Wireless Mouse using Tri-axis MEMS

B. B. S. Kumar[1], Dhruvakumar S B[2], Goutham R[3], Rudraprasad V[4], Shahbaaz[5]

[1]*Ph.D Research Scholar, JU, Associate Prof, Dept. of ECE, RRCE, Bengaluru, India,*
[2,3,4,5]*BE Final year Student, Dept. of ECE, RRCE, Bengaluru, India*

ABSTRACT

The HCI is a field in which the developer makes a user friendly system. In this paper, a real-time Human-Computer Interaction based on the hand data glove gesture recognition is proposed. This paper presents a wearable prototype model for Hand gesture recognition system using MEMS which is capable of recognizing head gesture, based on the signal from 3-axes MEMS accelerometer. The accelerations of a head motion in three perpendicular directions are detected by accelerometers and acceleration values were transmitted to microcontroller. An automatic gesture recognition algorithm is developed to identify individual gestures in a sequence. Finally, the gesture is recognized by comparing the acceleration values with the stored templates. According to recognized gestures, respective commands are performed. HCI is becoming more and more natural and intuitive to be used. The important part of body that is hand is most frequently used as interaction in digital environment and thus complexity and flexibility of motion of hand is a research topic.

The gestures classified are clicking, dragging, rotating, pointing and ideal position. Recognizing these gestures relevant actions are taken, such as air writing and 3D sketching by tracking the path. The results show that glove used for interaction is better than normal static keyboard and mouse as the interaction process is more accurate and natural. Also it enhances the user's interaction and immersion feeling by eye blink sensor.

Key words: *Human-Computer Interaction (HCI), MEMS(Micro Electro Mechanical Systems), Zigbee*

1. INTRODUCTION

Although a wealth of software exists, severely disabled people cannot benefit from it because of difficulties of access, which is usually via computer keyboard or mouse. A Computer Control System has been developed which enables this software to be utilized, in the case described. Computer control system is a computer input device for physically disabled and paralyzed users.

The system uses accelerometer to detect the users head tilt in order to direct mouse movement on the monitor. The keyboard function is implemented by allowing the user to scroll through letters with head tilt and with eye blink sensor as the selection mechanism.

Gesture recognition has been a research area which received much attention from many research communities such as human computer interaction and image processing. The increase in human-machine interactions in our daily lives has made user interface technology progressively more important. Physical gestures as intuitive expressions will greatly ease the interaction process and enable humans to more naturally command computers or machines.

In the evolution of computer user interfaces, the mouse and the keyboard have withstood challenges from other input devices such as joystick, light pen, track ball and many more devices. But still in most of the computer application [5] we are using mouse and keyboard as standard devices. This is not same for the people who with severe disabilities. However as computers become more compact and powerful, e.g., PDAs, notebooks, wearable computers…etc., traditional designs for the mouse and keyboard may not be suitable for interfacing with the small computing systems. But all these devices need physical connection with computer system. We believe that by combining the advent in sensors and wireless technologies, it is possible to develop a novel computer input system that could enable multi-functional input tasks and allow the overall shrinkage in size of the graphical and text interface devices. Our experimental results could be performed using MEMS based motion detection sensors and eye blink sensors[2], [3].

2. PROJECT OBJECTIVE

The main objective of our work is

- Head controlled keyboard and mouse using MEMS
- Accelerometers are used in order to direct to direct mouse movement on the monitor.
- The clicking of mouse is activated by the user's eye blinking.
- The keyboard function is implemented by allowing the user to scroll through letters with head tilt letters with head tilt and with eye blinking as the selection mechanism

3. PREVIOUS EXISTING SYSTEM

Most of existing systems in the gesture recognition follows image-based approaches. It requires sophisticated image processing platforms. Mostly cameras were used as input devices. Object needs to be present in front of the cameras for capturing gestures, which limits the mobility. Power consumption is a challenging one. Several other existing devices can capture gestures, such as a "Wiimote" , joystick, trackball and touch tablet. Some of them can also be employed to provide input to a gesture recognizer. But sometimes, the technology employed for capturing gestures can be relatively expensive, such as a vision system or a data glove. There are mainly two existing types of gesture recognition methods, i.e., vision based and accelerometer and/or gyroscope based.

4. PROPOSED SYSTEM

To overcome the limitations such as unexpected ambient optical noise, slower dynamic response, and relatively large data collections/processing of vision-based method, and to strike a balance between accuracy of collected data and cost of devices, a Micro Inertial Measurement Unit is utilized in this project to detect the accelerations of hand motions in three dimensions. The proposed recognition system is embedded [1] and implemented based on MEMS [3] acceleration sensors. Since heavy computation burden will be brought if gyroscopes are used for inertial measurement, our current system is based on MEMS accelerometers only and gyroscopes are not implemented for motion sensing.

4.1 Project Limitations

- Accelerometer is not much sensitive.
- Increasing the distance between transmitter and receiver would increase the cost of transmitter and receiver module.

4.2 Merits of Proposed System

- User friendly
- Simple programming inputs
- No training required – you just tell the computer what you want to do
- Can be quicker than keyboard entry
- Hands-free – could be invaluable in some environments
- Can be used by the disabled

4.3 Human Computer Interface

Human computer interface [4] is the study, planning and design of the interaction between people (users) and computers. It is often regarded as the intersection of computer science, behavioral sciences, design and several other fields of study. Interaction between users and computers occurs at the user interface (or simply interface), which includes both software and hardware; for example, characters or objects displayed by software on a personal computer's monitor, input received from users via hardware peripherals such as keyboards and mice, and other user interactions with large-scale computerized systems such as aircraft and power plants.

The Association for Computing Machinery defines human-computer interaction as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them." An important facet of HCI is the securing of user satisfaction. Because human-computer interaction studies a human and a machine in conjunction, it draws from supporting knowledge on both the machine and the human side. On the machine side, techniques in computer graphics, operating systems, programming languages, and development environments are relevant.

On the human side, communication theory, graphic and industrial design disciplines, linguistics, social sciences, cognitive psychology, and human factors such as computer user satisfaction are relevant. Engineering and design methods are also relevant. Due to the multidisciplinary nature of HCI [4], people with different backgrounds contribute to its success. HCI is also sometimes referred to as Man–Machine Interaction (MMI) or Computer–Human Interaction (CHI).

4.4 Goals

A basic goal of HCI is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs. Specifically, HCI is concerned with:

- Methodologies and processes for designing interfaces (i.e., given a task and a class of users, design the best possible interface within given constraints, optimizing for a desired property such as efficiency of use)
- Methods for implementing interfaces(e.g. software toolkits and libraries; efficient algorithms)
- Techniques for evaluating [5] and comparing interfaces
- Developing new interfaces and interaction techniques
- Developing descriptive and predictive models and theories of interaction

A long term goal of HCI is to design systems that minimize the barrier between the human's cognitive model of what they want to accomplish and the computer's understanding of the user's task.

Professional practitioners in HCI are usually designers concerned with the practical application of design methodologies to real-world problems. Their work often revolves around designing graphical user interfaces and web interfaces. Researchers in HCI are interested in developing new design methodologies, experimenting with new hardware devices, prototyping new software systems, exploring new paradigms for interaction, and developing models and theories of interaction.

4.5 Safety Measures

Given project (health related or not) is safety. Specifically, is it safe to expose the eye to *x* amount of IR light over a finite amount of time, directed to the same area of soft tissue?

We first note that IR light is not visible light. It is known that a large percentage of IR light is transmitted through the skin (another type of soft tissue). The same result is expected for IR emission towards the eye. With ultraviolet light, however, the complete opposite is true. Blue light is absorbed by soft tissues and is known to cause damage to cells (specifically, damage to DNA).

This is why the general populous is asked to be careful when exposed to sunlight for a long duration of time. Freasier and Sliney have acknowledged that 0.3mW/cm2 is the maximum allowable intensity that the retina can be exposed to IR without damage. Being that our LTE-4208 device has a maximum aperture radiant incidence measure of 1.68mW/cm2, one must be careful in using this setup for long durations of time.

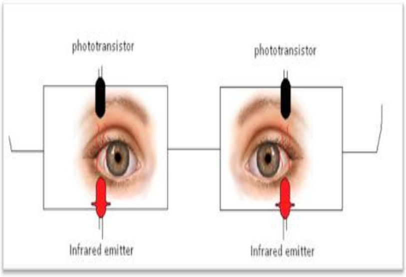

Fig-1: Safety Measures

4.6 Software Tools

- Keil µ vision 4: The µVision from Keil combines project management, make facilities, source code editing, program debugging, and complete simulation in one powerful environment. The µVision development platform is easy-to-use and helping you quickly create embedded programs that work. The µVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.
- Flash Magic: It Windows software from the Embedded Systems Academy that allows easy access to all the ISP features provided by the devices.

5. PROJECT DESIGN

This work describes the implementation of head operated mouse that uses tilt sensors placed on headset to determine head position. Also, it uses 3 axis MEMS accelerometers to detect head tilt in order to direct mouse movement on the monitor. Accelerometer sends the information to the microcontroller. Microcontroller then passes the actual information to encoder. Information encoded is then sent using Transmission to Zigbee receiver. Zigbee receiver will decode the received information. Microcontroller sends to PC through RS232 cable, it will perform the operation and same operation for selecting any documents with the help of eye blink. We constructed an interface system that would allow a similarly paralyzed user to interact with a computer with almost full functional capability. That is, the system operates as a mouse initially, but the user has the ability to toggle in and out of a keyboard mode allowing the entry of text. This is achieved by using the control from a single eye, tracking the position of the pupil for direction, and using blinking as an input. The proposed project describes the design of a system that is compatible for all operating systems.

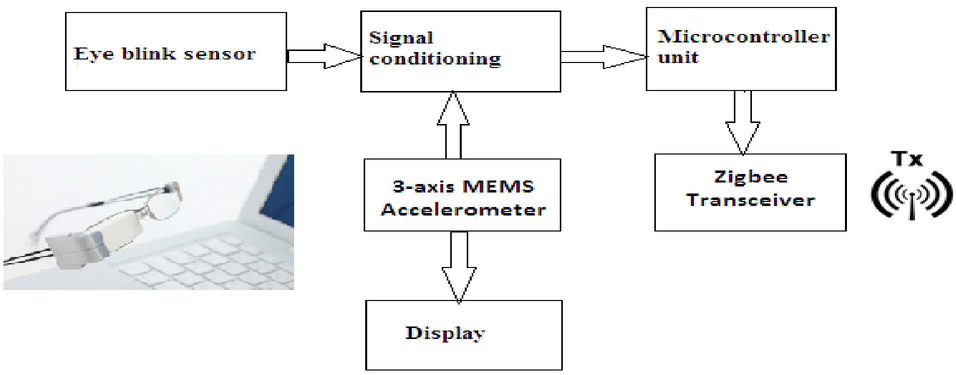

Fig-2:Transmitter Section

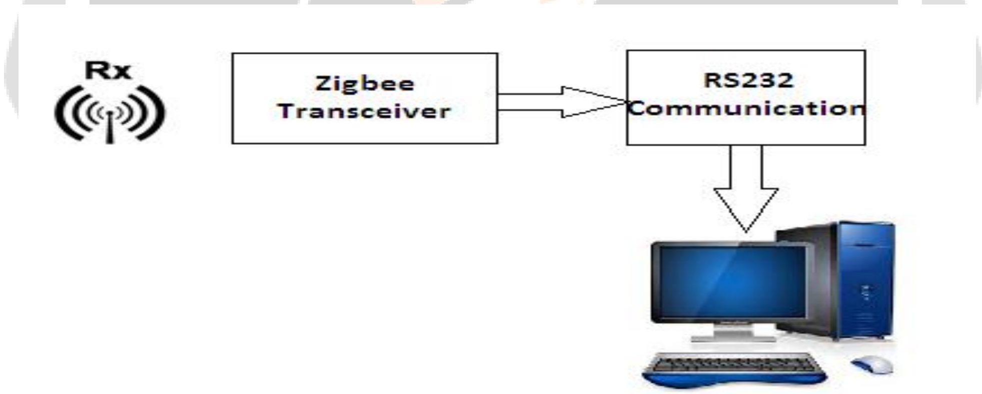

Fig-3:Receiver Section

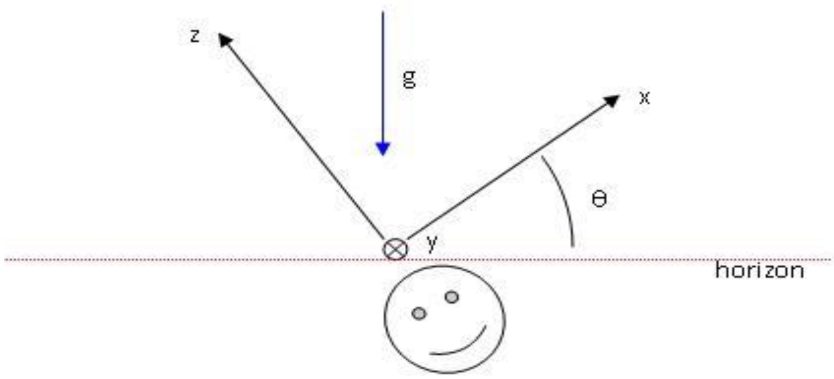

Fig-4: Head unit

Although initially had considered monitoring eye movement for Directional control, the inability to find a functional and adequately priced CMOS camera, combined with the difficulty of this task, caused us to reconsider things. Instead, we opted to detect head motion using accelerometers. Although, the accelerometers we are using ADXL335 was quite sensitive, outputting 1200mv/g, we found early on that this was not fine enough to accurately detect lateral motion or rotation.

Therefore forced to detect the relative tilt of the head (front-back and side to side) this caused the lateral axes to begin to read the sine of the gravitational force. The microchip was nice as three axes were RC filtered and there output could be feed directly into the first two pins of port A, and the internal ADC employed. This circuit was powered by the 12v battery or power supply. This proved to be the heaviest and the most cumbersome part of the whole unit.

6. WORKING PRINCIPLE

The transmitter part does two functions. It runs ADC to get the input from the accelerometer and the object sensor and then it transmits the data to the receiver.

Accelerometer

The output voltage for the accelerometer ranged from 0V to 3V which maps to 0 to 153 after ADC conversion. When the MCU starts, it first takes 100 Readings from the accelerometers [3] and takes the average of the sample data. The averages are used as the reference point for the initial head position. When the head of the user is tilted up/down or left/right, the reading from accelerometer is subtracted from the value of the reference point. The differences determined the level of head tile, decided to have three discrete level of head movement detection to eliminate the effect of noise and provide several states.

Eye Blink Sensor

This Eye Blink sensor [6] is capacitance based. An infrared LED & phototransistor were soldered on the PCB. When the eye closes for a blink, the infrared gets reflected back to the phototransistor. When the eye opens, the infrared light gets absorbed by the eye. Infrared is invisible to the eye, although the energy is still absorbed by the eye. This Eye Blink sensor is capacitance based.

The IR transmitter is used to transmit the infrared rays in our eye. The IR receiver is used to receive the reflected infrared rays of eye. The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator. The comparator is constructed with LM 358 operational amplifier and its output is converted into digital and given to the 89c51 micro controller.

Receiver Side

The receiver code does three things; it receives the data from the ARM LPC2148 microcontroller through wired, then converts the data to meaningful control logic by serial communication software and sends the control signal to computer using RS-232 Serial port.

ADC Operation

The ADC converts an analog input voltage to a 10-bit digital value through successive approximation. The minimum value represents GND and the maximum value represents the voltage i.e. 5V.ADC digital values are 0-1023, where 0 is 0v and 1023 is the 5V.

A single conversion is started by writing a logical one to the ADC start conversion bit, ADC Read( ). This bit stays high as long as the conversion is in progress and will be cleared by hardware when the conversion is completed.

If a different data channel is selected while a conversion is in progress, the ADC will finish the current conversion before performing the channel change and sending through a EUSART pin by commanding as USART Write.

Mouse Logic

When it is switched on, the X and Y moments are directly mapped to the moment of mouse. The more your head tilts, the faster the mouse moves and by blinking the eye the clicking is activated.

Serial Data Parameters and Packet Format

Data packet is 3 byte packet. It is send to the computer every time mouse state changes (mouse moves or keys are pressed/released).

	D7	D6	D5	D4	D3	D2	D1	D0
1.	X	1	LB	RB	Y7	Y6	X7	X6
2.	X	0	X5	X4	X3	X2	X1	X0
3.	X	0	Y5	Y4	Y3	Y2	Y1	Y0

Note - The bit marked with X is 0 if the mouse received with 7 data bits and 2 stops bits format. It is also possible to use 8 data bits and 1 stop bit format by receiving. In this case X gets value 1.The safest thing to get everything working is to use 7 data bits and 1 stop bit when receiving mouse information. The byte marked with 1 is sending first, then the others. The bit D6 in the first byte is used for synchronizing the software to mouse packets if it goes out of sync.

LB is the state of the left button (1 means pressed down)
RB is the state of the right button (1 means pressed down)
X7-X0moments in X direction since last packet (signed byte)
Y7-Y0 moment in Y direction since last packet (signed byte)

7. EXPERIMENTAL RESULTS

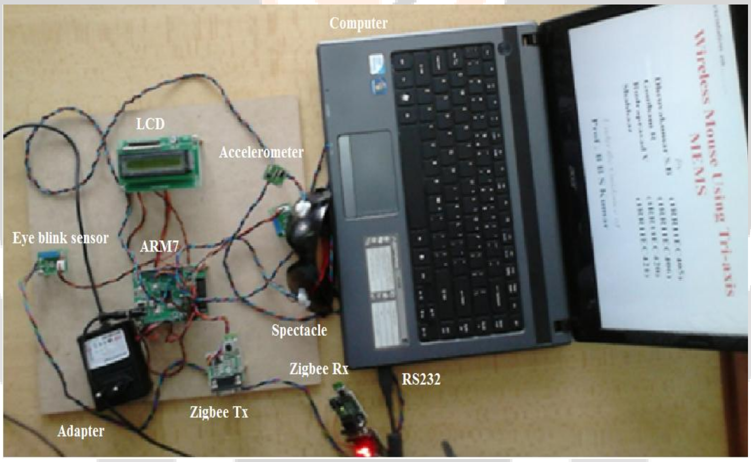

Fig-5: Project Hardware Model

The above figure shows the project hardware model, description as follows.

- The system uses 3-axis accelerometer[7], [8] to detect the user's head tilt in X-Y axis to direct mouse movement on the monitor.
- The clicking of the mouse is activated by user's eye blinking through a eye blink sensor [6].
- The keyboard function is implemented by allowing the user to select letters using onscreen virtual keyboard with head tilt.

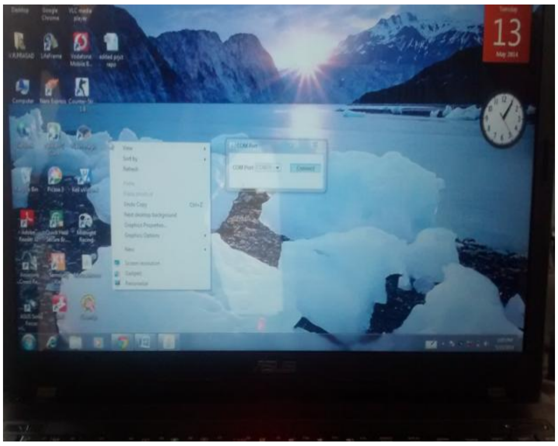

Fig-6: Left Cursor Movement

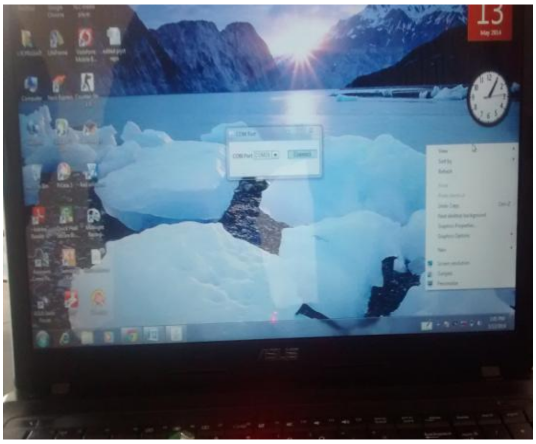

Fig-7: Right Cursor Movement

MEMS sensor tilted towards left direction and using spectacles blink a right eye [1], [2] then cursor moves left direction as shown in Figure 6. MEMS sensor tilted towards right direction and using spectacle blink a right eye then cursor moves right direction as shown in Figure 7.

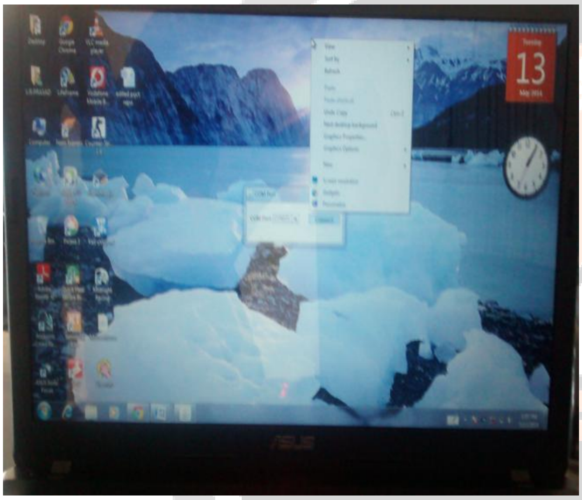

Fig.-8: Forward Cursor Movement

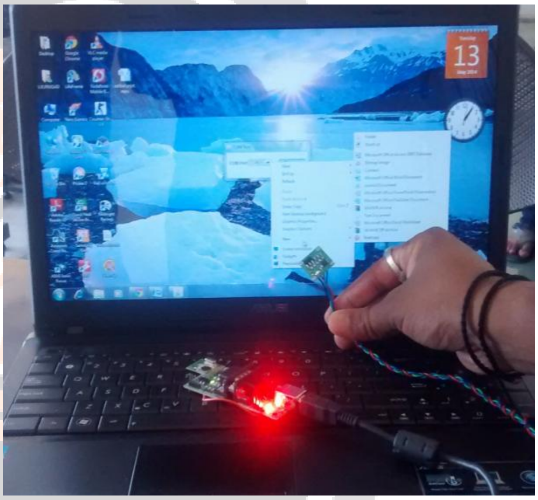

Fig-9: Reverse Cursor Movement

MEMS sensor tilted towards forward direction and using spectacle blink a right eye then cursor moves upward direction as shown in Figure 8. MEMS sensor tilted towards reverse direction and using spectacle blink a right eye then cursor moves downward as shown in Figure 9. The working code was written in visual basic software. MEMS sensor used in this program to get a 3 dimensional movement besides sensitivity, performance and accuracy.

Fig-10: Project Associates: From Left Goutham R, Rudraprasad V, Prof. B.B.S. Kumar, Shahbazz, Dhruvakumar S.B

8. CONCLUSION

The head unit of our final design is kept separately. The whole design performed well and demonstrated all the functionalities we tried to implement. The Controlled mouse and keyboard project met all the goals we set at the beginning of the 12-week period: a comprehensive, user friendly, practical input interface for people with disabilities. During our trial's testing, the head unit and ground unit worked together perfectly with wireless communication.

Although entering text in the keyboard mode takes some time, it does provide an attractive alternative for people who cannot use regular keyboards. In general, the device makes it convenient to browse websites, listen to music, watch videos and accomplish other common operations on the computer.

In the creation of head controlled mouse & keyboard, we ensured safety in the light emission on the photodiode through careful selection. The secondary safety hazard we considered was the user fatigue. Computer control system recognizes the original position when turned on as the reference origin, so when the user returns the head position to the reference origin, the mouse stops moving. Thus it provides a resting position for user in case of movie watching or article reading online. The sensitive of the devices has also been calibrated to ease the pressure on the neck when tilting the head.

Our system incorporates a high degree of usability. The compact and comprehensive design makes it ready for use by the public. The mouse functionality is fairly intuitive, and the keyboard functionality can be adapted to with a few instructions and practice.

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