze as a pointing modality. The prototype system combines head-mounted, video-based gaze tracking with capacitive facial movement detection that enable multimodal interaction by gaze pointing and making selections with facial gestures.

Brain Computer Interfaces (BCIs) measure brain signals of brain activity intentionally and unintentionally induced by the user, and thus provide a promising communication channel that does not depend on the brain‘s normal output pathway consisting of peripheral nerves and muscles. Present-day Brain Computer Interfaces determine the intent of the user from a variety of different electrophysiological signals. They translate these signals in real-time commands that operate a computer display or other device.

All of the above existing methods mainly includes cameras or expensive sensors and electrodes as input devices for sophisticated image processing ,video processing & signal processing purpose .It makes the system enormous complex & expensive to operate. It motivates to make one simpler, comfortable and cost effective device which can be used by a common disabled person with most intuitive way.

1.2 Problem Statement

In the era of new millennium, it is our concern that individuals with disabilities do not become technological orphans in the areas of electronics and computers. Specifically, for people with disabilities to overcome inconveniences in their daily lives. Moreover, war injured army personnels waste their intellect, experience and capabilities as they

have no means to communicate with the world through computers. There needs to be an aiding system that can help in utilizing their expertise.

The system presented shows people with disabilities can operate the system as good as nondisabled. This computer mouse interface, utilizes current circuit technology to accomplish the control of a computer mouse system effectively.

1.3 Proposed Solution

A Low cost based portable wireless head movement-controlled HCI system which can be used by physically disabled peoples & peoples who cannot use their hands in several applications (like computer operations, internet, typing, & communication) is Proposed here. The main purposeqof this system is to develop a non camera based feasible alternative HCI channel for common disabled people with higher precision, lesser complex & simpler to operate.

1.4 Scope

To provide the disabled with cost effective solution to overcome their disability and take part in the advancements going on around the globe and to utilize the intellect and experience of war injured army personals in the field. Human Computer Interaction is gaining mass popularity in the present days. This project provides a greater scope for improvement in the near future. Effective control of mouse cursor with speech recognition & increasing of writing speed are still some sectors to be improved in future. Better methods of transmission and reception channel can also be developed on further experiment.

1.5 Approach

A simple approch with minimum and cheap circuitry is used in the completion of this project. Two basic sensors (accelerometer and eye-blink sensor) with the combination of a bluetooth module and a pair of microprocessors (arduino), each at both transmitter and receiver section is used. The baasic approch is given in basic steps as:

- Both the sensors will be connected to a Bluetooth device through controllers.
- The data from both sensor will be processed into digital values by the microcontroller which is coded using the embedded C language.
- This Bluetooth device will send wireless feedback signals to the receiving module.
- The received data will be processed by the microcontroller into the respective cursor action.
- Cursor movement on display screen will show respective movements.

Chapter 2: Hardware Specifications

The hardware resources used in the project are described one by one.

2.1 Accelerometer MPU (6050)

The MPU-6050 sensor has a MEMS accelerometer as well as a MEMS gyro in a single chip. It is very precise, as it contains 16-bits analog to digital conversion hardware for every channel. Therefore it captures the x, y, and z channel at the same time. The sensor uses the I2 C-bus to interface with the Arduino.

Figure 1:Accelerometer MPU 6050 chip

2.1.1 Gyroscope Features

The triple -axis MEMS gyroscope in the MPU-60X0 which includes a wide range of features:

- Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full scale range of ±250, ±500, ±1000 and ±2000°/sec
- External sync signal connected to the FSYNC pin supports image, video and GPS synchronization
- Integrated 16-bit ADCs enable simultaneous sampling of gyros
- Enhanced bias and sensitivity temperature stability reduces the need for user calibration
- Improved low-frequency noise performance
- Digitally-programmable low-pass filter
- Gyroscope operating current:q3.6mA
- Standby current: 5µA
- Factory calibrated sensitivity scale factor
- User self-test 5.2 Accelerometer Features The triple-axis MEMS

Accelerometer in MPU-60X0 includes a wide range of features:

- Digital-output triple-axis accelerometer with a programmable full scale range of ±2g, ±4g, ±8g and ±16g
- Integrated 16-bit ADCs enable simultaneous sampling of accelerometers while requiring no external multiplexer
- Accelerometer normal operating current: 500µA
- Low power accelerometer mode current: 10µA at 1.25Hz, 20µA at 5Hz, 60µA at 20Hz, 110µA at 40Hz
- Orientation detection and signalling
- Tap detection

- User-programmable interrupts
- High-G interrupt
- User self-test

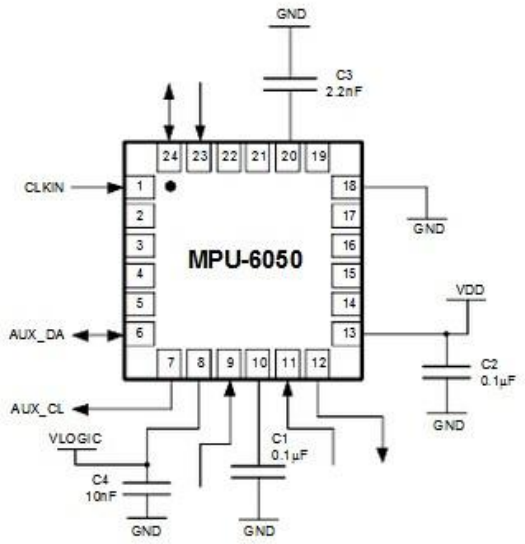

Figure 2: MPU-6050 Pin Configuration

2.2 IR Sensor (TCRT 5000)

The TCRT 5000 and TCRT 5000L are reflective sensors which include an infrared emitter and a phototransistor in a leaded package which stops visible light. The package contains two mounting clips. TCRT 5000L is the long lead version. The main features of the sensor are:

- Package type: leaded
- Detector type: phototransistor

• Dimensions (L x W x H in mm): 10.2 x 5.8 x 7

• Peak operating distance: 2.5 mm • Operating range within > 20 % relative collector current: 0.2 mm to 15 mm

• Typical output current under test: IC = 1 mA

• Daylight blocking filter

• Emitter wavelength: 950 nm

• Lead (Pb)-free soldering released

• Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

The sensor has the following applications

• Position sensor for shaft encoder

• Detection of reflective material such as paper, IBM cards, magnetic tapes etc.

• Limit switch for mechanical motions in VCR

• General purpose - wherever the space is limited

Figure 3: TCRT5000 Sensor

2.3 Bluetooth Module (HC-05)

Bluetooth is a wireless technology standard for exchanging the data over small distances (using short-wavelength UHF radioqwaves in the ISM band from 2.4 to 2.485 GHz) from fixed as well as mobile evices, and building personal area networks (PANs). Range is approximately 10 Meters (30 feet).

These modules are based on the Cambridge Silicon Radio BC417 2.4 GHz BlueTooth Radio chip. This is a complex chip which uses an external 8 Mbit flash memory.

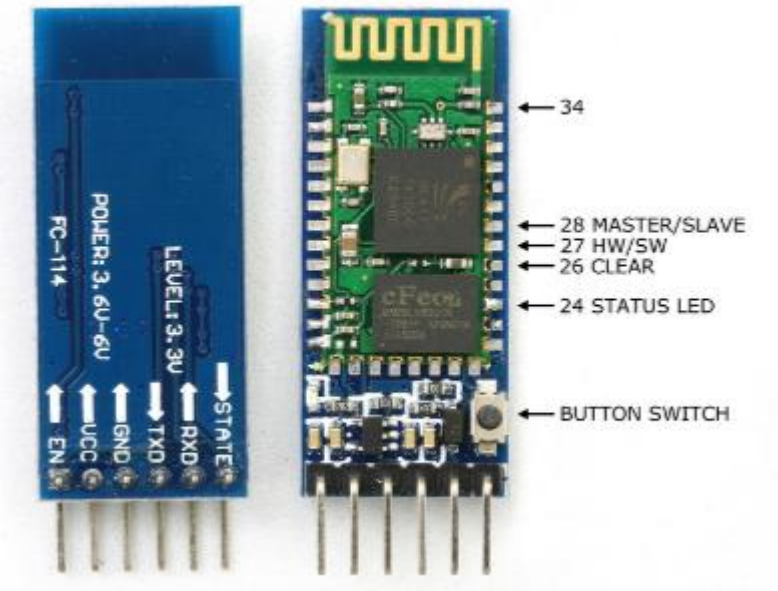

Figure 4: HC-05 Chip

2.4 Microcontroller (Arduino)

Arduino is an open-source computer hardware and software board. The board is based on a family of microcontroller board designs . These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits . The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C, C++ and Java programming languages.

2.4.1 Onboard Arduino Components

An Arduino board consists of an Atmel 8-, 16- or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU boardqto a variety of interchangeable add-on modules known as shields. In this case we would be using the Ethernet shield. Some shields communicate with theqArduino board directly over various pins, but many shields are individually addressable via an I²C serial bus —so many shields can be stacked and used in parallel.

At a conceptual level, when using the Arduino software stack, all boards are programmed over an RS-232 serial connection, but the way this is implemented varies by hardware version. Serial Arduino boards contain a level shifter circuit to convert between RS-232 level and TTL-level signals. Current Arduino boards are programmed via USB, implemented using USB-to-serial adapter chips such as the FTDIFT 232. Some boards, such as later-model Uno's, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware (itself reprogrammable via its own ICSP header).

2.4.2 ARDUINO Uno

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/ output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip and start over again.

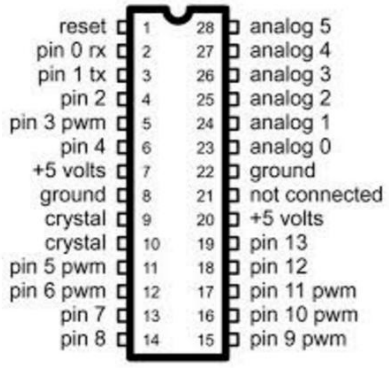

Figure 5: ATmega 328p Pin Configuration

2.4.3 ARDUINO Leonardo

The Arduino Leonardo is a microcontroller board based on the ATmega 32u4. It has 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analog inputs), a 16 MHz crystal oscillator, a micro USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simplyq onnect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started.

The Leonardo differs from all preceding boards in that the ATmega 32u4 has built-in USB communication, eliminating the need for a secondary processor. This allows the Leonardo to appear to a connected computer as a mouse and keyboard, in addition to a virtual (CDC) serial / COM port).

Figure 6: Arduino Leonardo chip

Chapter 3: Software Design

C Language is used for the coding of the project. The coding is done in two parts

- Coding for transmitter side
- Coding for receiver side

Codes for both the modules are atteched in Annex-A of this Thesis.

Chapter 4: Design Structure

The project is divided in two portions i-e transmitter end and receiver end. At the transmitter end accelerometer gets input from head movements while IR sensor gets input from eye blinking. These inputs will be fed to microprocessor which will transmit them with help of Bluetooth to the receiver end. At the receiver end the data will be processed and clicking action will be performed

4.1 Working Methodology

There will be two modules of the project as regards to the working methodology

4.1.1 Module 1

The first module will be comprising of sensors at the driver end. Two sensors are:

a. IR sensor
b. Accelerometer

Special glasses will be designed in which IR sensor will be mounted in a manner which will be user friendly .This IR sensor will sense the motion of eye blinking. Normal blinking of eye will be ignored while blink of eye up to certain time will be give stimulus to the IR sensor. Cursor movement will be defined by the input observed by the accelerometer which will be mounted on head. Right, left, upward and downward movement of head will give respective movement of cursor. These inputs from IR sensor and Accelerometer are fed to the microprocessor which transmit this data to the receiver end via Bluetooth device (HC-05).

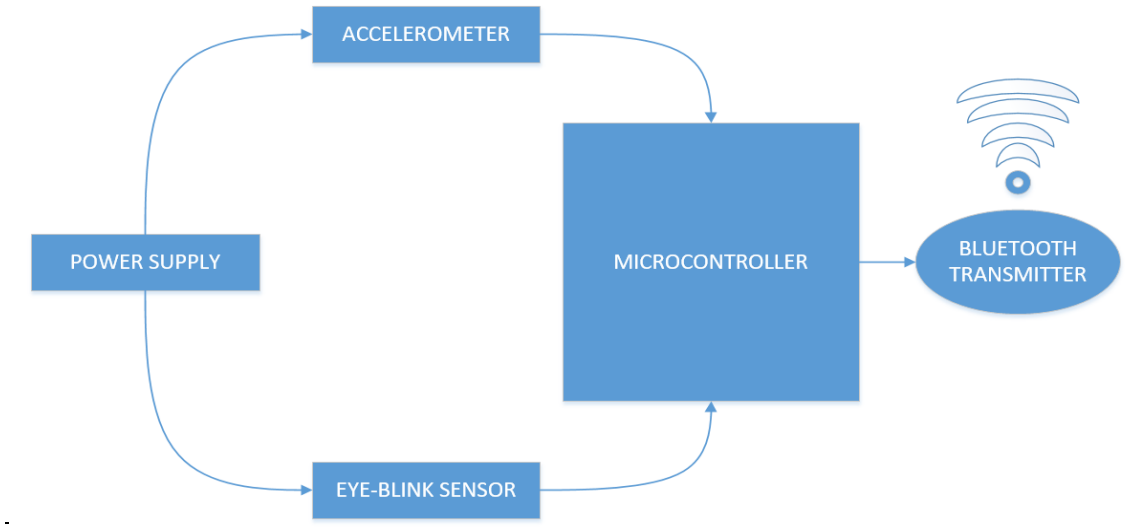

Figure 7: Transmitter Section (Block Diagram)

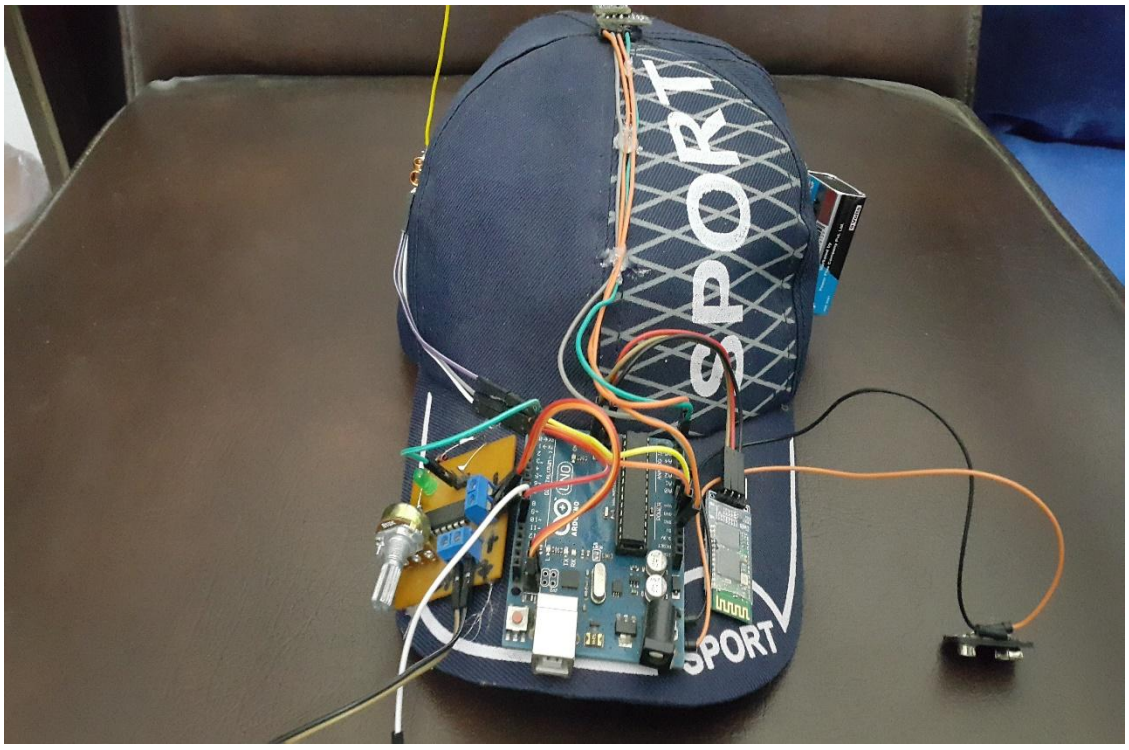

Figure 8: Transmitter Section (Accelerometer with Microcontroller)

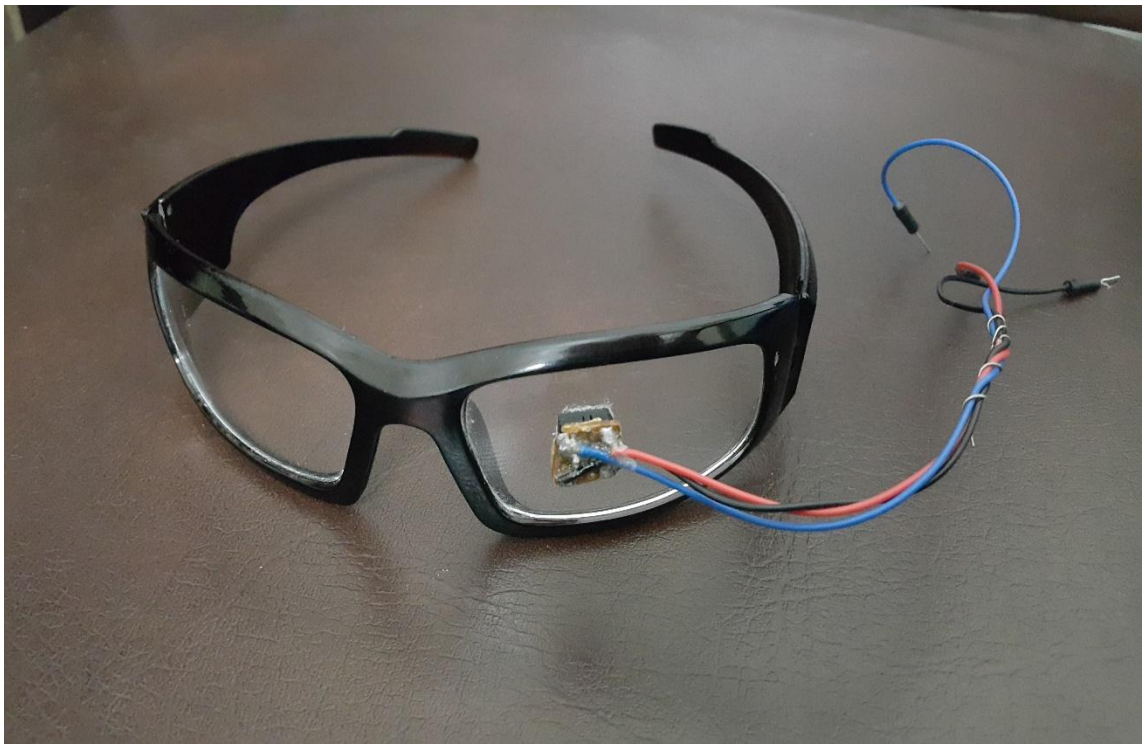

Figure 9: Transmitter Section (IR Sensor on glasses)

4.1.2 Module 2

In the second module, the data which was transmitted earlier will be received at receiver end by Bluetooth through pairing between the two modules. This data will now be fed to the microcontroller at the receiver side which will transform it in the respective cursor movements.

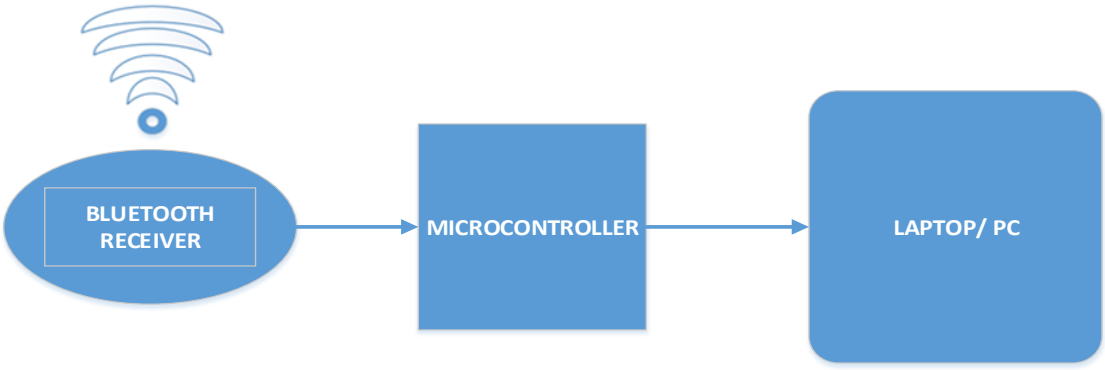

Figure 10: Receiver Section (Block Diagram)

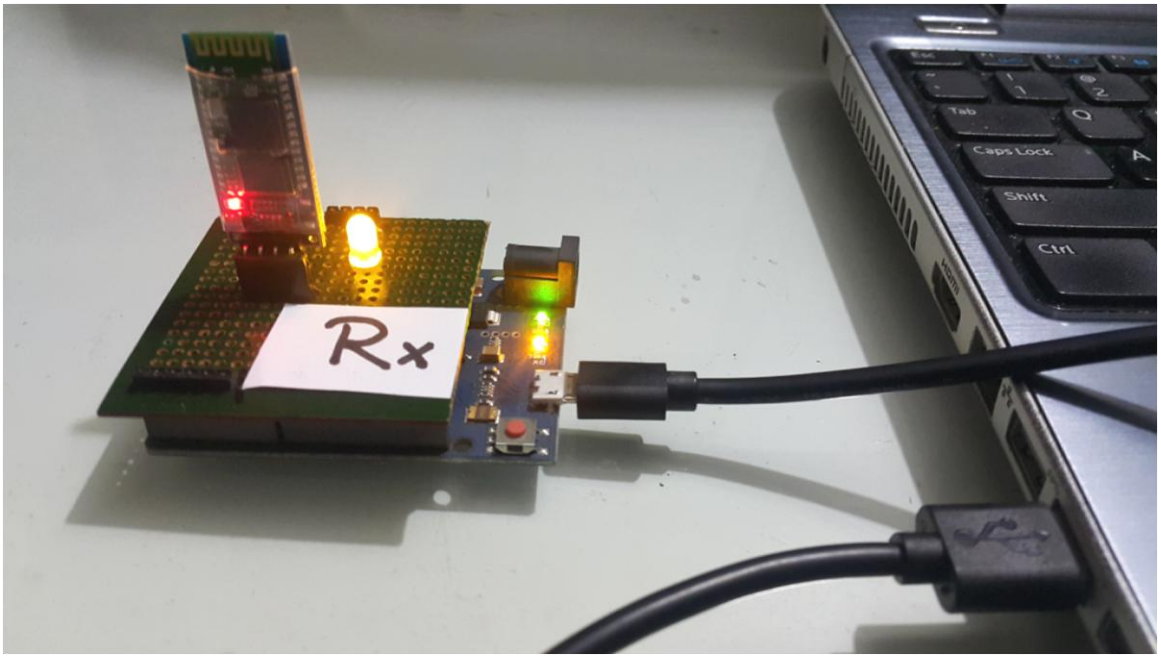

Figure 11: Receiver Section

Chapter 5: Applications

In this era of advancing computer technologies, everybody needs to interact to the world through a computer. This project provides the handicapped with the oppertunity to fully handle and control the computer with just simple head movements and eye blinks. Some of the applications if the project are discussed below.

5.1 For Disabled Persons/War Injured Army Personals

The lack of suitable input devices has made people with disabilities to come accross several obstacles while using computers. As now a days, keyboard and mouse are the most usual input devices and due to the expanding popularity of Microsoft Windows interfaces as Windows 98 and NT, the computer mouse has become even more important. Thus, it has become really important to create something like a simple mouse system for people who are disabled to operate their computer systems.

People who are paralyzed with spinal cord injuries (SCIs) have increasingly applied electronic assistive devices to improve their ability to perform certain essential functions. Electronic requipment, which has been modified to benefit people with disabilities include communication and daily activity devices, and powered wheelchairs. From our literature analysis there are many computer input devices are available. Finger mounted device using pressure sensors, but no hardware has been realized so far and it needs physical kind of interaction with computer system. A wide range of interfaces are available between the user and device and the interfaces can be enlarged keyboards or a complex system that allows the user to operate or control a movement with the aid of a mouth stick, However, for many people the mouth stick method is not accurate and comfortable to use. An eye imaged input system, electro-oculograpy (EOG) signals , electromyogram (EMG)

signals, Electroencephalogram (EEG) signals are capable of providing only a few controlled movements have slow response time for signal processing and require substantial motor coordination. In infrared or ultrasound-controlled mouse system. There are two primary determinants that are of concern to the user. The first one being whether the transmitter is designed to aim at an effective range or not with respect to receiver, the other one being whether the cursor of computer mouse can move with his head or not. These considerations increase the load for people with disabilities. Thus, alternative systems that utilize commercially available electronics to perform tasks with easy operation and easy interface control are sorely required.

5.2 Wireless Mouse For CAD

CAD, or computer-aided design and drafting (CADD), is the use of computer technology for design and design documentation. CAD software replaces manual drafting with an automated process.

If you work in the architecture, MEP, or structural engineering fields, you've probably used 2D or 3D CAD programs. These programs can help you explore design ideas, visualize concepts through photorealistic renderings, and simulate how a design will perform in the real world. Auto CAD software was the first CAD program, and it is still the most widely used CAD application.

CAD programs have different features depending on whether your design process involves 2D vector-based graphics or 3D modeling of solid surfaces. Most 3D CAD programs let you apply multiple light sources, rotate objects in three dimensions, and render designs from any angle.

Broadly speaking, **CAD software** helps you explore concept design ideas, create product designs, carry out simulations and analyses, and perform engineering

calculations. In other words, **CAD software** assists you with the experimentation, exploration, and iteration needed to make the most of your design's potential. The overarching goal, Better products produced more efficiently and at less cost so that you get your products to market faster.

Using Head controlled mouse as alternative mouse the disabled persons will be able to apply their intellect in an efficient manner.

5.3 Head Controlled Mouse as Photo-Editor

Photo editing is the changing of images. These images can be digital photographs, illustrations, prints, or photographs on film. Some types of editing, such as airbrushing, are done by hand and others are done using photo editing programs like Photoshop and Microsoft Paint.

Photos are vital to firms as well as individuals. For individuals, photographs served as important medium in saving momentous memories of friends, families, peers as well as loved ones. Moreover, firms used photographs as tools for their advertising and marketing campaigns. Nowadays, consumers are more inclined to captivating photos, therefore companies ensure that their adverts has alluring photographs. As expected advertisement that does not have photos will not draw the attention of consumers because they don't like reading plain text only. Other than adverts, images are also needed for other purposes such as press releases, website creation,product launches and much more. To make sure that photographs efficiently draw the attention of customers, business enterprises should possess quality photos, therefore they should make use of photo editor software.

5.4 Wireless mouse as Designing and Graphic tool

Graphic design, also known as communication design, is the art and practice of planning and projecting ideas and experiences with visual and textual content. The form of the communication can be physical or virtual, and may include images, words, or graphic forms. The experience can take place in an instant or over a long period of time. The work can happen at any scale, from the design of a single postage stamp to a national postal signage system, or from a company's digital avatar to the sprawling and interlinked digital and physical content of an international newspaper. It can also be for any purpose, whether commercial, educational, cultural, or political.

The various techniques that designers employ, like using specific color palettes to elicit predictable emotional responses, are part of the science of design are added through head Controlled Wireless mouse device. Graphic design is applied to everything visual, from road signs to technical schematics, from interoffice memorandums to reference manuals.

Design can aid in selling a product or idea. It is applied to products and elements of company identity such as logos, colors, packaging and text as part of branding (see also advertising). Branding has increasingly become important in the range of services offered by graphic designers. Graphic designers often form part of a branding team.

Graphic design is applied in the entertainment industry in decoration, scenery and visual story telling. Other examples of design for entertainment purposes include novels, comic books, DVD covers, opening credits and closing credits in filmmaking, and programs and props on stage. This could also include artwork used forqT-shirts and other items screen printed for sale.

Chapter 6: Future Work

Human Computer Interaction is becoming popular universally in the present days. This project provides a greater scope for improvement in the near future. More features can be added and the project can be enhanced. Effective control of mouse cursor and speech recognition can be included. Converting the mouse into both mouse and keyboard by using eye motion detection techniques can take the project to a next level. Better methods of transmission and reception channel can also be developed on further experiment.

Chapter 7: Conclusion

A compact and easy to use device is created for thr disabled in this project. Keeping cost effictiveness as a prime requirement, the project focuses on providing the handicapped with an easy to use gadget for using a computer like a normal person. It has a wide range of applications that extend from online banking to graphic designing. Thus the project proves to be very helpful and an innovative contribution for the society.

Chapter 8: Previous Work Done

Wireless HCI System for Disabled Persons Using ARM7 Surya Narayan Pradhan, Debidatta Acharya, Soumyashree, Mongaraj M.Tech Student (Department of Electronics & Communication, KIIT University, INDIA)

Easy Input head-controlled mouse input device for paralyzed users. Sara Xiangrong Huang, Jesse McMullen, (Frank) Wai Shing Wong Students (Cornell University School of Electrical and Computer Engineering, New York.

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- Shang-Lin Wu†, Lun-Dee Liao, Shao-Wei Lu, Wei-Ling Jiang, Shi-An Chen ―Controlling a Human–Computer Interface System With a Novel Classification Method that Uses Electrooculography Signals IEEE,2013.

- B. Barreto, S. D. Scargle, and M. Adjouadi, ―A practical emg-based human computer interface for users with motor disabilities, J. Rehabil. Res. Dev., vol. 37, no. 1, pp. 53–64, Jan/Feb 2000.

- Natural Eye Movement & its application for paralyzed patients, Yash Shailesh kumar Desai. IJETT April 2013.

APPENDIX A

Transmitter Section Coding

```
#include <RH_ASK.h>
#include <SPI.h> // Not actually used but needed to compile
#include <SoftwareSerial.h>

SoftwareSerial mySerial(10, 11); // RX, TX

#include "I2Cdev.h"
#include "MPU6050.h"

const byte interruptPin = 2;
const byte ledPin = 13;
int ter=0;
int y=0;
volatile byte state = LOW;
// is used in I2Cdev.h
#if I2CDEV_IMPLEMENTATION == I2CDEV_ARDUINO_WIRE
    #include "Wire.h"
#endif

RH_ASK driver;



MPU6050 accelgyro;
//MPU6050 accelgyro(0x69); // <-- use for AD0qhigh

int16_t ax, ay, az;
int16_t gx, gy, gz;
int x=0;
unsigned long duration=0;
void setup()
```

```
{
 #if I2CDEV_IMPLEMENTATION == I2CDEV_ARDUINO_WIRE
        Wire.begin();
    #elif I2CDEV_IMPLEMENTATION == I2CDEV_BUILTIN_FASTWIRE
        Fastwire::setup(400,qtrue);
    #endif
 pinMode(ledPin, OUTPUT);

pinMode(interruptPin, INPUT);
  attachInterrupt(digitalPinToInterrupt(interruptPin), blink,
FALLING);

    Serial.begin(9600);   // Debugging only
    if (!driver.init())
         Serial.println("init failed");
mySerial.begin(9600);
    Serial.println("Initializing I2C devices...");
    accelgyro.initialize();

    // verify connection
    Serial.println("Testing device connections...");
    Serial.println(accelgyro.testConnection() ? "MPU6050qconnection
successful" : "MPU6050 connection failed");



}

void loop()
{
      accelgyro.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
       //Serial.print(ax); Serial.print("\t");
        //Serial.print(ay); Serial.print("\t");
        //Serial.print(az); Serial.println("\t");

   if(ax>5000&&ay<5000&&ay>-5000){
    mySerial.write("a");
```

```
    x=1;
    }
    else if(ax<-5000&&ay<5000&&ay>-5000){
      mySerial.write("s");
      x=2;
      }
else if(ay<-5000&&ax<5000&&ax>-5000){
  mySerial.write("d");
  x=3;
  }
  else if(ay>5000&&ax<5000&&ax>-5000){
    mySerial.write("w");
  x=4;
  }
  else{
    mySerial.write("1");
    x=5;}

if(y==1&&ay<3000){
  x=6;
  y=0;
  mySerial.write("2");
  }
  else if(y==1&&ay>3000){
    x=7;
    y=0;
    mySerial.write("3");
    }

  digitalWrite(ledPin, state);
    Serial.println(x);
    String str=String(x);
    char msg[]="";
    str.toCharArray(msg,5);

    driver.send((uint8_t *)msg, strlen(msg));
    driver.waitPacketSent();
```

```
    delay(10);
    interrupts();
}


void blink() {
  noInterrupts();
 y=1;
  state = !state;
  Serial.println("interrupt occured");
   interrupts();
}
```

Receiver Section Coding

```
#include <RH_ASK.h>
#include <SPI.h> // Not actualy used but needed to compile
#include <SoftwareSerial.h>

SoftwareSerial mySerial(10, 11); // RX, TX

RH_ASK driver;

#include "Mouse.h"

// set pin numbers for the five buttons:


int range = 5;              // output range of X or Y movement;
affectsqmovement speed
int responseDelay = 10;     // response delay of the mouse, in ms




 int upState = 0;
  int downState = 0;
  int rightState = 0;
  int leftState = 0;
  int clickState = 0;
void setup() {
  // initialize the buttons' inputs:

  pinMode(13,OUTPUT);
  digitalWrite(13,LOW);
  // initialize mouse control:
  Mouse.begin();
mySerial.begin(9600);
   if (!driver.init())
         Serial.println("init failed");
```

```
}

void loop() {

 uint8_t buf[1];
    uint8_t buflen = sizeof(buf);
    if (driver.recv(buf, &buflen)) // Non-blocking
    {
      int i;
      // Message with a good checksum received, dump it.

      //Serial.println((char*)buf);
      String a=buf;
     int z=buf[0];
      Serial.println(z);
      if(mySerial.available()>0){
        z=mySerial.read();
        }

if(z==52){
  upState = 0;
  downState = 1;
  rightState = 0;
  leftState = 0;
  clickState = 0;

  }

else if(z==49){
   upState = 0;
  downState = 0;
   rightState = 0;
  leftState = 1;
  clickState = 0;

  }
```

```
else if(z==50){
  upState = 0;
  downState = 0;
  rightState = 1;
  leftState = 0;
  clickState = 0;

  }


 else if(z==51){
   upState = 1;
  downState = 0;
   rightState = 0;
  leftState = 0;
  clickState = 0;

  }

 else if(z==54){
   upState = 0;
  downState = 0;
   rightState = 0;
  leftState = 0;
  clickState = 0;
   Mouse.click(MOUSE_LEFT);
  }

   else if(z==55){
   upState = 0;
  downState = 0;
   rightState = 0;
  leftState = 0;
  clickState = 0;
   Mouse.click(MOUSE_RIGHT);
  }
```

```
else{
   upState = 0;
  downState = 0;
   rightState = 0;
  leftState = 0;
  clickState = 0;

  }
            }




  // read the buttons:


  // calculate the movement distance based on the button states:
  int  xDistance = (leftState - rightState) * range;
  int  yDistance = (upState - downState) * range;

  // if X or Y is non-zero, move:
  if ((xDistance != 0) || (yDistance != 0)) {
    Mouse.move(xDistance, yDistance, 0);
  }

  // if the mouse button is pressed:
  if (clickState == HIGH) {
    // if the mouse is not pressed, press it:
    if (!Mouse.isPressed(MOUSE_LEFT)) {
      Mouse.press(MOUSE_LEFT);
    }
```

```
  }
  // else the mouse button is not pressed:
  else {
    // if the mouse is pressed, release it:
    if (Mouse.isPressed(MOUSE_LEFT)) {
      Mouse.release(MOUSE_LEFT);
    }
  }

  // a delay so the mouse doesn't move too fast:
  delay(responseDelay);
}
```