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Design of Gesture Controlled Wireless Mouse Using Microcontroller

Prof. Suneeta V.Budihal[1], Anant R Choudhari[2], Kripa S Patil[3], Nayana P Desai[4]

Associate Professor, Dept. of Elec & Comm, BVB College of Engg & Tech, Hubli, Karnataka, India[1]

B.E Scholar, Dept. of Elec & Comm, BVB College of Engg & Tech, Hubli, Karnataka, India[2]

B.E Scholar, Dept. of Elec & Comm, BVB College of Engg & Tech, Hubli, Karnataka, India[3]

B.E Scholar, Dept. of Elec & Comm, BVB College of Engg & Tech, Hubli, Karnataka, India[4]

ABSTRACT: This paper presents an advanced design of a Human Computer Interface (HCI) using wireless and accelerometer technology, for better interaction facility with computer and serves to be of great use to physically challenged people. To ensure wearable computing to be more widely accepted, the associated Human-Computer Interface will have to move past today's keyboard, keypad, touch screen, and any other bulky hand-held interfaces to allow a user to specify their input through their fingers without taking their eyes and attention off their immediate focus and without disturbed attention. As a result, this leads to invention of a wearable system to track hand gestures with the help of an accelerometer. The primary goals of the system are to have a comfortable and easily wearable device without interfering with other everyday activities while tracking particular movements of hand that could be used to control a wearable mouse or assist in interaction with ubiquitous or other wearable devices. The technique of Gesture Recognition provides an efficient Human-Computer interface for interactive and intelligent computing. This technique uses a single 3-axis accelerometer for data acquisition and comprises of two main stages: 1) Training stage and 2) Testing stage. During training, the system employs dynamic time warping as well as affinity propagation to create exemplars for each gesture while during testing, the system projects all candidate traces and also the unknown trace onto the same lower dimensional subspace for recognition. A dictionary of gestures is defined and a database of traces is created. The hardware for the same has been implemented and tested using ATMega 64.

KEYWORDS: Gesture recognition and processing, Wireless mouse control, accelerometer sensors.

I.INTRODUCTION

Recently, due to digitization in every field, data processing speeds have increased dramatically, with computers being advanced to the levels where they can assist humans in complex tasks. Yet, input technologies seem to cause a major bottleneck in performing some of the tasks by under-utilizing the available resources and usage restriction as a result of cost constraint. Compared to the optical mouse which offers a limited range of length of connecting cable and also they require a surface to work on, the wireless in not of much use other than allowing for a desktop with fewer wires attached. HUMAN COMPUTING INTERACTION (HCI) is one of the important area of research were people try to improve the computer technology. Gesture is a very natural human communication capability.

Human computer interaction (HCI) also referred as Man-Machine Interaction (MMI) refers to the relation between the human operator and the computer or rather specifically the machine. Since the role of human operator is very significant in operating the machine, it is important that the two main characteristics should be considered when designing a HCI system i.e., the functionality and usability. Here system functionality refers to the set of functions or services that the system equips to the users, while system usability refers to the level and scope that the system can operate and perform specific user purposes efficiently. Any system that achieves a suitable balance between these concepts can be considered as influential performance and powerful system [1].

II. GESTURE RECOGNITION TECHNIQUE

Often gestures are in two forms: 1) Static (i.e., posture or certain pose) which may require less computational complexity or 2) Dynamic (i.e., sequence of postures) which may be more complex but are suitable for real time environment. There are different methods having been proposed for acquiring this information necessary for Gestures

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recognition system. Some of the methods use additional hardware devices such as data glove devices and colour markers to easily explore a thorough description of features of different gesture. Some other methods are based on the appearance of the hand based on the skin colour in order to segment the hand and extract necessary features, these methods are considered to be easy, natural and less expensive compared to methods mentioned before. Recent reviews explain gesture recognition system applications and its growing importance in our life particularly in Human computer Interaction (HCI), Robot control, games, and surveillance, using different tools and algorithms [1].

There already exist many methods of hand gesture identification and tracking, as summarized below. They tend to all involve constraints that make their use in a commonplace wearable system impractical. As per the work in [3], authors present a new approach for controlling mouse movement using a real-time camera. Most existing approaches involve changing mouse parts such as adding more buttons or changing the position of the tracking ball. This method is to use a camera and computer vision technology, such as image segmentation and gesture recognition, to control mouse tasks (left and right clicking, double-clicking, and scrolling) and show how it can perform everything current mouse devices can. This paper shows how to build this mouse control system.

As mentioned in [6] by Satjakarn Vutinuntakasame et. al., we can see a hand-gesture based interface for facilitating communication among people with speech and hearing impaired disabilities. The input device in the system is a wireless sensor glove equipped with five flex sensors and a 3D accelerometer. The user's hand gestures can be translated into sounds, by integrating the speech synthesizer on to an automatic gesture recognition system.

As mentioned by *Popa M et. al*. [7] a hand gesture recognition system built around an accelerometer sensor can be studied. This system consists of a sensing and transmitting part and a computer. The computer receives the data describing the motion trajectory and interprets it, through OCR, as a letter. The commands which are given by gesture can be used in a more complex human-computer friendly interface. The system can be also used in gaming systems, embedded systems, and intelligent peripherals and so on, without the OCR.

III LITERATURE SURVEY

To interface our project with computers, we realized that we would be required to implement a USB HID class device. During the planning stages of our design, we researched different ways implementing a USB HID and discovered that we could either proceed by doing this through software or hardware support. We came to the conclusion that our design would require a micro-controller in our base station in order to receive wireless messages and process the information. With this in mind, we decided it would be a more practical and simple to purchase a single hardware board that could perform both these functions. Almost too fittingly, we found a board that could perform the functions we needed and provided relevant example libraries, all within our budget. Additionally, we took into account the short time span we had for this project, and believed it would be more effective to focus on developing our design than getting caught up in the details and semantics of the USB HID class.

IV SYSTEM MODELAND SOFTWARE IMPLEMENTATION

The physical design of our project includes two main parts: 1) A hand mouse unit and 2) A base station. The hand mouse unit mainly processes the information from sensors and transmit the user input to the base station. The functionality is shown in Fig 1 & Fig 2. The base station's purpose is to receive the hand's sent data and forward it to the user's computer in a HID class friendly format. Each unit has its own unique microcontroller and respective peripherals, which are detailed more below.

A. Hand Mouse Unit:

This Unit as shown in Fig 1 is the set of hardware that the user physically wears during operation of the Mouse. It carries Atmega1284 microcontroller mounted onto a custom PCB. Connected to the glove's microcontroller are 5 contact pads, a 3-axis accelerometer, a ZigBee module, 3 different colored LEDs, and a 4 pin of a 8-pin DIP switch.

The user of the Wireless Mouse has two primary modes of input as well as one auxiliary mode. The primary modes of input are hand orientation for mouse movement control and buttons for mouse clicks and control over movement enabling. Hand orientation is sensed by the 3-axis accelerometer in terms of tilt, and outputs an analog voltage to pin A.0, A.1, and A.2 of the glove MCU. These pins are connected to the Atmega1284's internal analog-to-digital convertors, and are converted to a char value between -128 and 127. Button presses are sensed by contact pads placed on the sides of the fingers. All these packets are transmitted to ZigBee transmitter by Atmega1284.

B. **Base Station:**

The base station as shown in Fig 1 serves one important purpose: to receive packets sent from the Glove Unit, wrap them in a proper HID format, and forward mouse commands to the user side computer. The base station microcontroller receives input to RXD1 (pin D.2) from the ZigBee module's TXD0 output. Communication is processed via UART in the same fashion as in the glove unit.

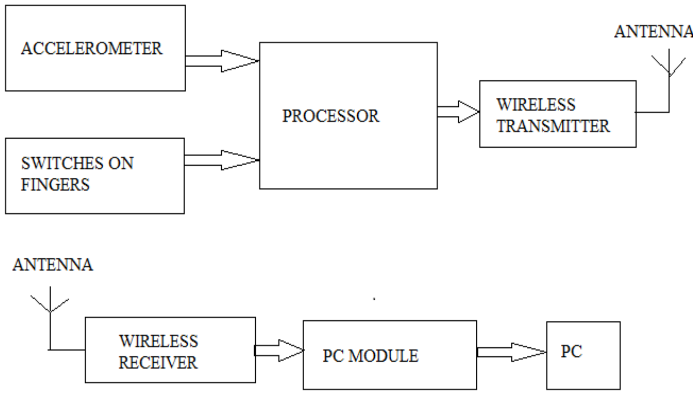

Fig 1. Block diagram of the set up

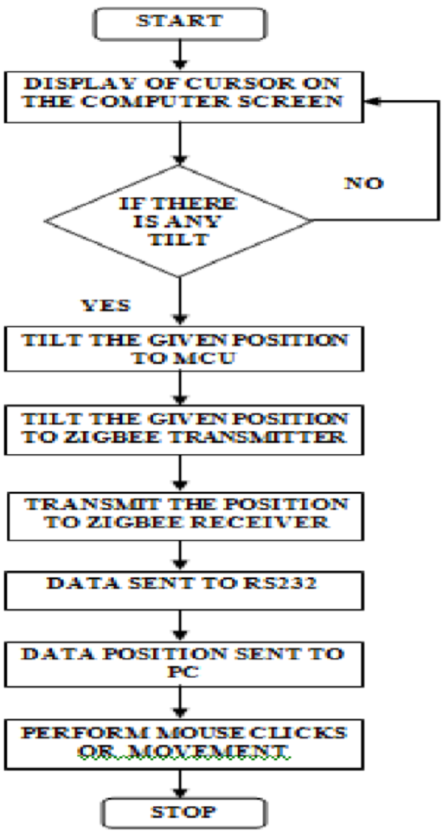

Fig 2 Flowchart to design the gesture controlled mouse.

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Software:

A. Mouse Movement

In this project, a 3-axis accelerometer is used to control cursor movement. The accelerometer reads the tilt of each axis and outputs each as an analog voltage.

The three ports of MCU are connected to the tilt outputs of the accelerometer respectively. Then, each of the voltage value of tilt is converted to digital numbers. These numbers are converted to final mouse movement values by noise detection and scaling. In order to provide accurate mouse-motion and a user-friendly interface, several different types of post-processing are applied to the converted ADC values. Different possible gestures are shown in Fig 3.

B. Initial Axes Calibration

When the move or scroll is enabled, the calibrate() function is called to read the current tilt values. This function averages 1024 samples to get reliable offset values, which are used as the starting reference point. By subtracting those offsets from every ADC sample, the user can start at any position and use that hand orientation as the current reference axes.

C. Cursor Acceleration

This mouse also has the ability to mimic the cursor acceleration: the faster the user changes the tilt, the faster the cursor moves. The tilt change rate can be obtained by subtracting the previous tilt value from the current. To prevent sudden bursts of movement, we implement nonlinear scaling for calculating the cursor acceleration as shown in equation below.

D. Button Clicking and Switching

When these buttons are pressed and then released, the corresponding flag is toggled. If move enable flag is on, the ADC is sampled and the cursor speed is transmitted to the base station. Similarly, the scroll command is transmitted to the base station only if the scroll enable flag is set. The design ensures that scroll enable will have priority over move enable. Encoding and decoding of packets is shown in Table 1 & Table 2 respectively.

E. Wireless Communication

For wireless communication between the glove unit and the base station, two ZigBee modules are used. The XBee and XBee-PRO OEM RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other The XBee®/XBee-PRO OEM RF Modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any serial device (For example: Through a Digit proprietary RS-232 or USB interface board).

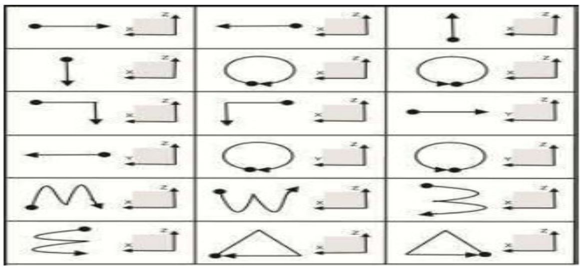

Fig 3. Dictionary of Gestures

.V. SIMULATION RESULTS

The software side of the project includes programming in Keil and PC interfacing. The Keil code and PC interface are as shown below.

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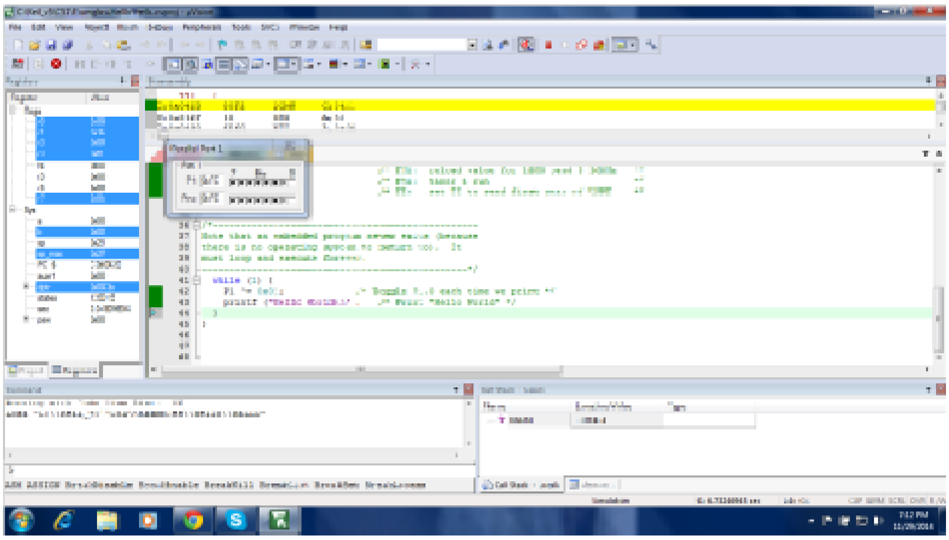

Fig 4. Keil code for Execution

Also the working of a wireless mouse based on gesture is simulated and studied using a virtual mouse implementation. As shown in fig 5, working of a virtual mouse can be studied. The below simulation is executed using Proteus software and using the support of USB driver tool. On running the simulation, an involuntary cursor movement is observed as per any defined pattern in the simulation code, for ex circular movement for 15 secs is observed in this work.

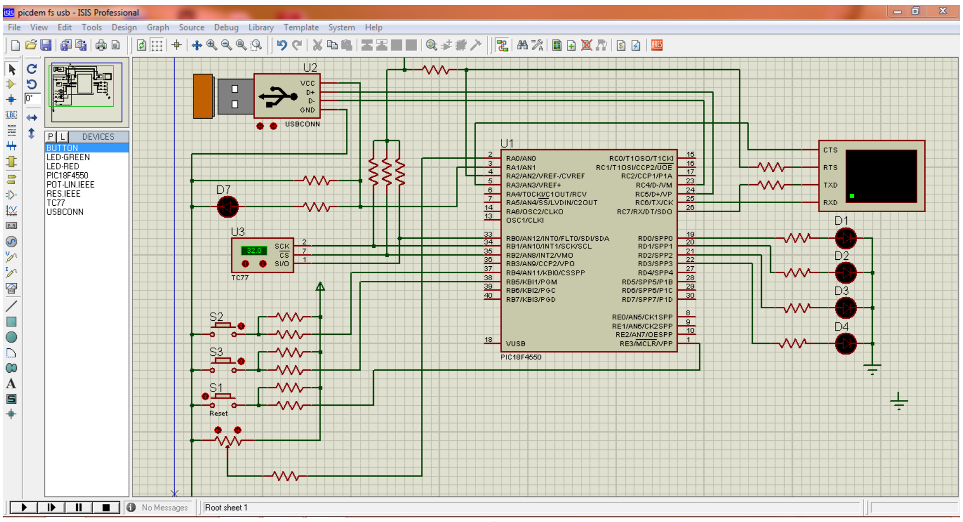

Fig 5. Simulation of a virtual mouse

VI HARDWARE SET UP AND IMPLEMENTATION

This design is implemented through portable embedded device which consists of a triaxial accelerometer, microcontroller (PIC16F877A) and zigbee wireless communication module. The acceleration signals measured from the MEMS accelerometer are transmitted to the computer via the zigbee wireless module.

In this work, MEMS accelerometer measures the acceleration of the signal in three co-ordinates such as x-axis, y-axis, and z-axis. An executable file should be installed in the computer. A required COM port is selected and enabled .Then moving the accelerometer will also produce the movement of the computer cursor. This system could be useful in presentations and to reduce work space. Fig 4 shows the hardware set up.

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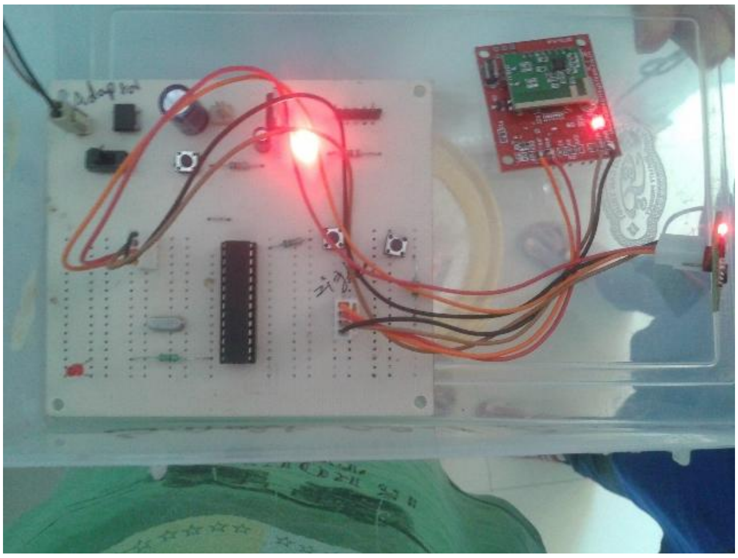
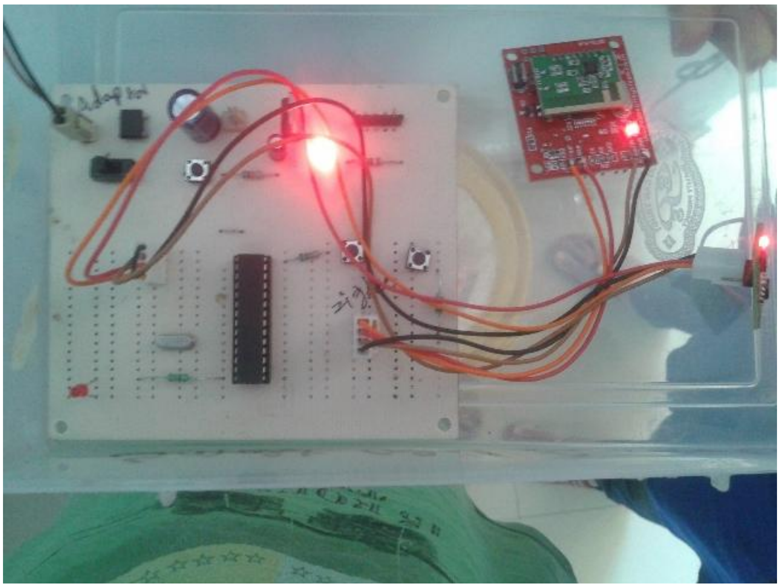


(a)



(b)

Fig 4. Hardware set up. a) Transmitter Module of Gesture Based Wireless Mouse b) Receiver Module of Gesture Based Wireless Mouse

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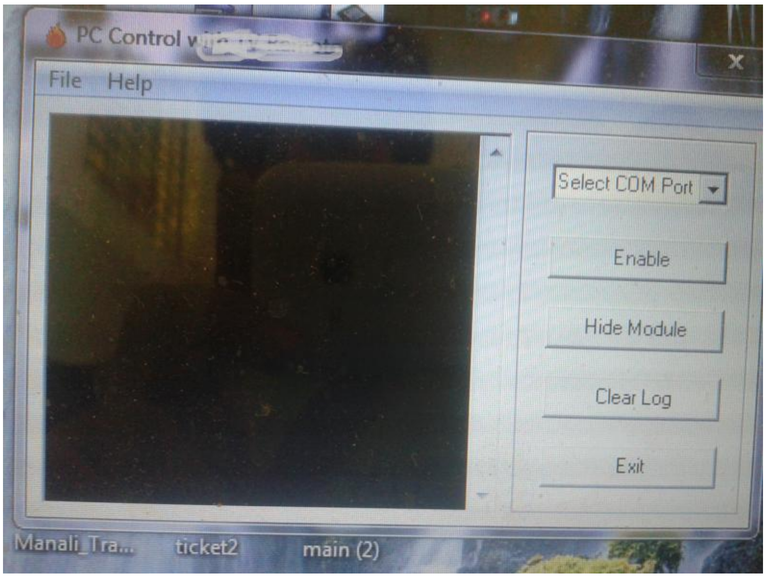

Fig.5 PC Application Interfacing File

As shown in fig 5. The connection between PC and the hardware set up is established using serial port and on choosing enable the transmitter and receiver communicates in such a way that on reading a hand signal the relevant cursor movement is observed.

VII APPLICATIONS

Practical applications include Sign Language Recognition, Graphic Editor Control, Virtual Environments (VEs), Robot Control, Numbers Recognition, Television Control, 3D Modelling etc [1].

VIII RESULTS AND CONCLUSION

As per the objective a portable embedded device consisting of triaxial accelerometer, microcontroller (PIC16F877A) and zigbee wireless communication module has been built and tested.
The acceleration signals measured from the MEMS accelerometer are transmitted to the computer via the zigbee wireless module.
In this project, MEMS accelerometer measures the acceleration of the signal in three co-ordinates such as x-axis, yaxis, and z-axis. An executable file should be installed in a PC. A required COM port is selected and enabled .Then moving the accelerometer will also produce the movement of the computer cursor. This system could be useful in presentations and to reduce work space.

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