Accelerometer and Eye Blink Based Mouse Using Micro-Controller

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***Abstract* —This project presents an innovative human computer interaction system that utilizes an accelerometer and eye blink detection for mouse control, implemented on a microcontroller board. The primary objective is to enhance the accessibility and usability of computer interfaces for individuals with limited mobility or disabilities. The methodology involves integrating a sensitive accelerometer to capture hand gestures and movements, enabling users to control the cursor with subtle hand gestures. Additionally, eye blink detection technology is employed to facilitate mouse clicks, providing a comprehensive and intuitive control mechanism. Through rigorous testing and user feedback, the findings reveal a promising and responsive alternative to traditional mouse control, offering a more inclusive solution for users with diverse physical abilities. The system's adaptability and ease of use demonstrate its potential to bridge the accessibility gap in computer interaction. This project contributes to the advancement of assistive technology by presenting a novel approach to mouse control, catering to the needs of individuals with physical limitations. The intended result is a user-friendly and efficient system that empowers users to interact with computers more seamlessly, fostering a more inclusive computing environment. In an era where digital accessibility is paramount, traditional mouse interfaces often pose challenges for individuals with physical disabilities. This project presents an innovative solution by leveraging accelerometers and eye blink detection integrated with a microcontroller board to create an alternative mouse interface.**

I. INTRODUCTION

The convergence of technology and accessibility has become a critical focus in human-computer interaction, particularly in addressing the needs of individuals with limited mobility or disabilities. This project introduces an innovative approach to mouse control through the integration of accelerometers and eye blink detection on a microcontroller board. Rooted in embedded systems, this innovation combines accelerometers for precise hand gestures and eye blink detection for mouse clicks. The project responds to the growing demand for assistive technology, aiming to empower individuals with physical challenges. In the modern era of technology, accessibility and ease of use are paramount considerations in the design and development of human computer interaction systems. Traditional input devices such as mice and keyboards, while effective for many users, may present challenges for individuals with physical disabilities or limitations. As such, there is a pressing need to explore alternative input methods that cater to a diverse range of users, thereby promoting inclusivity and accessibility in computing environments. The motivation behind our project stems from this need for inclusive technology. We aim to develop an innovative input device that harnesses the power of accelerometers and eye blink detection, integrated with a microcontroller board, to create a mouse interface that is not reliant on traditional physical movements or manual dexterity. This approach offers a promising solution for individuals who may have mobility impairments or conditions such as paralysis, muscular dystrophy, or severe motor disabilities. The project aims to enhance accessibility and inclusivity in computing environments by enabling users to control cursor movements and perform mouse functions through natural gestures and eye blinks. Through this innovative approach, it seeks to empower individuals with disabilities to navigate digital interfaces effectively and independently.

II. LITERATURE REVIEW

The An accelerometer is micro electromechanical sensor (MEMS) that measures acceleration. The analog output of the accelerometer sensor is given to three analog inputs of the Arduino board. The inbuilt ADC of the board converts the values to digital and sends the data to the Wireless module through Serial UART port. Accelerometer based Wireless Mouse using Arduino Board is presented in this paper. Accelerometer is used as a motion sensor with two axes of the accelerometer that is the X-axis and Y-axis, which forms a plane of motion, are used to sense the tilt in the specific direction and the mouse cursor is moved accordingly

[1]. In our proposed system accelerometer sensor is used to detect the motion of the gesture. Accelerometer is interfaced to a microcontroller. NODE MCU microcontroller gets the input from the accelerometer sensor. The microcontroller Process the sensor input data and transmits it through a wireless transmitter module. In this paper, Accelerometer based Wireless Mouse using NODE MCU microcontroller is used in this paper. Accelerometer is used as a motion sensor with two axes of the accelerometer is used to sense the tilt in the particular direction and the mouse cursor is moved accordingly.

[2]. MPU6050 sensor module is used in it for detecting the orientation of the sensor to control the cursor position. ESP32 microcontroller development board of 30 pin configuration to interface it with multiple sensors. Another accelerometer sensor that is connected with ESP32 is ADXL335 which give analog reading of voltage proportional to the acceleration in the given direction. GPIO pin 32 and 34 are connected with one axis out pin in both the sensors. The development of an accelerometer-based mouse connected via ESP32 has significant implications for the future of human-computer interaction. This research paper has demonstrated the feasibility and effectiveness of using an accelerometer to control a computer mouse, as well as the benefits of using the ESP32 microcontroller to facilitate wireless communication

[3]. The optical flow sensor used in this work is the ADNS 3080 from Avago Technologies. Using the default lens and the recommended working height defined by the manufacturer as 2.4 mm, the sensor can measure two dimensional displacements with resolutions up to 800 counts per inch (cpi). To achieve the goal of this work, both the default optics and the illumination source have been replaced in order to increase the capturing area and working distance. There are several well-known pupil detection algorithms in the literature. One of the most widely used during the years is the integrodifferential operator proposed by Daug man which is extensively applied for pupil localization in iris recognition applications. A new implementation of an inexpensive eye-controlled human-computer interface device using an optical mouse sensor is presented. The device takes advantage of the image acquisition capabilities of the ADNS 3080 low-cost optical mouse sensor, originally designed to operate as a displacement sensor, for pupil detection and tracking.

[4]. BCI system focuses on aspects of extracting EOG signals. An EOG measuring device will be used to record the eye-movements from the subjects. A signal acquisition system is used to collect EOG signals from the devices and the processed signals are transmitted to personal devices with the aid of Bluetooth devices. Thereby, HCI computations are carried out. Classification algorithms are applied for eye-movement detections, and the output is represented by a graphical user interface. It is evident from the HCI Baseball game that the classification can be utilized in everyday life. Usability and simplicity of the classification is made efficient due to online computation. The performance accuracy of the system has been improved by scaling down the measurement to fit a tablet. The proposed method has established that by utilizing eight eye-directional movement the accuracy and performance of the accelerometer and eye blink system can be increased.

[5]. The literature survey reveals a trend in developing innovative human-computer interaction methods, such as accelerometer-based wireless mice and optical sensors for eye-controlled pointing devices. Existing works demonstrate successful integration of accelerometers with Arduino and NODE MCU microcontrollers for gesture-based cursor control. Additionally, recent advancements leverage MPU6050 and ADXL335 sensors interfaced with ESP32 for baseless and wireless mouse systems. Furthermore, eye-controlled pointing devices utilizing optical flow sensors and electrooculography (EOG) signals exhibit potential for enhancing accessibility. This synthesis underscores the need for our project, emphasizing the evolving landscape of sensor-based interfaces for improved user interaction and accessibility in computing.

III.METHODOLOG

The block diagram represents a system that allows users to control a computer's mouse cursor and clicking using an accelerometer sensor for cursor movement detection and a camera for eye blink gesture detection as click inputs. The key components are an accelerometer sensor, camera, microcontroller board (ATMEGA324) for processing sensor data and a PC/Laptop as the target device. The microcontroller board interfaces with the sensors, processes the data, and communicates the appropriate commands to the PC/Laptop via USB connection for controlling the mouse functionality.

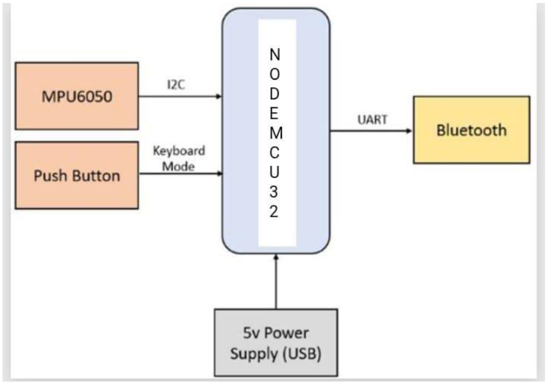


Fig 1. AEBM Transmitter Block diagram

This system enables users to control a computer's mouse cursor using hand movements detected by an accelerometer, and perform mouse clicks using eye blink gestures captured by a camera, all processed and communicated through a microcontroller board connected to the PC/Laptop via USB.

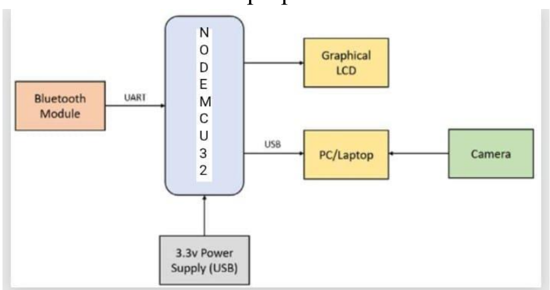


Fig 2. AEBM Receiver Block diagram

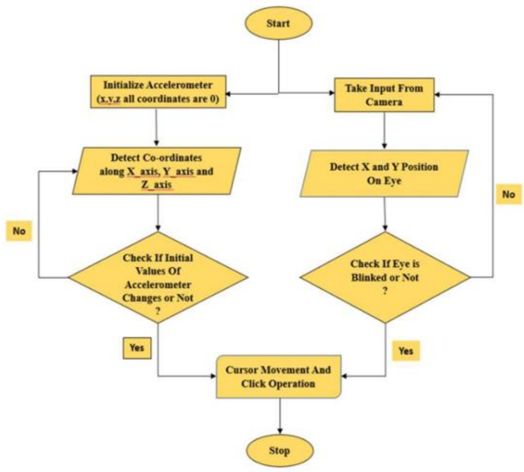
Functions of Blocks:

1) Sensors Input: • Accelerometer (MPU6050): Captures hand gestures and movements, providing analog output. • Detects linear acceleration along X, Y, and Z axes. • Measures angular rotation rates (gyroscope). • Eye Blink Detection Sensor: Detects eye blinks, generating signals indicating user commands. • Infrared LED and photodiode pair to detect eye blink • Analog output signal representing eye blink occurrence

2) Microcontroller Board: • Microcontroller (ESP32): Receives analog signals from the accelerometer and eye blink detection sensor. • Processes sensor data and executes control algorithms • Communicates with the computer via USB • Analog-to-Digital Converter (ADC): Converts analog signals into digital data for processing. • Quantizes analog sensor values into digital representation • Enables digital signal processing on the microcontroller

3) Data Processing: • Gesture Recognition Algorithm: Processes digital accelerometer data to interpret hand gestures and determine cursor movement. • Filters and processes accelerometer data to remove noise • Implements pattern recognition to identify specific gestures • Eye Blink Detection Algorithm: Analyzes signals to identify eye blinks and translates them into mouse clicks or specific commands. • Thresholding and signal processing techniques to detect blinks • Mapping of blink patterns to different mouse actions

4) PC/Laptop:



The initialize Accelerometer: The first step is to initialize the accelerometer, which likely means setting it up and calibrating it to establish a baseline for what a stationary position looks like.

• Detect Coordinates: Detect coordinates along the X, Y, and Z axis. This is the data coming from the accelerometer. The program detects the current values of the accelerometer along the three axes.

• Take Input from Camera: Take input from the camera and the program takes input from a camera, likely for eye blink detection.

• Detect X and Y Position On Eye: The program processes the camera input to detect the position of the eye along the X and Y coordinates.

• Check Initial Values of Accelerometer: Check if the initial values of the accelerometer have changed. This is likely referring to the data from step 2. If the values haven't changed from initialization, it means the accelerometer hasn't moved, so the process jumps down to step3.

• Check If Eye is Blinked or Not: Here, checks if the eye has blinked or not by using presumably the camera input from step 2. If there is no eye blink detected, the process jumps back up to step 2.

• If both conditions (accelerometer values changed and eye blinked) are met, it performs "Cursor Movement And Click Operation," which likely means moving the mouse cursor based on accelerometer data and performing a click operation based on the eye blink detection.

• Stop: This step stops the process.

1.Software Required:

- Arduino: A Software (IDE) is also known as the Arduino Integrated Development Environment. It includes a text editor for writing code, a message box, a text console, a toolbar with buttons for frequently used tasks, and other menus. In order to upload and interact with programs, it establishes a connection with the Arduino hardware.

- EasyEDA: EasyEDA is a cloud-based electronic design automation (EDA) software that provides a comprehensive suite of tools for designing and simulating electronic circuits. It is a web-based platform that allows users to access their projects from anywhere, without the need for installing software on their local machines.

- PyCharm: PyCharm is an integrated development environment (IDE) specifically designed for Python programming language. It is developed by JetBrains, a company known for its high-quality IDEs for various programming languages. PyCharm is widely used by Python developers, both professionals and beginners, due to its comprehensive features and tools that streamline the development process.

2. Hardware specifications:

MPU-6050 Sensor: The MPU-6050 is a popular inertial measurement unit (IMU) that combines a 3 axis accelerometer and a 3-axis gyroscope on a single chip. It is widely used in various applications, including robotics, drones, motion tracking, and human-computer interfaces. The MPU-6050 is manufactured by Sense.

• Voltage Regulator (LM7805): The LM7805 is a widely used linear voltage regulator IC that provides a stable 5-volt output voltage. It accepts input voltages up to 35 volts and can deliver output currents of up to 1.5 amps. With a typical dropout voltage of 2 volts, it efficiently regulates higher input voltages down to the desired 5-volt level. The LM7805 includes built-in thermal shutdown and short-circuit protection features, enhancing its reliability and safety in various electronic circuits. It has a wide range of applications requiring a regulated 5-volt power supply, such as powering microcontrollers, sensors, and other low power electronic devices.

Bluetooth HC-05: The HC-05 supports two work modes: Command and Data mode. The work mode of the HC-05 can be switched by the onboard push button. The HC-05 is put in Command mode if the push button is activated. In Command mode, user can change the system parameters (e.g. pin code, baud rate, etc) using host controller itself of a PC running terminal software using a serial to TTL converter. Any changes made to system parameters will be retained even after power is removed. Power cycle the HC-05 will set it back to Data Mode. Transparent UART data transfer with a connected remote device occurs only while in Data Mode.

Microcontroller: NodeMCU

The NodeMCU is a popular development board based on the ESP32 32-bit microcontroller, widely used in IoT and embedded applications. Developed by Espress if Systems, the ESP8266 integrates a powerful processor with built-in Wi-Fi connectivity, making it ideal for wireless communication projects.

Testing strategies & Test Procedures:

Microcontroller and Sensor Connectivity: Ensure that the MPU6050 sensor is correctly connected to the ATmega32U4 microcontroller. Check the power supply, ground, and communication (I2C) pins for proper wiring.

• Power Supply: Verify that the power supply to the microcontroller and sensor is within the recommended voltage range and provides sufficient Current. Field testing: Conducting field tests in real underwater environments to validate the performance of the Wi Fi system under actual operating conditions.

- Accelerometer Data: Connect the microcontroller to a serial monitor or a debugging interface, and check if the raw accelerometer data from the MPU6050 sensor is being received correctly.
- OpenCV Installation: Ensure that OpenCV is correctly installed and configured in your PyCharm environment. Test a simple OpenCV program to capture and display video from your webcam Methodology.
- Eye Blink Detection: Test the eye blink detection algorithm on sample images or video recordings with known eye blink instances. Adjust the algorithm parameters and thresholds as needed to improve accuracy.
- Mouse Movement Integration: Implement a simple test program that maps the accelerometer data to mouse cursor movement on your computer screen. Verify that the cursor responds correctly to the sensor data.
- Click Integration: Integrate the eye blink detection algorithm with the mouse movement code. Test if the mouse click functionality works as expected when an eye blink is detected.

VI. CONCLUSION AND FUTURE STUDIES

The accelerometer and eye blink-based mouse project successfully demonstrates the integration of motion sensing and computer vision technologies to create an innovative and intuitive input device. By leveraging the NODE MCU microcontroller, the MPU6050 accelerometer sensor, and the OpenCV library for eye blink detection, this project offers a hands-free solution for controlling a computer mouse cursor. Throughout the development process, various challenges were encountered and overcome, including hardware integration, sensor calibration, and algorithm optimization. Extensive testing and troubleshooting efforts were undertaken to ensure the system's reliability, accuracy, and responsiveness. The project's potential applications extend beyond traditional mouse control, offering opportunities in fields such as accessibility, virtual and augmented reality, gaming, multimedia control, and industrial environments. By providing an alternative input method, this project can empower individuals with disabilities, enhance user experiences, and promote inclusivity in technology. The project's portability and mobility also contribute to its versatility and potential for widespread adoption. While the current implementation demonstrates the project's feasibility and functionality, there are opportunities for further improvement and expansion. Future enhancements could include refining the eye blink detection algorithm for increased accuracy, exploring additional sensor fusion techniques for more precise cursor control, and incorporating advanced features such as gesture recognition or voice commands.

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