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Original Research Paper

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NOVEL MOTION BASED CURSOR CONTROL SYSTEM, USING HAND GESTURES CAPTURED FROM ACCELEROMETER THROUGH A MOTION DETECTION TECHNIQUE.

Shahrukh Javed	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076
ArunVikas Singh	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076
Ghousia Banu S	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076
Syed Moula	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076
Mohammed Amir	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076
Mohammed Hassan M.	Dept Of Electronics And Communication Engineering, T John Institute of Technology, Gottigere, Bengaluru-560076

ABSTRACT Here we present an approach to develop a virtual human computer interaction (HCI) to control the mouse cursor movement in more natural and intuitive way in a cost effective manner.This is the system to overcome the hand operated process to motion level system and control the mouse by using I2C (inter-integrated circuit) communication. An approach for developing an intangible interface system which will allow the user to navigate the computer cursor using their hand and cursor functions, such as right and left clicks, double clicks, scroll up and down will be performed using different hand gestures, which are interpreted as mouse functions. This project proposes a novel motion based cursor control system, using hand gestures captured from accelerometer through a motion detection technique. The purpose of this work is to design & develop device for real-time gesture recognition that can be used in a variety of ways to enhance the users the ability to interact with computers.

KEYWORDS : Inter-integrated circuit,accelerometer,cursor functions, motion detection technique

Introduction:

Present industry is increasingly shifting towards automation with the changing technology, people are trying to find new techniques and interested in smaller and smaller electronic devices for interacting with computers. The traditional modes of interaction which include mouse or a touchpad to control requires physical contact with the devices, will soon become obsolete because they lack in speed and require space.The proposed system "Gesture Based Pc Control Using Accelerometer" is designed and developed to accomplish the various tasks in an adverse environment of an industry. The developed system will be compatible with a diverse group of users. It is a fast learning method and does not require extensive training and also low computational speed and cost. 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 to make it more natural.Gesture recognition is a natural technique and a promising mode of human computer interaction in future. Gesture recognition enables humans to be able to communicate with the machine (HMI) directly and interact naturally, so mouse control using hand gesture is a unique and new concept to control the computer mouse. It is fast, interactive and easy to learn. Here we are using the electronic components that are PIC microcontroller, accelerometer sensor, keypad, zigbee and the corresponding values are displayed by using LCD display. The basic technique is the use of microcontroller and a wireless channel which will bring the mouse in the contact of the computer wirelessly and accelerometer technology for better interaction facility with computer. In this system the values from the accelerometer are used to control the mouse cursor of the pc. The system makes use of accelerometer which senses the hand movements of the user and in turn controls the pc. There is a keypad which is available for controls and for the alphabetical use. All the functions of the system are made wireless using zigbeemodule. The system can be grouped into subsections for validating and verifying the phases of software&hardware andto test sub module functionalities therefore the method used in each component of the system will be explained separately. Herethesystem includes three levels of module testing and the steps followed are discussed below:Unit testing,integration testing and system testing Unit Testing: Unit testing is performed to test the interfaces of components and even to test the methods of class underlying in the components. Unit tests are conducted using test tools or automated test suites run in component phases individually.

Integration Testing: Integration Testing is performed to check whether the integrated modules work properly or not. It is done to check the GUI interfaces, connectivity of sub modules, and their functionality. Integration testing is done manually not in automated method.

System Testing: System Testing is well known for performing the tests on software and hardware modules functionality based on the requirements. This testing is done manually in bottom – up or top – down processes.

Objective:

There are multiple objectives to this prototype. The main motto is to design a device that can control the cursor movement of pc so differently abled persons (Handicapped), such as people who have lost their fingers can mount this device to part of their hand so they can control the cursor movements and with their other hand they can operate the keys.The same can also be used in virtual reality environment where using the mouse for controlling the movements of different object is a little difficult and creates problems to user.This system can also be used in the automation industry to control different machines and automatic plants and it also provides the usability of mouse.

Existing system and disadvantages:

Location- computer mouse needsanunobstructed and a flat surface to effectively monitor and manage user movements. However, flat surfaces may not always be available, especially when computer user becomes more mobile.

Movement flexibility- The present computer mouse constrains the user to a limited set of directions. This system will give the mouse cursor more flexibility as compared to the actual computer mouse.

Difficulty in virtual environments- The use of existing mouse is bit difficult for the users in a virtual environment. As there are only limited set of controls in mouse the future virtual applications may need an upgraded device. Future games will require a device for flexible movements.

Presence of cords- As the most widely used mouses are connected to pc through a cord, the proposed system incorporates a zigbee module for wireless transmission.

Eliminates the need of two separate devices – As compared to current systems where the mouse and keyboards requires two separate connections for their working. But in this proposed system both mouse and keyboard are incorporated to one.

Proposed system and advantages:

Location flexibility- As the propose system is wireless it can be used in mobile environment. This systemdoesn't need a flat surface as compared to mouse. This system works effectively in all sort of environment.

Movement'sflexibility- The current system offers multiple control directions than the mouse. It can be effectively used in automation and virtual reality environment.

Effective use in automation industry- The proposed system can be used in automation industry to control multiple plants and machines where the flexible movements are very much required. The proposed system can be applied in digital classrooms, seminar halls, conferences, etc. It can also be used as a writing aid for paralyzed people.

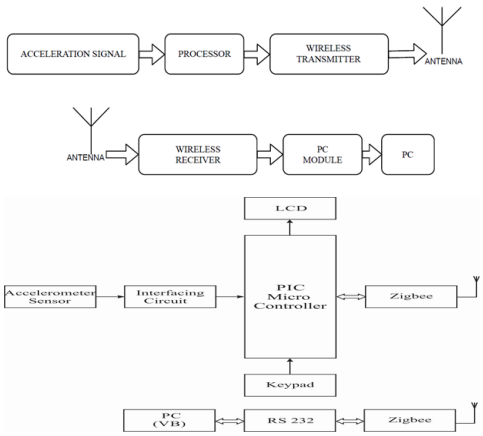
Better usability in VR environment- This prototype offers better usability to the users working in virtual reality environment. Controls to multiple actions can be provided accurately in this system.

Comparison of background related work: Table 01

Year	Author	Title	Methodology	Limitations
2014	Abhik Banerjee, Abhirup Ghosh	Mouse Control using a Web Camera based on Color Detection	Mainly focuses on the use of a Webcam to develop a virtual human computer interaction. Hand gestures were acquired using a camera based on color detection technique.	The operating background should be light and no bright colored objects be present. The system might run slower on certain computers with low computational capabilities.
2013	Ashwini M. Patil, Sneha U. Dudhane, Monika B. Gandhi	Cursor Control System Using Hand Gesture Recognition	Focuses on the development of machine-user interface which implements hand gesture recognition using simple computer vision and multimedia techniques.	Before actual implementing gesture comparison algorithms, skin pixel detection and hand segmentation from stored frames need to be done.
2013	Angel, Neethu. P.S	Real-Time Static and Dynamic Hand gesture recognition.	Design, develop and study a practical framework for real-time gesture recognition that can be used in a variety of human- computer interaction applications.	Unable to work at much complex background and not compatible at different light conditions.
2010	Chen-Chiung Hsieh and Dung-Hua Liou	A Real Time Hand Gesture Recognition System Using Motion History Image.	Focuses on a real time hand gesture recognition system based on adaptive skin color model and motion history image (MHI). A face based adaptive skin color model and a motion history image based hand moving direction detection method were proposed.	Cannot work for recognition of more complicated hand gestures.

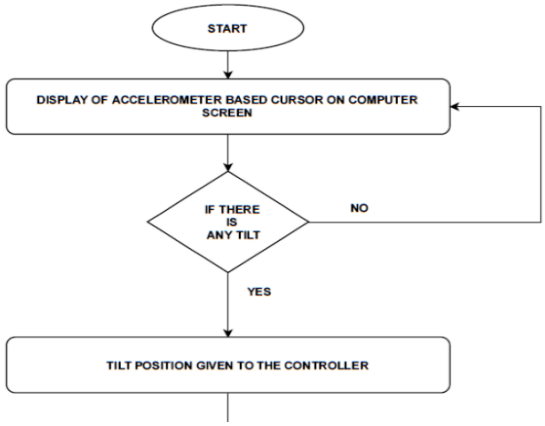
Table: 01

Work flow/process diagram:



This block diagram consists two module transmitting and receiving shown in figure. Here a wireless human computer interface for controlling the computer mouse cursor is developed. Transmitting module divided in different unit, power supply unit, microcontroller unit, LCD (16*2) display unit, accelerometer and transmitting unit and receiving part is an integration of power supply, receiving unit, MAX 232, DB9 connecter.

Flow chart:



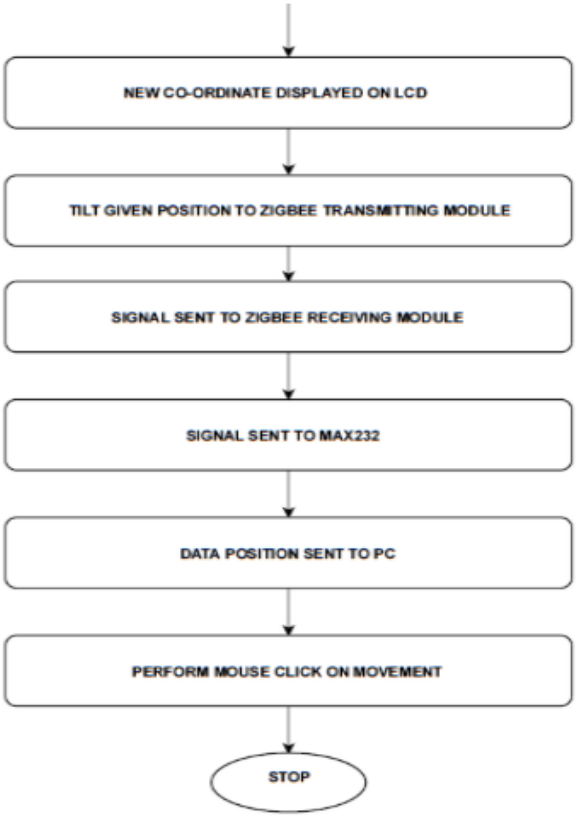


Fig 1: Flowchart to control the gesture control mouse

Working:

This project is an own to the technical advancement. Microcontroller is the heart of the device which handles all the sub devices connected across it and because of their small size and weight, accelerometers are attached to the fingertips and back of the hand. In this model we are using ADXL335 accelerometer, which is 3-axis accelerometer and gives digital output (I2C).As per the objective a portable embedded device is developed consisting of tri-axial accelerometer, PIC16F877A microcontroller and zigbee wireless communication module. Here the accurate hand gestures are recorded as acceleration signals using accelerometer which is connected with controller for analog to digital conversion and further connected with LCD for displaying the co-ordinates along with the transmitter which is used to transmit the wireless signal to the receiver module, so that there would not need to be any wires connection, which limit the range and comfort. In transmitting section accelerometer is used to get the movement of user wrist to move cursor of mouse. The inertial navigation sensors are used to measure the tilt of a platform with respect to earth axis, and then analog output of accelerometer in X, Y plane is applied to controller, which controls the display. The microcontroller is energized by 5V power supply and the LCD is used to display co-ordinate according to which the cursor movement takes place and the transmitting module are used to transmit the signal to receiver module which receives the signal sent by transmitter and then this signal is applied to MAX232.MAX232 is a dual transmitter / dual receiver and is used while interfacing microcontroller with PC to verify the baud rate and changes the voltage level because microcontroller is TTL (Transistor–transistor logic) friendly, whereas PC is CMOS friendly. MAX232 connects the microcontroller and PC through female DB9 pin, and the signal received through the receiver from the transmitting end is transferred to PC through MAX232 serial communication. An executable file should be installed in a PC and the required COM port must be selected & 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. The need of this research work is to show the operation of the mouse in response to movements/sloping/tilting of inertial navigational sensors and also to investigate the possibility of creating a wireless mouse that could be used by anyone, anywhere, without having a solid/flat surface to move it and also without holding mouse in hand. A major drawback in this approach is that the position and orientation information cannot be obtained using an accelerometer but processing of 2-dimensional hand profiles/shapes gives better output and relatively lowers the computational cost. For this reason we are using the hand gestures with analog output of accelerometer in X, Y plane which can operate it wirelessly at a large distance. This can be very comfortable method to control mouse.

Result:

Before testing the users were instructed to practice for few minutes in order to prevent the wrong operation. Three persons were requested to do the defined hand gestures at a distance of 0.5m and the result were shown in terms of direction and co-ordinates of cursor on LCD display.Accelerometer sensor is used to detect the static or dynamic change in position. If there is some tilt then the co-ordinate values from the accelerometer and the cursor position changes in response to that tilt and position of mouse cursor on computer screen changes; i.e left, right, up, down direction.The system is designed to work efficiently and the proposed hand gesture recognition system is tested to demonstrate its feasibility and the experimental results showed the accuracy of 90.83%, as shown in Table III.

User can control the basic functionality of mouse i.e, movement of cursor such as up, down, left, right by using an accelerometer.

Basic Gestures actions. Table :02

Gestures	Mouse Function
UP	Move cursor Up
DOWN	Move cursor Down
LEFT	Move cursor Left
RIGHT	Move cursor Right

Fig 2. Shows the IDE developed using Visual basic for mouse.

We obtained the following results from acceleration sensor which is used to drive the cursor movement in four directions.

DIRECTION	No. Of Trials	Success	Success Rate
UP/FORWARD	30	28	93.33%
DOWN/BACKWARD	30	26	86.67%
LEFT	30	28	93.33%
RIGHT	30	27	90.00%
OVERALL RESULT 90.83%			

Table: 03

Future scope:

The future advancement in this project can be faster signal communication speed, better Sensitivity. The system can be

embedded with voice recognition system and robots, so we can also handle dynamic image processing accordingly. With improvisations in the code, gesture control and mouse movement in 3D environment using z axis, will make it also useful for gaming. This system can be included in wheel chairs of disabled persons for more flexible movements controlwith more precise and accurate change of directions. This can be made into a compact device which can be carried in the form of touch free anywhere and used for any purpose.

Conclusion:

The progress in science & technology is a non-stop process; new things and new technology are being invented. As technology grows day by day, we can imagine about the future. In conclusion, this mechanism of "Gesture based pc control" device was implemented which can control the PC wirelessly. This device can be used in real world for Handicapped, disabled, or limited-mobility users, some people only have the use of one of their hands, or they can't manage the motions necessary for regular PC control. This system can give some computer control backup to people who have lost it. Though it is designed keeping in mind about the need for industry, it can extended for other purposes such as commercial & research applications. Due to the probability of high technology, the system is mostly software controlled with less hardware circuit. This feature makes this system is the base for future systems. The principle of the development of science is that "nothing is impossible". From 'touch' generation, we are moving to 'no touch' generation. It is the generation of intangible interfaces. From computer platform to mobile platform/wired to wireless, gesture control can be implemented everywhere. So we shall look forward to a bright & sophisticated world.

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