PORTABLE WIRELESS HEAD-MOVEMENT CONTROLLED HUMAN-COMPUTER INTERFACE FOR PEOPLE WITH DISABILITIES

PROJECT REFERENCE NO.: 39S_BE_1300

COLLEGE: RAO BAHADUR Y. MAHABALESWARAPPA ENGINEERING COLLEGE, BELLARY
BRANCH: DEPARTMENT OF INSTRUMENTATION TECHNOLOGY
GUIDE: MRS. ASHWINI. K
STUDENTS: MS. AYESHA BEE R
MS. RANJITHA SH
MS. RUQSAR BEGUM
MS. GEETHA PRIYA JP

INTRODUCTION:

Owing to the lack of appropriate input devices, people with disabilities often encounter several obstacles when using computers. Currently, keyboard and mouse are the most common input devices. Due to the increasing popularity of the Microsoft Windows interface, computer mouse has become even added important. Therefore, it is necessary to invent a simple mouse system for people with disabilities to operate their computers. People with spinal cord injuries (SCIs) and who are paralyzed have increasingly applied electronic assistive devices to improve their ability to perform certain essential functions. Electronic equipment, which has been modified to benefit people with disabilities include communication and daily activity devices, and powered wheelchairs.

From our literature analysis there are many computer input devices are available. Finger mounted device using pressure sensors, mouth stick etc. However, for many people the mouth stick method is not accurate and comfortable to use. So we have designed a simple mouse system called “A PORTABLE WIRELESS HEAD MOVEMENT CONTROLLED HCI FOR PEOPLE WITH DISABILITIES”. The ability to operate a computer mouse has become increasingly important to people with disabilities especially as the advancement of technology allows more and more functions to be controlled by computer.

OBJECTIVE:

This project describes about an economical head operated computer mouse for people with disabilities. It focuses on design and development of portable wireless Human-Computer Interface System to create robust (strong) hands free interface for disabled people. The ability to operate a computer mouse has become increasingly important to people with disabilities especially as the advancement of technology allows more and more functions to be controlled by computer. There are many reasons for people with disabilities to operate a computer. For instance, they need to acquire new knowledge and communicate with the outside world through the Internet. In addition, they need to work at home, enjoy leisure activities, and manage many other things, such as home shopping and internet banking.
This research focuses on a tilt sensor controlled computer mouse. A tilt sensor (3 axis accelerometer) is used to detect both lateral and vertical head movements to navigate the mouse cursor position placed on helmet. Clicking of mouse is activated by the user's eye blink movement through a sensor. Voice recognition section is also used to identify the small letters which are pronounced by the paralyzed user. Due to the increasing popularity of the Microsoft Windows interface, i.e., Windows 98 and NT, computer mouse has become even added important. Therefore, it is necessary to invent a simple mouse system for people with disabilities to operate their computers. People with spinal cord injuries (SCIs) and who are paralyzed have increasingly applied electronic assistive devices to improve their ability to perform certain essential functions. This system was invented to assist people with disabilities to live an independent professional life.

**METHODOLOGY:**

The complete system model of our proposed system circuit of computer mouse interface controlled by tilt sensor is composed of six major elements:

1. The Tilt sensor module
2. The voice recognition module
3. Eye brow sensor module
4. The signal processing module
5. Microcontroller module
6. Wireless communication module

The block diagram representation of the tilt sensor controlled computer mouse is shown below:

Fig: 1. The block diagram representation of the tilt sensors-controlled computer mouse interface.
1. TILT SENSOR MODULE:

FUNCTIONAL BLOCK DIAGRAM

![Functional block diagram](image)

THEORY OF OPERATION:

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 g minimum. It contains a polysilicon surface micromachined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator output is amplified and brought off-chip through a 32 k Ω resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

PERFORMANCE:

Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or non-monotonic behavior, and temperature hysteresis is very low (typically less than 3 mg over the −25°C to +70°C temperature range).
AXES OF ACCELERATION SENSITIVITY:

Fig: Axes of Acceleration Sensitivity; Corresponding Output voltage increases When accelerated along the sensitivity axis.

Fig: Output response versus orientation to gravity.
2. VOICE RECOGNITION MODULE:

Voice recognition kit processes in analyzing voice, recognition of process and controlling system functions. Voice recognition system can be composed of external microphone, Keyboard, 64K SRAM and some additional components, an intelligent recognition system can be built by combining the microprocessor. It can recognize maximum of 1.92 sec of word and its response time is less than 300ms. HM 2007 IC is used for voice recognition. Maximum 80 words can be recognized by single chip. When the user enters a voice input through microphone then that voice is send for recognition process there it compares with the stored voice pattern and the resultant signal is send to micro controller for further processing.

Voice recognition module is compact and easy control speaking recognition board. This product is a speaker dependent voice recognition module. It supports up to 80 voice commands in all. Maximum 7 voice commands could work at the same time. Any sound could be trained as command. Users need to train the module first before let it recognizes the voice commands. This board has three controlling ways: serial port(full function), general input pins(part function). General output pins could generate several kinds of waves while corresponding voice command was recognized.

1. VR3- Voice recognition module V3
2. Recognizer- a container where acting voice commands were loaded. It is a core part of voice recognition module.
3. Recognizer index- Maximum 7 voice commands could be supported in the recognizer.
   The recognizer has 7 regions for each voice commands.
4. Train- the process of recording your voice commands.
5. Load- copies the trained voice to the recognizer.
6. Voice command record- the trained voice command store in flash, number from 0 to 79.
7. Signature- text commented for record.
8. Group- help to manage records, each group 7 records.

---

Fig: Recognizer index

On V3, Voice commands are stored in one large group like a library. Any 7 voice commands in the library could be imported into recognizer. It means 7 commands are effective at the same time.

3. EYE BLINK SENSOR MODULE:

WORKING:

1. IR Sensor works on the principle of emitting IR rays and receiving the reflected ray by a receiver (Photo Diode).
2. IR Source (LED) is used in forward bias.
3. IR Receiver (Photodiode) is used in reverse bias.

---

Fig: Working of IR transmitter and reciever
A typical IR sensing circuit is shown below.

![IR sensing circuit diagram](image)

Fig: IR sensing circuit

It consists of an IR LED, a photodiode, a potentiometer, an IC Operational amplifier and an LED.

IR LED emits infrared light. The Photodiode detects the infrared light. An IC Op – Amp is used as a voltage comparator. The potentiometer is used to calibrate the output of the sensor according to the requirement.

When the light emitted by the IR LED is incident on the photodiode after hitting an object, the resistance of the photodiode falls down from a huge value. One of the input of the op – amp is at threshold value set by the potentiometer. The other input to the op-amp is from the photodiode’s series resistor. When the incident radiation is more on the photodiode, the voltage drop across the series resistor will be high. In the IC, both the threshold voltage and the voltage across the series resistor are compared. If the voltage across the resistor series to photodiode is greater than that of the threshold voltage, the output of the IC Op – Amp is high. As the output of the IC is connected to an LED, it lightens up. The threshold voltage can be adjusted by adjusting the potentiometer depending on the environmental conditions.

The positioning of the IR LED and the IR Receiver is an important factor. When the IR LED is held directly in front of the IR receiver, this setup is called Direct Incidence. In this case, almost the entire radiation from the IR LED will fall on the IR receiver. Hence there is a line of sight communication between the infrared transmitter and the receiver. If an object falls in this line, it obstructs the radiation from reaching the receiver either by reflecting the radiation or absorbing the radiation.

4. The Signal-Processing Module:

The signal-processing module, as shown in Fig.1 consists primarily of three components: an amplifier, a low-pass filter, and analog to digital (A/D) converters. In order to
receive a small signal from tilt sensors, a high performance amplifier was employed in this system. A second order low-pass filter of 2 Hz is designed for the system, which can reduce the acceleration effects and remove the noise frequency. The 10-bit A/D converters are used to digitize the signals of the tilt sensor and voice recognition circuitry.

5. Microcontroller module:

The ARM microcontroller is the main controller of the system, as shown in Fig. 1(C). Port0 and Port1 of the microprocessor can receive the digitized signals from the tilt sensor via the signal-processing module. At the same time, Port1 receives the trigger signal from the eye brow sensor to perform the click motions. A parallel-to-serial method is deployed via Port1 to dispatch signals capable of controlling input motion of the computer mouse (COM1). Port1 dispatches all control signals to the operator to confirm that his input motion has been completed.

Lateral and up-and-down motions from user’s head can be detected by the tilt sensors and are fed into the microprocessor for analysis and processing. The microprocessor maps the fed-in signal immediately to its command code as Port 1 receives signal from one AD converter only. It commands the mouse to have the cursor move in vertical or horizontal direction, i.e., up, down, left, right, upper or lower left, upper or lower right. The Port 0 of the microprocessor converts the parallel data into serial data and transmits these data to the computer through a radio-frequency (RF) method. The serial port (COM1) of the computer forwards both the command codes and digitized trigger signals to the computer. A set of desirable controlling parameters may be preset to satisfy the user depending on how familiar the operator is with the system.

6. Wireless Communication Module (Zigbee):

1. The Zigbee Modules were designed to meet the standards of IEEE 802.15.4 and maintain the unique needs of wireless sensor networks to have low cost and low power.
2. The modules need minimal power to provide reliable data delivery between devices.
3. The modules are operated in the 2.4 GHz frequency band and are pin-for-pin compatible. The Modules interface to a host device through a logic-level serial port which is asynchronous.
4. The module can communicate with any logic and voltage compatible UART through its serial port; or a level translator to any serial device.

CONCLUSION:

The main advantage of this project is to eliminate the disability for the handicapped people so that they can enjoy this world as a normal human being are enjoying. Those people can control or operate all the computer application by the gesture of their eye movement and the interactive application are done by their tooth click and also gaming, swapping, page scrolling, etc. are also done using their head movement by placing a MEMS (Micro-Electro Mechanical System). The complete replacement of wired communication It finds the solution to the disabled person to operate the computer fully with the enabled mode.
The HCI (Human Computer Interface) is an evolving area of research interest nowadays. This project aims to be a convenient process for helping out the disabled to operate computers. These systems can also be used in other application like robotics efforts, in process to make the device cost effective and more complex thereby reducing the size. Thus we have developed a real hand free mouse. This project will be very effective and accurate using of both MEMS and eye blink sensors as a wireless mouse for future.

**FUTURE WORK:**

Human Computer Interaction is gaining mass popularity in the present days. This project provides a greater scope for improvement in the near future. Effective control in increasing of writing speed is still one of the sectors to be improved in future. Better methods of transmission and reception channel can also be developed on further experiment. In the future this interface can be introduced into many control systems at home such as powered wheelchairs, telephones, and appliances with great potential demanded by the market.