

HAND GESTURE TRACKING WITH VISUAL FEEDBACK

A MAIN PROJECT REPORT

Submitted by

JISIE DAVID

LUCIYA P J

MARY MARIYA K S

SABRINA VIVIAN THOMAS

*in partial fulfillment for the award of the degree
of*

BACHELOR OF TECHNOLOGY (B.TECH)

in

COMPUTER SCIENCE & ENGINEERING

of

UNIVERSITY OF CALICUT

Under the guidance of

Ms. KUMARY R SOUMYA



JUNE 2011

**Department of Computer Science & Engineering
JYOTHI ENGINEERING COLLEGE, CHERUTHURUTHY
THRISSUR 679 531**

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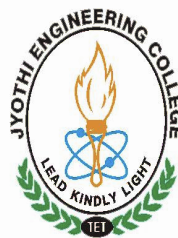
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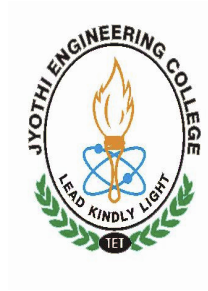
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BONAFIDE CERTIFICATE

Certified that this project report “ **HAND GESTURE TRACKING WITH VISUAL FEEDBACK** ” being submitted in partial fulfillment of the requirements for the award of degree of **Bachelor of Technology of University of Calicut** is the bonafide work of **JISIE DAVID, LUCIYA P J, MARY MARIYA K S, SABRINA VIVIAN THOMAS** , who carried out the project work under our supervision.

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ABSTRACT

Augmented reality has become a promising and fast-growing application of computer graphics over the course of the last years . Augmented reality refers to a system in which the physical surroundings of a person are mixed with real-time computer generated information creating an enhanced perception of surrounding environment. In this project we are creating a system which is capable of tracking the hand gestures and gives a visual feedback according to the recognized gestures. In here we have two units one is the user unit and the next is the device unit. The user unit consists of sensors which generate a signal according to the hand movements. The signals are then transmitted from the user unit to the device unit. The received signals are processed and feedback is accordingly given as mouse movements seen on the monitor. The project aims at bringing the real world and virtual world together. The user will be able to use hand movements in the place of a regular mouse in order to control the operations usually carried out with a mouse. According to the different hand movements, the system will respond and carry out the many operations that are available. Integration of reality and the computer system is apparent in this project where a computer can be operated in a simplified manner using our hand.

List of Abbreviations

HCI	: <i>Hand Computer Interaction</i>
AR	: <i>Augmented Reality</i>
RF	: <i>Radio Frequency</i>
PIC	: <i>Peripheral Interface Controller</i>
ASIC	: <i>Application Specific Integrated Circuit</i>
OOK	: <i>On Off Keying</i>
ADC	: <i>Analog to Digital Converter</i>
RC	: <i>Resistor Capacitor</i>

CHAPTER 1

Introduction

1.1 Overview

AR is a new technology that involves the overlay of computer graphics on the real world. The term Augmented Reality is believed to have been first used by an aircraft manufacturing researcher at Boeing. In simple words Augmented reality adds virtual information to our real world view. This is most often done by a display device through which the user sees the reality, combined/augmented with virtuality. There are many definitions for Augmented Reality. Some of them are: augmented reality combines real and virtual, augmented reality is interactive in real time, augmented reality is registered in 3D.

AR can be defined as referring to cases in which an otherwise real environment is augmented by means of virtual objects. Augmentation can be achieved with various different techniques. Augmentation is done in order to enhance the users surrounding environment in real-time in respect to some function or purpose. Computer generated part of the environment makes AR a very close relative to the concept of virtual reality. It actually takes a real object or space as the foundation and incorporates technologies that add contextual data to deepen a persons understanding of the subject.

Now a days AR is being used in many fields specially in gaming. Here we are going to create a system which is capable of tracking the hand gestures and gives a visual feedback according to the recognized gestures . We dont have to use a mouse in this system so it is more user friendly .Here we have two units to work on. One is the user unit and next is the device unit. We use a glove with flex sensors that are situated in the finger tips. As the hand moves the system will track the movement with the help of the sensors and the result is obtained as a visual feedback on the screen.

1.2 Motivation and Technical Relevance

When we watch movies these days, all of them seem to have such upscale technology that could we can only dream of seeing in our lifetime but chances are we wont. From flying cars to interactive holographic computers that the heroes manipulate with such ease; it makes us think if only we had something like that. So while searching for our project topic, we were told about an area called augmented vision and technology. Not really knowing what it was, our online searches resulted in the revelation that it was the idea behind one of the TED talks we had recently heard which everyone had deemed as unbelievably awesome. So it was the idea that through this project we could also be part of paving the new path for the future in computers. Although our project is not exactly the refined and out-of-this-world looking system; it will, we hope, be a stepping stone down that path.

Augmented vision and reality is a relatively new field that has seen a lot of activity in the recent years. From smart phones and the sports we see on TV, to wearable computers that will work with just a touch of your hands, we can see augmented reality in many forms. Technically speaking, our project is aimed at reducing the amount of use of the physical computer screen. It will be simple and easy to use, since we are making use of hand gestures. Although the specified hand gestures for certain actions must be learned in order to use the system, it will still be easy to learn. The system is designed so that users can easily interact with the a operating system and manipulate application programs with simple actions without the use of a screen.

1.3 Overview of Project

The project was initialized at the beginning of the seventh semester. The idea for project was conceived by the group members after much research. This idea was chosen due to its relative uniqueness and due to the interest of all the group members in the topic. Soon after some brainstorming and further research, the initial phases of the project was started. The circuits for the two separate units were designed. Along with the circuit design, the components and their specifications were decided. Then different parts of the circuits were implemented separately and tested before integration of the two units took place. The sensor that we have used is the flex sensor which are fitted into rubber gloves that can be worn on the hands of the user. Then, there is also an accelerometer that is used. This is simply provided as an alternate option for the flex sensors. These two sensors are very important and are the core component

of the project.

1.4 Member roles and responsibilities

Our team consist of four memebers who will all come together to implement this project and reach our goal. As this is a group project, it is important that the each member of the team contribute to this project. Though each group member plays a specific role, it is important for all members to be aware of all aspects of the project. The best results will be obtained if all four of us put our heads together in order to do this project. It would be beneficial to each of us to learn about each and every step necessary to complete this project instead of learning a lot about only one phase and not so much about the others.

1.1: Team Organization

Name	Responsibility
Jisie David	Leader, Programmer
Luciya P J	Designer, Programmer
Mary Mariya K S	Designer, Programmer
Sabrina Vivian Thomas	Debugger, Programmer

Our team members will work together during each phase of our project. This is due to our teams belief that it is important for each member to be aware of all phases of the project. And also, working together as a team toward one goal enables us to achieve better results and motivate each other throughout the course of the project.

1.5 Layout

Here is a brief outline of the contents of the chapters to follow.

Chapter 2 presents the relevant documents referenced during the initial survey of the project concept.

Chapter 3 presents the project model that is implemented.

Chapter 4 includes the hardware and software requirements for the project.

Chapter 5 gives an overview of the project work. Includes the member work effort and

module allocations to each member here as per his/her responsibility. The section also presents the general architecture of the project concept.

Chapter 6 includes the program code elements for the working implementation of the project.

The last chapter, Chapter 8 summarizes the work done in our project.

CHAPTER 2

Literature Survey

2.1 Documentation

When the literature survey was conducted we came to know about that there are two commonly accepted definitions of Augmented Reality today .One was given by Ronald Azuma. Azumas definition says that Augmented Reality combines real and virtual, is interactive in real time, is registered in 3D. Additionally Paul Milgram and Fumio Kishino defined Milgrams Reality-Virtuality Continuum. They describe a continuum that spans from the real environment to a pure virtual environment.

2.1.1 Papers & related works

Wear Ur World-A Wearable Gestural Interface relates to augmented reality research where digital information is superimposed on the user's view of a scene. Its a project that is introduced by Pranav Mistry. Our project Hand Gesture Tracking with Visual Feedback is just a small model of what Pranav Mistry has done. In *Hand Gesture Selection and Recognition for Virtual Based Human-machine Interface*, a new paradigm has been proposed for gesture selection and recognition. The paradigm is based on statistical classification, which has applications in telemedicine, virtual reality, computer games, and sign language studies. Here, the aims are how to select an appropriate set of gestures having a satisfactory level of discrimination power, and comparison of invariant moments and geometric properties in recognizing hand gestures. In *Visual Interpretation of Hand Gestures for Human-Computer Interaction: A Review*, the use of hand gestures provides an attractive alternative to cumbersome interface devices for human-computer interaction (HCI). In particular, visual interpretation of hand gestures can help in achieving the ease and naturalness desired for HCI. This has motivated a very active research area concerned with computer vision-based analysis and interpretation of hand gestures. Although the current progress is encouraging, further theoretical as well as computational advances are needed before gestures can be widely used for HCI. The future of research in gesture recognition, including its integration with other natural modes of human-

computer interaction are on-going. Then, there is *Visual Hand Gesture Interface for Computer Board Game Control*. In computer vision interface for interactive computer game, gestures can be used as commands for the game control instead of keyboard or mouse. The utilization of hand gesture in human-computer interaction enables human operators to interact with computer environments in a natural and intuitive manner. Proposals for visual gesture recognition for manipulating objects in a board game such as chess are being implemented.

CHAPTER 3

Proposed System

3.1 Process Model

Our project uses evolutionary process model. A process model that views development as a series of hills, each representing a separate loop of the spiral model. The Evolutionary Models take the concept of evolution into the engineering paradigm. Therefore Evolutionary Models are iterative. They are built in a manner that enables software engineers to develop increasingly more complex versions of the software.

3.1.1 The Incremental Model

The Incremental Model combines elements of the Linear Sequential Model (applied repetitively) with the iterative philosophy of prototyping. When an Incremental Model is used, the first increment is often the core product. The subsequent iterations are the supporting functionalities or the add-on features that a customer would like to see. More specifically, the model is designed, implemented and tested as a series of incremental builds until the product is finished.

Advantages

1. It is useful when staffing is unavailable for the complete implementation.
2. Can be implemented with fewer staff people.
3. If the core product is well received then the additional staff can be added.
4. Customers can be involved at an early stage.
5. Each iteration delivers a functionally operational product and thus customers can get to see the working version of the product at each stage.

CHAPTER 4

System Requirements Specification

4.1 Software Requirements

1. Windows OS: Windows OS is nothing but an entire line of operating systems, which has been initiated and developed, by Microsoft and it can be used on several computer systems that are general-purpose, including desktops at home and business, media centers and notebook computers. Windows XP was codenamed "Whistler", after Whistler British Columbia, and the letters "XP" stand for experience. The two words were combined together to form "Windows XP".
2. MPLAB IDE: The current version of MPLAB IDE is version 8. It is a 32-bit application on Microsoft Windows and includes several free software components for application development, hardware emulation and debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third-party software and hardware development tools. Both Assembly and C programming
3. Hi Tech C: The HI-TECH C Compiler for PIC10/12/16 MCUs (Lite mode) is a freeware compiler. It supports all PIC10, PIC12 and PIC16 series devices. The features of HI-TECH C Compiler are listed as followings: Fully compatible with Microchips MPLAB IDE. Fully ANSI-compliant, Includes Library source - for standard libraries and sample code for I/O drivers. And Includes macro assembler, linker, preprocessor, and one-step driver. It Runs on 32/64-bit Windows, Linux and Mac OS X.
4. Express PCB: It is a software for design the PCB according to the circuit diagram.
5. Express Schematic

4.2 Hardware Requirements

1. PIC16F877A Microprocessor with features as:

High performance RISC CPU

DC - 20 MHz clock input DC - 200 ns instruction cycle as operating speed

Up to 8K x 14 words of FLASH Program Memory

Up to 368 x 8 bytes of Data Memory

(RAM) Up to 256 x 8 bytes of EEPROM Data Memory

Interrupt capability (up to 14 sources)

2. Personal Computer with Windows OS
3. Stepper motor: A stepper motor (or step motor) is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism (see Open-loop controller), as long as the motor is carefully sized to the application. Stepper motors are similar to switched reluctance motors (which are very large stepping motors with a reduced pole count, and generally are closed-loop commutated.)
4. Accelerometer MMA7260QT: The Freescale accelerometer is a surface-micromachined integrated-circuit accelerometer. The device consists of two surface micromachined capacitive sensing cells (g-cell) and a signal conditioning ASIC contained in a single integrated circuit package. The sensing elements are sealed hermetically at the wafer level using a bulk micromachined cap wafer. The g-cell is a mechanical structure formed from semiconductor materials (polysilicon) using semiconductor processes (masking and etching). It can be modelled as a set of beams attached to a movable central mass that move between fixed beams. The movable beams can be deflected from their rest position by subjecting the system to an acceleration. As the beams attached to the central mass move, the distance from them to the fixed beams on one side will increase by the same amount that the distance to the fixed beams on the other side decreases. The change in distance is a measure of acceleration.
5. Power supply: A power supply is a device that supplies electrical energy to one or more electric loads. The term is most commonly applied to devices that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (e.g., mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

6. H-bridge: An H-bridge is an electronic circuit which enables a voltage to be applied across a load in either direction. Sometimes called a "full bridge" the H-bridge is so named because it has four switching elements at the "corners" of the H and the motor forms the cross bar. There are four switching elements called, high side left, high side right, low side right, and low side left. The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge. If both switches on one side of a bridge are turned on it creates a short circuit between the battery plus and battery minus terminals. This phenomenon is called shoot through in the Switch-Mode Power Supply (SMPS) literature. If the bridge is sufficiently powerful it will absorb that load and your batteries will simply drain quickly. Usually however the switches in question melt. To power the motor, you turn on two switches that are diagonally opposed.
7. Buffer 7451: These octal buffers and line drivers are designed to have the performance of the popular HC240 series devices and to offer a pin out with inputs and outputs on opposite sides of the package. This arrangement greatly facilitates printed circuit board layout. The 3-state control gate is a 2-input NOR. If either output-enable (OE1 or OE2) input is high, all eight outputs are in the high-impedance state. The HCT541 devices provide true data at the outputs.
8. Relay Circuit: A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply.
9. Encoder HT12E: An encoder can be a device used to change a signal (such as a bit stream) or data into a code. The code serves any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. This is usually done by means of a programmed algorithm, especially if any part is digital, while most analog encoding is done with analog circuitry. The HT12E encoder is a CMOS IC built especially for remote control system applications. It is capable of encoding 8 bits of address (A0-A7) and 4 bits of data (AD8-AD11) information. Each address/data input can be set to one of the two logic states, 0 or 1. Grounding the pins is taken as a 0 while a high can be given by giving +5V or leaving the pins open (no connection). Upon reception of transmit enable (TE-active low), the programmed address/data are transmitted together with the header bits via an RF medium.
10. Decoder HT12D: A decoder is a device which does the reverse of an encoder, undoing

the encoding so that the original information can be retrieved. The same method used to encode is usually just reversed in order to decode. In digital electronics this would mean that a decoder is a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs. Enable inputs must be on for the decoder to function, otherwise its outputs assume a single disabled output code word. Decoding is necessary in applications such as data multiplexing, 7 segment display and memory address decoding. The HT12D is a decoder IC made especially to pair with the HT12E encoder. It is a CMOS IC made for remote control system application. The decoder is capable of decoding 8 bits of address (A0-A7) and 4 bits of data (AD8-AD11) information. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from programmed encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The decoders are capable of decoding information that consists of N bits of address and 12 N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits, and HT12F is used to decode 12 bits of address information.

11. 433 MHz RF Transmitter: It is an ideal for remote control applications where low cost and longer range is required. The transmitter operates from a 1.5-12V supply, making it ideal for battery-powered applications. The transmitter employs a SAW-stabilized oscillator, ensuring accurate frequency control for best range performance. Output power and harmonic emissions are easy to control, making FCC and ETSI compliance easy. OOK (On off Keying) modulation is a binary form of amplitude modulation. When a logical 0 (data line low) is being sent, the transmitter is off, fully suppressing the carrier. In this state, the transmitter current is very low, less than 1mA. When a logical 1 is being sent, the carrier is fully on. In this state, the module current consumption is at its highest, about 11mA with a 3V power supply. On-off keying (OOK) is a type of modulation that represents digital data as the presence or absence of a carrier wave. In its simplest form, the presence of a carrier for a specific duration represents a binary one, while its absence for the same duration represents a binary zero. Some more sophisticated schemes vary these durations to convey additional information.
12. 433 MHz RF Receiver: It is an ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions, making FCC and ETSI ap-

provals easy. The super-regenerative design exhibits exceptional sensitivity at a very low cost. The RF Receiver module uses a super-regenerative AM detector to demodulate the incoming AM carrier. A super regenerative detector is a gain stage with positive feedback greater than unity so that it oscillates. An RC-time constant is included in the gain stage so that when the gain stage oscillates, the gain will be lowered over time proportional to the RC time constant until the oscillation eventually dies. When the oscillation dies, the current draw of the gain stage decreases, charging the RC circuit, increasing the gain, and ultimately the oscillation starts again. In this way, the oscillation of the gain stage is turned on and off at a rate set by the RC time constant. This rate is chosen to be super-audible but much lower than the main oscillation rate. Detection is accomplished by measuring the emitter current of the gain stage. Any RF input signal at the frequency of the main oscillation will aid the main oscillation in restarting. If the amplitude of the RF input increases, the main oscillation will stay on for a longer period of time, and the emitter current will be higher. Therefore, we can detect the original base-band signal by simply low-pass filtering the emitter current. The average emitter current is not very linear as a function of the RF input level. It exhibits a $1/\ln$ response because of the exponentially rising nature of oscillator start-up. The steep slope of a logarithm near zero results in high sensitivity to small input signals.

13. The internal chip of a Logitech roller mouse
14. Flex Sensor: The impedance buffer in the [Basic Flex Sensor Circuit] (above) is a single sided operational amplifier, used with these sensors because the low bias current of the op amp reduces error due to source impedance of the flex sensor as voltage divider. The Flex Sensor patented technology is based on resistive carbon elements. As a variable printed resistor, the Flex Sensor achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius the smaller the radius, the higher the resistance value.

4.3 Conclusion

These are the major software and hardware components needed to implement this project.

CHAPTER 5

Design & Analysis

5.1 System Analysis

This section presents an analysis of the project in terms of the module elaboration and effort distribution.

5.1.1 Module breakup

This section presents the module break-up. The entire project is broken into two main parts: the user unit and the device unit. Module break-up is done accordingly ie, there are two modules.

5.1: Module Description

Module	Description
User Unit	The portable part where the sensors sense the hand movements
Device Unit	The stationary part used with the system in order to move the mouse pointer

The module division is carried out in accordance with the natural division of the project. That is there are two units, where one transmits the signals and the other receives the signals. In the way there are two modules: one for transmitting unit and the other for the receiving unit. In the user module we sense the hand movements. The user modules consist of micro controller, sensor, RF transmitter, analog to digital converter (a part of the micro controller). Here we are using flex sensors along the length of each finger. The sensor outputs a stream of data that varies with the degree of bend. The output for the sensor is analog values which are converted to digital and processed by using a micro controller. Then it will be transmitted through wireless communication (RF). The device unit consists of RF receiver, decoder, level converter, buffer and driver circuit. The digital values that are transmitted will be received at the receiver section and processed by the controller which in turn runs the stepper motor based on the requirement. The response to the hand gestures are displayed on the monitor.

5.1.2 Member effort

This section presents each member's effort in the team. The work-hours are also mentioned here alongside the module assigned.

5.2: Module Allocation

#	Task	Estimated Effort	Start Date	End Date	Person
1	User Unit	(60 percentage)	(28/10/2010)	(25/04/2011)	All Members
2	Device Unit	(40 percentage)	(20/11/2010)	(25/04/2011)	All Members

5.2 System Design

The overall design of the project is as follows. The two units: the user unit and the device unit are both separately designed. These two units then communicate using RF transmission. Architecture of a system describes the overall organization and structure of the system in terms of its major constituents and their interactions. There are some structuring principles that govern the design of the architecture. There are basically four standard architectures that exist. By studying existing systems, designers and researchers have found that certain architectures occur frequently. Pipeline architecture, blackboard architecture, event based architecture and domain specific architecture are the four commonly encountered architectures. In event based architecture, components respond to occurrence of events. An event might be the direction of the signal by a sensor or arrival of message. Components are designed to create events or start their operations when they receive an event. Event based architecture is appropriate when components wait for input from environment. Types of events are dependent on application. Event based architecture satisfy a public subscribe paradigm or pattern. Components publish events that are delivered to those components which have previously subscribed to those events. In our project, we are using event based architecture. Actually, the event is formed by producing analog signals from flex sensors. These signals are converted into digital using ADC. That is, the event in our system is any hand movement or any change in the position of your hand that is sensed by the sensor. Once the sensor senses some movement, then it sends the corresponding signals to appropriate units. And it is seen that when there is no movement of the hand, the system is idle. Therefore, our project can be classified as an event based architecture.

5.2.1 Flow Diagrams

The block diagrams for our system is shown below. These block diagrams show how the system works and how each component works within the entire system.

The block diagrams and the circuits for both the user and device unit are given below.

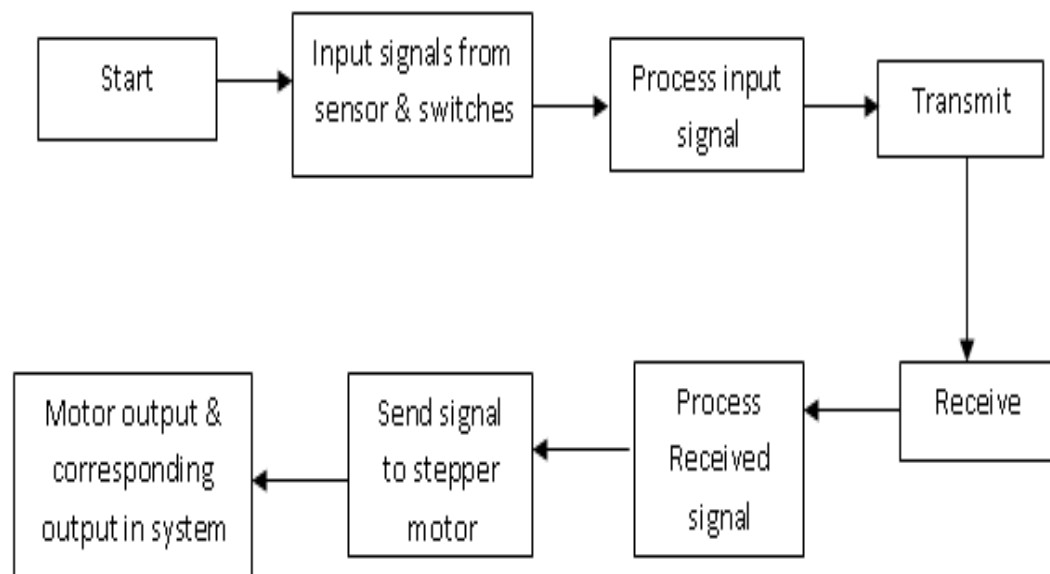


Fig 7.1 Block Diagram of Entire System

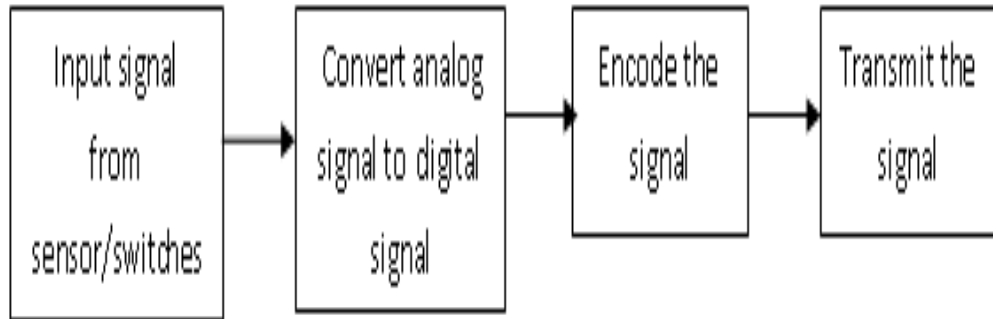


Fig 7.2 Block Diagram of User Unit

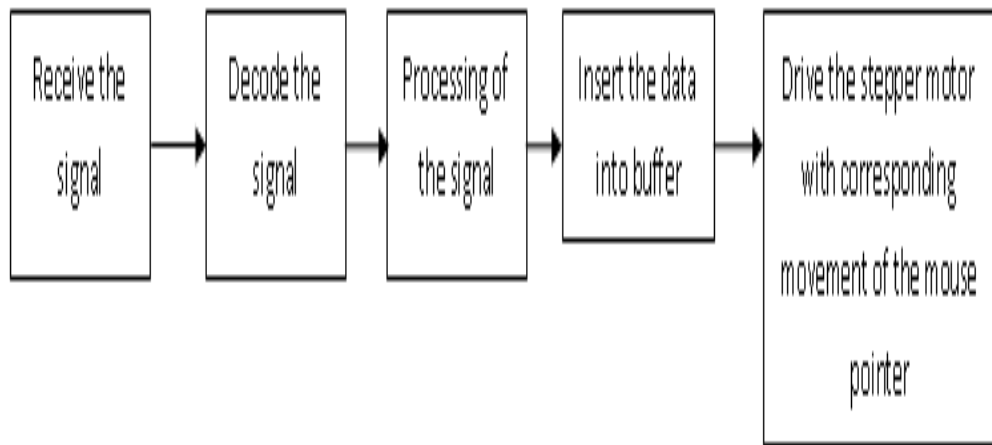


Fig 7.3 Block Diagram of Device Unit

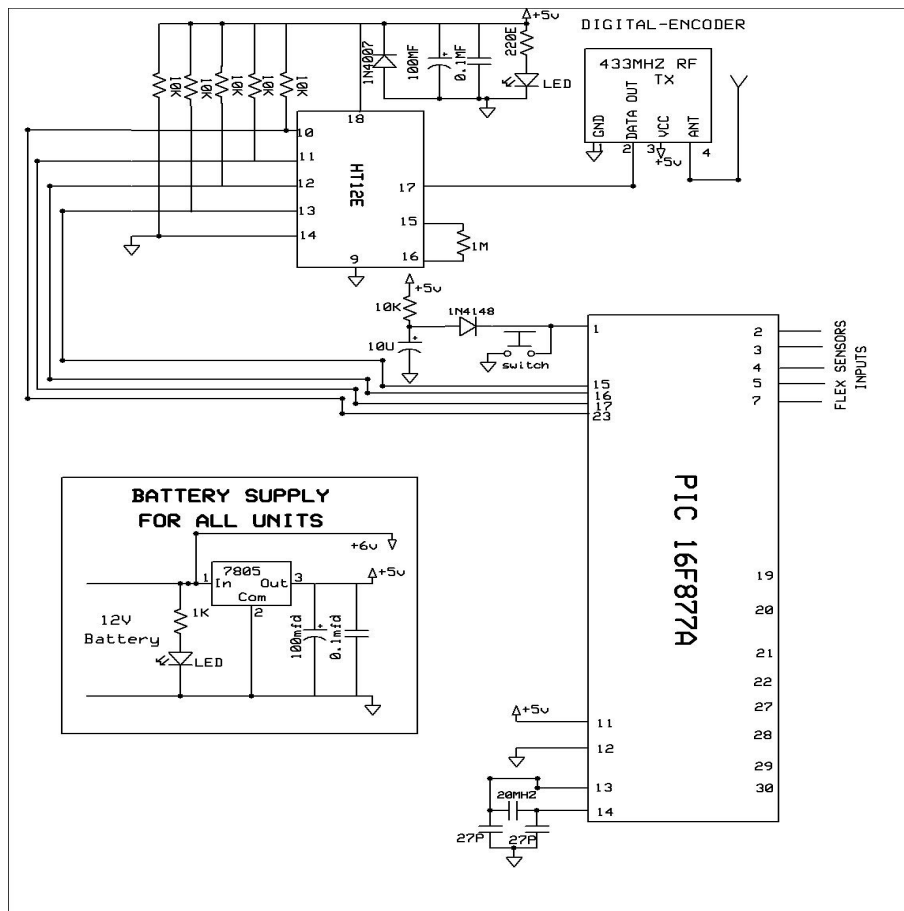


Fig 7.4 Circuit Diagram of User Unit

CHAPTER 6

Implementation

6.1 Introduction

Here we give the snapshots of our device and user units. Also given are the flex sensor and the accelerometer that are used in the project. Then a sample portion of the codes of both the device and user unit are given.

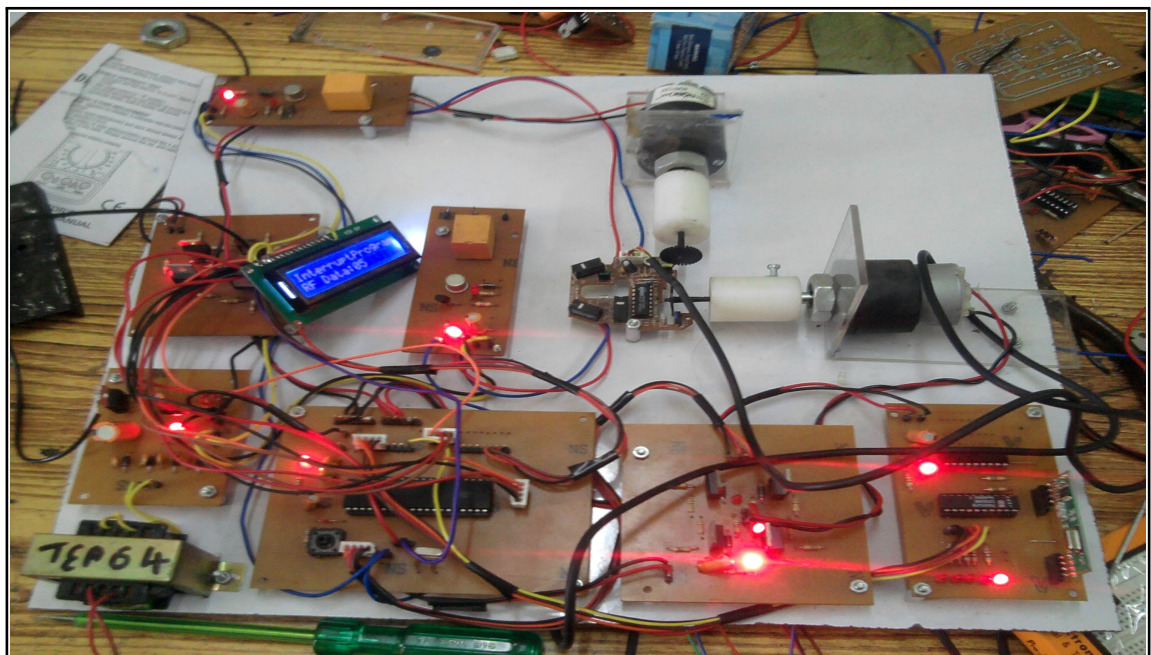


Fig. 6.1: Device Unit

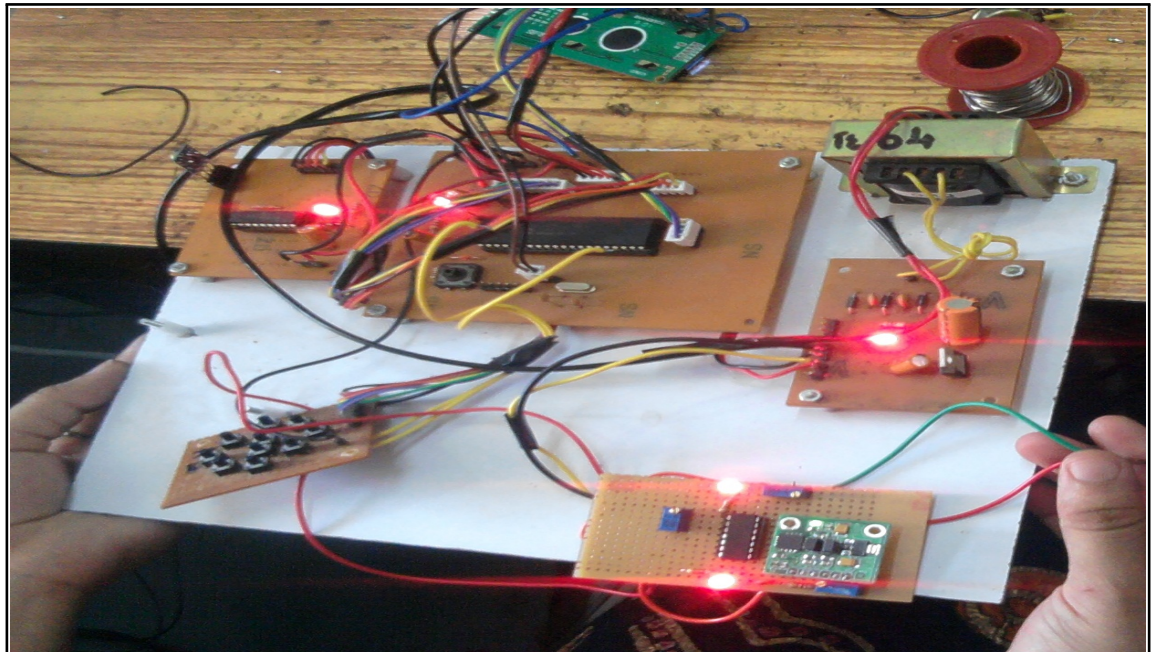


Fig. 6.2: User Unit



Fig. 6.3: Flex Sensor

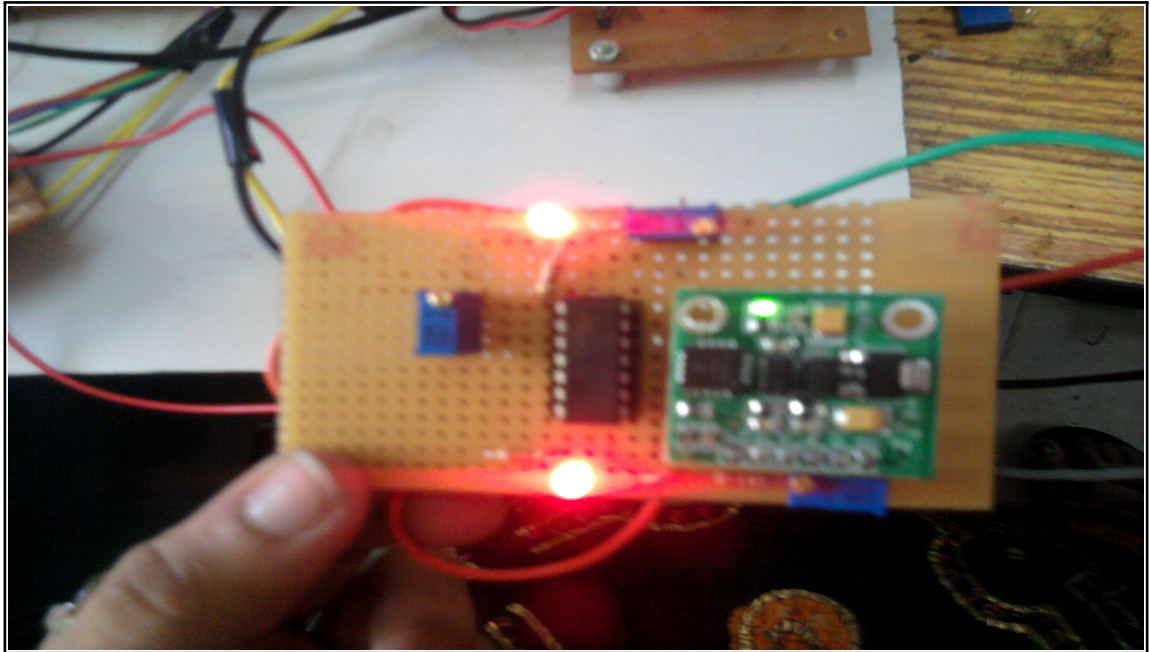


Fig. 6.4: Accelerometer

6.2 Pseudo codes

```
//USER UNIT (User Unit): Transmitter
#include <pic.h>
__CONFIG(HS & WDTDIS & PWRTEN & BOREN & UNPROTECT & LVPDIS);

void adcconvert1 ()
{
    CHS2=0;
    CHS1=0;
    CHS0=0;
    delay (25);
    ADON=1;
    ADCON0=(ADCON0|0x04);
    delay (100);
    lcd_command(0x80);
    temp=ADRESL/2;
    adcvalue=ADRESH;
    if (adcvalue!=0x00)
    {
        if (adcvalue==0x01)
        {
            adcvalue=(0x0100+ADRESL)/0x02;
            temp=adcvalue;
        }
        else if (adcvalue==0x02)
        {
            adcvalue=(0x0200+ADRESL)/0x02;
            temp=adcvalue;
        }
        else if (adcvalue==0x03)
        {
            adcvalue=(0x0300+ADRESL)/0x02;
            temp=adcvalue;
        }
    }
}
```



```
    }
    adcvalue=temp;
    if ( adcvalue >70)
    {
        status1=0x00;
    }
    else if (( adcvalue >60)&&(adcvalue <70))
    {
        status1=0x01;
    }
    else if ( adcvalue <60)
    {
        status1=0x02;
    }
    v1=temp/10;
    v1=v1/10;
    sensor13=(v1+0x30);
    lcd_data ( sensor13 );

    v1=temp/10;
    v1=v1%10;
    sensor12=(v1+0x30);
    lcd_data ( sensor12 );

    v1=temp%10;
    sensor11=(v1+0x30);
    lcd_data ( sensor11 );
}

void main()
{
    TRISA=0xff;
    ADCON1=0x82;
    ADCON0=0x00;
    PORTA=0xff;
    TRISE=0x00;
```

```
PORTE=0x00 ;
TRISB=0xff ;
PORTB=0xff ;
TRISC=0x00 ;
TRISD=0x00 ;
PORTC=0x00 ;
PORTD=0x00 ;
te =1;
lcd_init ();
delay (100);
lcd_condis ("Leakage current " ,16);
lcd_command(0xc0);
lcd_condis ("Measurement " ,16);

while (1)
{
    if (RB0==0)
    {
        for (i=0;i<4;i++)
        {
            adconvert3 ();
            adconvert4 ();
            adconvert5 ();
            delay (1000);
        }
    }
    else
    {
        for (i=0;i<4;i++)
        {
            adconvert1 ();
            adconvert2 ();
            adconvert3 ();
            delay (1000);
        }
    }
}
```

```
    lcd_command(0x8d);
    lcd_data(status1+0x30);
    lcd_command(0x8e);
    lcd_data(status2+0x30);
    lcd_command(0x8f);
    lcd_data(status3+0x30);
    lcd_command(0xcd);

    statusx=0;
if ((status1!=0)&&(status2!=0))
{
    if ((status1==1)&&(status2==1))
    {
        PORTC=0x05;
        te = 0;
        delay(20000);
        te = 1;
        delay(1000);
        PORTC=0x00;
        statusx=1;
    }
    else if ((status1==2)&&(status2==2))
    {
        PORTC=0x06;
        te = 0;
        delay(20000);
        te = 1;
        delay(1000);
        PORTC=0x00;
        statusx=1;
    }
    else if ((status1==1)&&(status2==2))
    {
        PORTC=0x07;
        te = 0;
        delay(20000);
```

```
        te = 1;
        delay(1000);
        PORTC=0x00;
        statusx=1;
    }
    else if ((status1==2)&&(status1==1))
    {
        PORTC=0x08;
        te = 0;
        delay(20000);
        te = 1;
        delay(1000);
        PORTC=0x00;
        statusx=1;
    }
}

if (statusx==0)
{

    if (status1==1)
    {
        PORTC=0x02;
        te = 0;
        delay(20000);
        te = 1;
        delay(1000);
        PORTC=0x00;
    }
    if (status1==2)
    {
        PORTC=0x01;
        te = 0;
        delay(20000);
        te = 1;
    }
}
```

```

        delay (1000);
        PORTC=0x00;
    }
    if ( status2 ==1)
    {
        PORTC=0x03;
        te = 0;
        delay (20000);
        te = 1;
        delay (1000);
        PORTC=0x00;
    }
    if ( status2 ==2)
    {
        PORTC=0x04;
        te = 0;
        delay (20000);
        te = 1;
        delay (1000);
        PORTC=0x00;
    }
}
delay (100);
}
}

//DEVICE UNIT (COMPUTER): Reciever
//BRGH=1, Fosc=3.6864MHz
//Program to receive the RF data in port B by handling in interrupt

#include <pic.h>
__CONFIG(HS & WDTDIS & PWRTEN & BOREN & UNPROTECT & LVPDIS);

static bit rs @((unsigned)&PORTE*8+0);
static bit en @((unsigned)&PORTE*8+1);

```

```
unsigned char portdata , int_count=0x30 , portb_int=0x00 , rf_rxdata ;

void main ()
{
ADCON1=0x07 ;
TRISA=0x00 ;
PORTA=0x00 ;
TRISD=0x00 ;
PORTD=0x00 ;
TRISC=0x00 ;
PORTC=0x00 ;
TRISB=0xF1 ;
PORTB=0xF1 ;
TRISE=0x00 ;
PORTE=0x00 ;
lcd_init () ;
delay (100) ;
lcd_command (0x80) ;
lcd_condis (" InterruptProgram " ,16) ;
lcd_command (0xc0) ;
lcd_condis (" RF Data :          " ,16) ;
lcd_command (0xc8) ;
RBPU=0 ;
GIE=1 ;
INTE=1 ;
INTEDG=1 ;
lcd_command (0xc8) ;
lcd_data ( int_count ) ;
while (1)
{

if ( portb_int==0x01 )
{
int_count=int_count+1 ;
lcd_command (0xc8) ;
// lcd_data ( int_count ) ;
```

```
portb_int=0x00;
portdata =PORTB;
portdata=(portdata >>4);
portdata=(portdata&0x0f);
portdata=(portdata+0x30);
lcd_command(0xc9);
lcd_data(portdata);
rf_rxdata=portdata;
    if (rf_rxdata==0x31)
    {
        PORTC=0x06;
        delay(12000);
        // delay(60000);
        PORTC=0x05;
    }
    else if (rf_rxdata==0x32)
    {
        PORTC=0x09;
        delay(12000);
        // delay(60000);
        PORTC=0x05;
    }
    else if (rf_rxdata==0x33)
    {
        PORTA=0xf6;
        delay(30000);
        // delay(60000);
        PORTA=0xf5;
    }

// Pos 4
    else if (rf_rxdata==0x34)
    {
        PORTA=0xf9;
        delay(30000);
        // delay(60000);
```

```
        PORTA=0xf5 ;  
    }  
  
}  
  
}
```


6.3 Limitations

This system has a few limitations. The main limitation is that the sensors used are very fragile and easily damaged. At a higher cost, more optimum sensors with better capacity and durability can improve the system. Also, the user unit is larger than anticipated. That is, the user unit is difficult to carry around and therefore the portability of the system is reduced.

CHAPTER 7

Testing & Maintenance

7.1 Tests

Testing is an important phase in our project. Testing is vital to the success of the system. Errors can be injected at any stage during development. System testing makes a logical assumption that if all the parts of the system are correct, the goal will be achieved.

7.1: Unit test chart

No	Unit Name	Test Status
1	User Unit	Complete
2	Device Unit	Complete
3	Flex Sensor	Complete

Testing of each separate component was carried out. After which the user unit and device unit were tested separately. And then the entire system was put together and testing was done to make sure the integrated system worked well together and the desired output was obtained.

7.2 Maintenance

Maintenance of our project is very difficult. This is due to the fragility of our components. Especially the flex sensors, they are very fragile and extensive use of the flex sensors tend to wear them out. The sensors after much use may not respond as well and the sensors will become damaged. Better maintenance of the project can be obtained if better and more sturdy sensors are used.

7.3 Conclusion

Testing and maintenance took up a major phase of our project.

CHAPTER 8

Conclusion

8.1 Introduction

The project we have undertaken is the implementation of being able to recognize hand movements by way of sensors. And according to the hand movements, have the appropriate feedback. That is after processing the signals from the sensors according to each hand movement, there will be a response that can be observed on the monitor. The feedback is in the form of movements and manipulation of the mouse. This means that, using this project, the user can interact with a regular personal computer without the use of their hands.

8.2 Conclusion

Our project is progressing at a steady rate. There are many improvements to be made still and we are working on it.

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