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**NBA Accreditation for B.Tech. CE, EEE, ME, ECE, CSE, EIE, IT Programmes**
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## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Estd. 1995

## SEVEN HABITS OF SUCCESSFUL PEOPLE

- **Be Proactive**
- **Begin with the End in Mind**
- **Put First Things First**
- **Think Win-Win**
- **Seek first to understand, Then to be Understood**
- **Synergize**
- **Sharpen the Saw**

We have followed the above Seven habits during the course of our project work.

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# ASSISTIVE DEVICE BASED CURSOR CONTROL WITH HUMAN COMPUTER INTERACTION

**A PROJECT WORK SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF**

**BACHELOR OF TECHNOLOGY**
**IN**
**ELECTRONICS & COMMUNICATION ENGINEERING**
**UNDER THE SUPERVISION OF**

**Dr NARRA DHANALAKSHMI**
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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

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Estd. 1995

## CERTIFICATE

This is to certify that the Project Report entitled "**HEAD MOVEMENT BASED CURSOR CONTROL WITH HUMAN COMPUTER INTERACTION**" that is being submitted by **Adithya Phani Thota (21071A0490)**, **Paramjoth Singh (21071A04B1), and Pattem Guru Mahesh (21071A04B2)** in partial fulfillment for the award of **Bachelor of Technology in Electronics & Communication Engineering** of the VNR VJIET, Hyderabad during the academic year **2024-2025** is a record of bonafide work carried out by them under my guidance and supervision.

Certified further that to the best of my knowledge, the work presented in this thesis has not been submitted to any other University or Institute for the award of any Degree or Diploma.

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| **Associate Professor** | **Professor and Head** |
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## DECLARATION

We do declare that the Minor Report entitled "**HEAD MOVEMENT BASED CURSOR CONTROL WITH HUMAN COMPUTER INTERACTION**" submitted to the department of Electronics and Communication Engineering (ECE), Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology, Hyderabad, in partial fulfillment of the requirement for the award of the degree of **Bachelor of Technology in Electronics & Communication Engineering** is a bonafide record of our work carried out under the supervision of **Dr Narra Dhanalakshmi,** Associate Professor, VNRVJIET.

Also, we declare that the matter embodied in this thesis has not been submitted by me in full or in any part thereof for the award of any degree/diploma of any other institution or university previously.

**Place :** Hyderabad **Date:** 12-12-2024

**ADITHYA PHANI THOTA** **PARAMJOTH SINGH** **PATTEM GURU MAHESH**

## ACKNOWLEDGEMENT

We are thankful to the Principal **Dr .C.D.NAIDU**, VNRVJIET, Hyderabad, for giving me permission to carry out this project.

Our sincere thanks to **Dr Lam Padma Sree**, Professor and Head of the Department, ECE, VNR VJIET for her esteemed guidance and encouragement provided during the course of my project.

We would like to express our sincere thanks to **Dr Narra Dhanalakshmi**, Associate Professor, VNR VJIET for her precious guidance and kind co-operation at every step of this project work.

We are thankful to all the staff members of the ECE department, VNR VJIET for helping us during this project.

We are thankful to all the project committee members of the ECE department, VNR VJIET for helping us during this project.

Finally, we are very thankful to our family members and friends for their great moral support.

**ADITHYA PHANI THOTA**

**PARAMJOTH SINGH**

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# ABSTRACT

This report discusses the use of assistive technologies for individuals with physical disabilities to control personal computers or laptops. It focuses on the design and implementation of a head mouse, an innovative assistive technology aimed at enhancing accessibility and independence for such individuals. The system utilizes a microcontroller combined with a gyroscope to create a cost-effective solution. Its core functionality involves translating head movements into cursor movements, enabling users to control devices without conventional input methods. The system also integrates connectivity features, providing flexibility for use in various environments. Furthermore, it incorporates a lithium battery charging mechanism (03962A) to ensure sustained and reliable power, enhancing its portability.

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# LIST OF FIGURES

# CHAPTER -1: INTRODUCTION

## 1.1 Accessibility and Technological Innovation:

In the modern era, everyday life heavily depends on technology from professional tasks and entertainment to communication and education. However, because mainstream software and devices often lack inclusive design, this technological world frequently remains inaccessible to individuals with physical limitations. Accessibility is not merely a matter of convenience it is a fundamental right that ensures equal opportunities for all, regardless of physical impairments.

**The Impact of Innovation in Technology on Accessibility**

Technological innovation holds the potential to break down barriers and foster a more inclusive society. Assistive technologies such as speech recognition software, screen readers, and adaptive hardware have already improved the quality of life for many individuals with disabilities. The demand for solutions that are not only functional but also seamless, user-friendly, and versatile enough to address the needs of a diverse range of users is growing rapidly.

According to the World Health Organization (WHO), 16% of the global population is affected by some form of disability. This underscores the importance of developing technologies that cater to a broader audience. Moreover, as technology becomes increasingly integral to education, employment, and leisure prioritizing accessibility is essential to ensure that individuals with disabilities are not left behind in the rapidly evolving digital age.

**Fig 1.1 Virtual Aid of Head-controlled Mouse Device**

The **Fig 1.1** illustrates a virtual head-controlled mouse system, where a user interacts with the computer screen through simulated head movements.

## 1.2 Privacy-Centric Design:

In an era where technology alters every aspect of daily life, privacy has become a top concern for users of all backgrounds. This concern is particularly significant for individuals with disabilities who rely on assistive technology. Many existing solutions, such as camera-based tracking systems, unintentionally compromise user privacy, highlighting the need for alternatives that prioritize the protection of personal data.

**Problems with Current Camera-Based Approaches**

**1.Risks to Data Security**

Camera-based systems often collect and transmit video data, making them vulnerable to security breaches or unauthorized access.

**2. User Discomfort**

The constant use of cameras for tracking can make users feel monitored, leading to discomfort and reluctance to use the device.

**User Adoption and Trust:**Privacy concerns represent one of the biggest barriers to adopting new technologies. According to a Pew Research Center survey, 81% of Americans believe they have little control over the information collected about them online. The design of the head mouse addresses these concerns by prioritizing user privacy, thereby fostering trust and encouraging broader adoption of the technology.

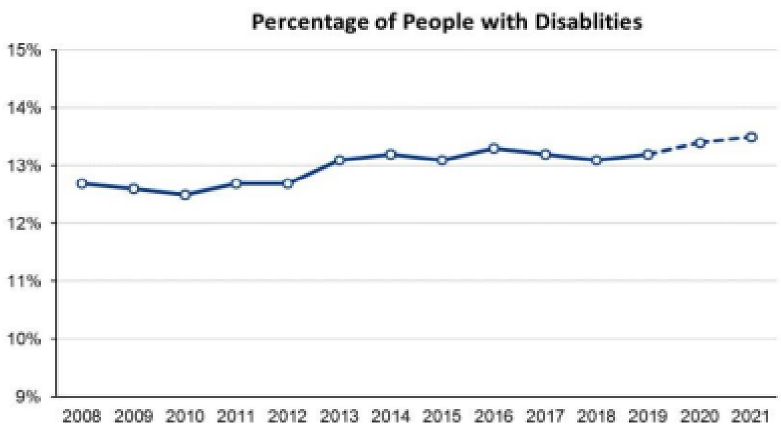


**Fig 1.2 Year-Wise graph of people with disabilities**

The **Fig 1.2** shows the percentage of people with disabilities from 2008 to 2021. It indicates a gradual increase,reaching approximately 13.5% by 2021. This upward trend suggests a growing recognition or reporting of disabilities over the years.

## 1.3 Problem Statement:

When it comes to using technology, which is becoming more essential to daily life, work, and education, people with physical impairments encounter several obstacles. These difficulties may lead to less freedom, reduced engagement, and fewer opportunities for both professional and personal development. Even while current assistive technology makes an effort to solve these problems, many of them rely on camera-based solutions which not only jeopardize user privacy but may also have trouble detecting accurately in different lighting conditions. Furthermore, their utility in a variety of situations is limited by their incompatibility with various devices including PCs, tablets, and mobile platforms. The need for creative, inclusive solutions is further highlighted by the growing incidence of diseases like arthritis which now impacts over 24% of American adults. To overcome these obstacles, a generally compatible and privacy-conscious approach is needed.

## 1.4 Objective:

To create a head-controlled mouse that offers a user-friendly, inclusive, and accessible way for those with physical limitations to engage with technology, the following are the main goals:

**Universal Compatibility:** Ensure the device easily connects with several platforms, such as PCs, Macs, and tablets, to accommodate the wide range of technological environments.

**Adaptability and Inclusivity:** Develop a solution that supports equitable access to opportunities while meeting the needs of individuals in professional, recreational, and educational settings.

**Meeting Particular Needs:** Assist individuals with conditions like arthritis and other impairments in overcoming obstacles related to their work and digital interactions.

**Encouragement of Digital Learning:** Enhance the accessibility of digital learning materials, allowing students with disabilities to fully engage in online courses and learning activities.

# CHAPTER -2: RESEARCH BACKGROUND

## 2.1 Literature

In the context of assistive technology, the examined literature emphasizes the crucial elements of privacy, compatibility, accessibility, inclusion, and education. This provides a thorough foundation for understanding the importance and challenges involved in creating novel solutions, such as a head-controlled mouse.

**Assistive Technology and Accessibility**

**Book:**

Assistive Technologies: Principles and Practice by Albert M. Cook and Janice Miller

This resource emphasizes the principles of designing assistive technologies that address the unique needs of individuals with disabilities. It underlines the importance of usability reliability.

**Inference:** Assistive technologies must focus on user-centric design to enhance accessibility.

**Device Compatibility and Market Trends**

**Article:** Cross-Device Compatibility: Challenges and Opportunities by Y. Zhang et al.

This article explores the technical and practical challenges of ensuring cross-device compatibility in a rapidly evolving technological ecosystem. It highlights the importance of that seamlessly integrate with diverse platforms to meet the demands of a dynamic market.

**Inference:** Assistive devices must prioritize universal compatibility to remain relevant and accessible across different platforms such as PCs, Macs, and tablets, addressing the varied need of users.

# CHAPTER -3: IMPLEMENTATION

## 3.1 Sensors:

**Arduino Pro Micro:**

This microcontroller board is compatible with Arduino. It runs at 16 MHz and 5 V and is based on the ATmega32u4. It may be powered by an external power source or a Micro-USB connection, and it features 4 analog connectors, 12 digital I/O pins, and 5 PWM pins.


**Fig 2.1 Arduino Pro Micro**

The **Fig 2.1** depicts an Arduino Pro Micro board, a compact microcontroller development board. It features built-in USB support, multiple I/O pins, and compatibility with the Arduino IDE, making it ideal for compact and USB-based projects.

**Micro Electro-Mechanical Systems (MEMS) module MPU6050 Gyroscope:**

This device has a 3-axis accelerometer and A three-axis gyroscope. In addition to other motion-related metrics, it can monitor acceleration, velocity, orientation.

The MPU6050 is a 6-axis motion tracking device that includes an on-chip temperature sensor, digital motion processor, 3-axis gyroscope, and 3-axis accelerometer. It has four full scale configurable ranges for measuring angular rotation. Gyroscopic range: 16 bits, ±250, ±500, ±1000, and ±2000 °/s. For communication with the microcontrollers, the MPU6050 features an I2C bus interface.


**Fig 2.2 Gyroscope MPU6050**

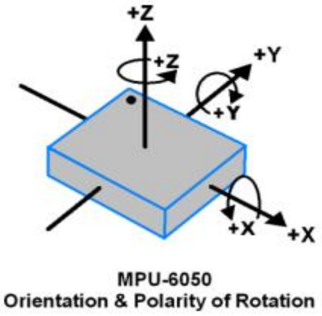


**Fig 2.3 Orientation and Polarity**

The **Fig 2.2** shows the MPU6050 sensor module, which integrates a gyroscope and accelerometer for motion sensing. It features pins for power, communication SDA and SCL.

The **Fig 2.3** the orientation and polarity of rotation for the MPU6050 sensor. It shows the positive axes (+X, +Y, +Z) and the corresponding rotational directions around each axis.

**Lithium battery charger module(03962A):**

Lithium batteries may be charged effectively with the 03962A lithium battery charger module. It can handle a maximum charging current of 1000 mA and runs on a 5V input voltage.The module has safeguards such over-current protection set at 3A and battery overcharge prevention with a threshold voltage of 2.5V.The module's input interface makes use of a Micro USB connection, making it compatible with common Micro USB connections.The features of this module make it appropriate for a number of uses where a dependable and regulated lithium battery charging procedure is crucial.


**Fig 2.4 Lithium battery charger module(03962A)**

The **Fig 2.4** depicts the 03962A lithium battery charger module, which features a micro-USB input and terminals for battery connection (B+, B-) and output (OUT+, OUT-). It is designed for efficient charging and protection of lithium batteries.

## 3.2 Circuit Design and Approach:

Circuit design and approach is explained in a systematic and structured way through following points.

**A. Arduino Micro with MPU-6050 Pro**

• Attach the Arduino Pro Micro's 5V to the MPU-6050's VCC.

• Attach the Arduino Pro Micro's GND to the MPU-6050's GND.

• Attach the Arduino Pro Micro's SDA to A4.

• Attach the Arduino Pro Micro's SCL to A5.

**B. Module for Charging:**

• Attach a suitable power supply to the charging module's input.

• Attach the output of the charging module to the VIN pin of the Arduino Pro Micro.

• Use the Arduino IDE to write code that will track the battery level.

• For precise voltage measurements, use the Arduino "BatteryStatus" library.

• To avoid overcharging and extend battery life, set up a charging management algorithm.

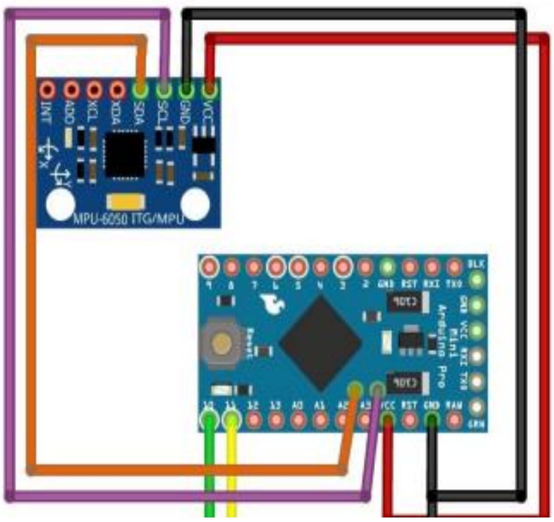


**Fig 2.5 Circuit diagram**

The **Fig 2.5** demonstrates the connection of an MPU-6050 accelerometer and gyroscope module to an Arduino Pro, with appropriate power (VCC, GND) and data lines (SCL, SDA) for communication. The setup enables data acquisition from the sensor for motion and orientation analysis.

**C. Sensor Data Acquisition:**

• Program the Arduino Pro Micro using the Arduino IDE.

• Write code to access the MPU-6050 sensor's data.

• For precise motion detection, process and filter sensor data.

**D. Head Mouse Algorithm:**

• Apply an algorithm to analyze sensor data while taking calibration, speed, and sensitivity into account.

**E. Integration of Charging Modules:**

• To avoid overcharging, create a battery monitoring system.

• Use code to control the charging procedure.

**F. Testing and Calibration:**

• To guarantee precise and responsive mouse control, carry out comprehensive testing.

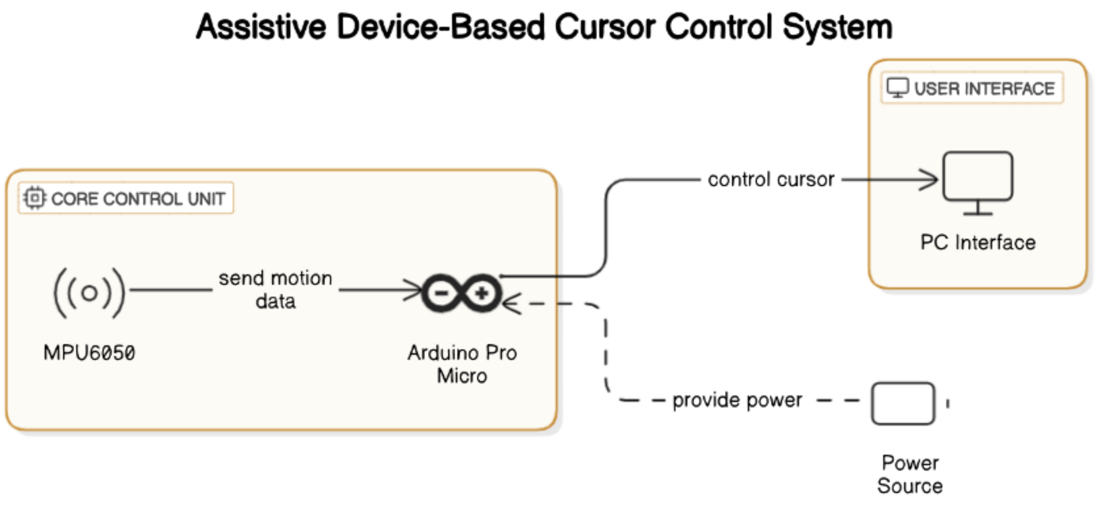


**Fig 2.6 Block diagram**

This **Fig 2.6** illustrates an assistive device-based cursor control system where motion data from the MPU6050 sensor is processed by an Arduino Pro Micro to control the cursor on a PC interface. The system is powered by an external power source**.**

## 3.3 Flow chart:

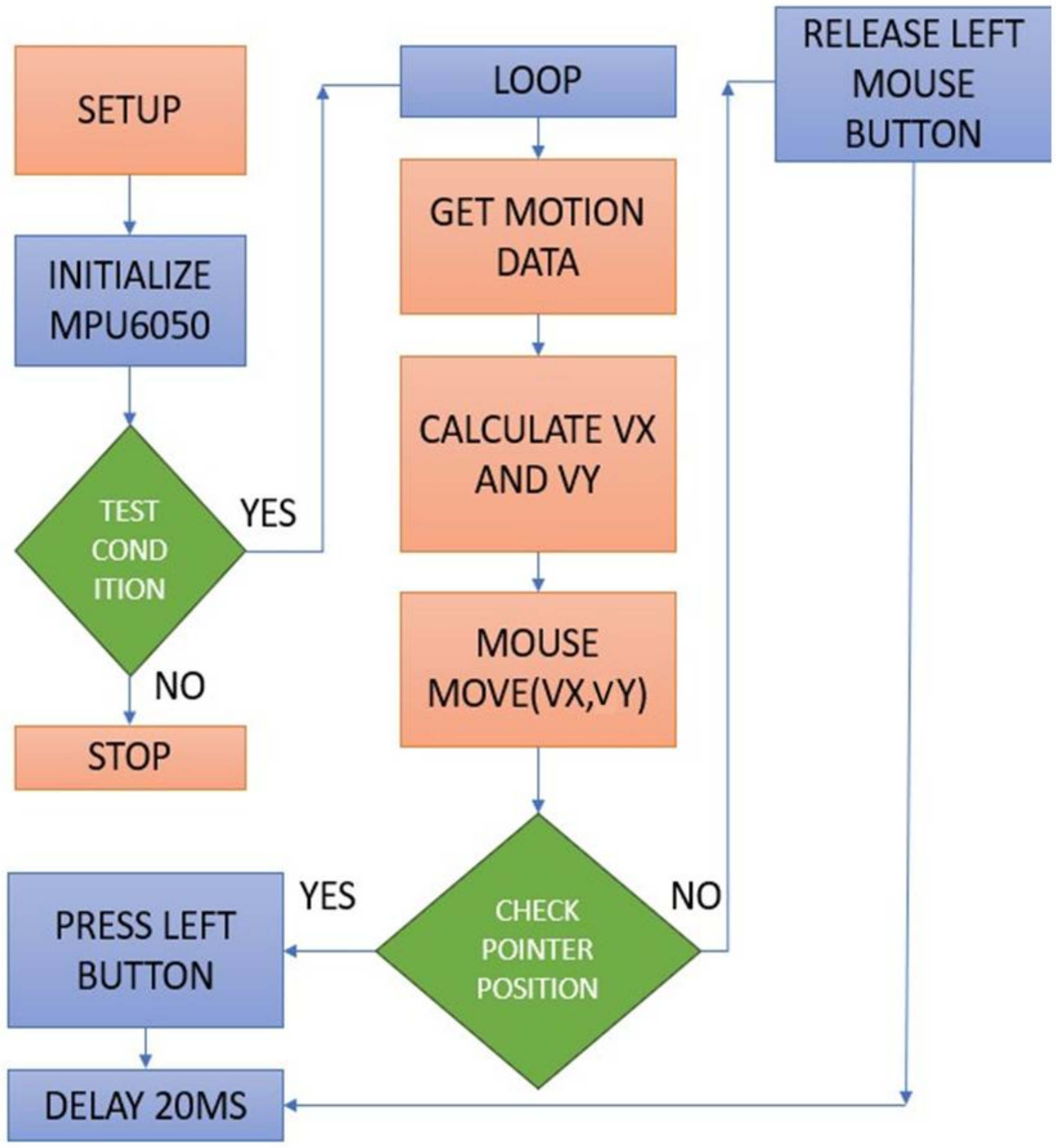


**Fig 2.7 Flow Chart**

The **Fig 2.7** outlines the operational logic of a cursor control system, beginning with MPU6050 initialization and motion data acquisition. It calculates movement vectors (Vx, Vy), updates the cursor position, and handles left-click actions based on pointer conditions, iterating every 20 milliseconds.

# CHAPTER -4 : RESULTS

The head mouse system accomplishes its goals as intended and has been successfully put into service. The technology emphasizes usability and user experience by demonstrating precise and responsive cursor control through rigorous testing and calibration. Individuals with physical limitations are empowered in both work and leisure settings due to the integration of cutting-edge sensor technology and networking.

The thorough process ensures the system's reliability and effectiveness, aligning with the global focus on inclusion and the growing demand for technological proficiency in the workforce. The innovative approach presented in this study significantly enhances accessibility and freedom for individuals with physical limitations, meeting efficiency standards and resulting in an improved user experience overall.

## 4.1Demonstration Steps:

**1.Initialization:**

- Power on the device.
- Connect that to a laptop or computer.

**2. Head Movement for Left/Right Cursor Action:**

- Slightly tilt your head in your desired direction.
- The gyroscope detects the tilt and sends signals to the microcontroller.
- The microcontroller processes the input and transmits the command to the computer.

**3. Observe the Cursor:**

- The cursor on the screen should move to the direction in response to the head tilt.
- Repeat the motion to demonstrate smooth and responsive movement.

## 4.2 Demonstration the movement of cursor to the left:

**Fig 2.8 Cursor on top left**

This **Fig 2.8** showcases a practical demonstration of an assistive cursor control system, where head movements control the on-screen cursor, achieved through the MPU6050 sensor and Arduino interface. The cursor is observed in the top-left corner of the display.

## 4.2 Demonstration the movement of cursor to the right:

**Fig 2.9 Cursor on top right**

This **Fig 2.9** illustrates the assistive cursor control system in action, where head movements guide the cursor to the top-right corner of the screen, enabled by the MPU6050 sensor and Arduino-based processing.

# CHAPTER -5 : CONCLUSION

## 5.1 Conclusion:

In summary, a significant advancement in improving accessibility and independence for individuals with physical limitations has been achieved with the creation and use of the head mouse. By effectively addressing the crucial need for hands-free interaction with electronic devices, this research supports the global movement to increase technology inclusivity. The combination of cutting-edge sensor technologies, particularly the Arduino Pro Micro and MPU6050 gyroscope module, produces an easy-to-use and cost-effective solution.

The system’s core feature—converting head movements into cursor control—provides a smooth and user-friendly way to navigate computers and devices without relying on traditional input methods. By utilizing accelerometers and gyroscopes instead of cameras, the approach also prioritizes privacy, aligning with the legitimate concerns highlighted by the Pew Research Center. The focus on universal compatibility across different devices ensures the technology’s flexibility in the evolving technological landscape, as evidenced by the anticipated growth in the global tablet market.

The system’s portability is further enhanced by the inclusion of a lithium battery charging mechanism, which ensures consistent and reliable power. For individuals with physical disabilities, this feature, along with the compact size, contributes to greater convenience and independence. The comprehensive approach, covering head mouse algorithm integration, circuit design, sensor data collection, and testing, guarantees the system's reliability and effectiveness. According to the results, the head mouse effectively meets usability, responsiveness, and power efficiency requirements, significantly enhancing the overall user experience.

## 5.2 Future Scope:

The future trajectory of head mouse technology envisions substantial advancements that go beyond its current capabilities. The potential avenues for future research extend beyond simple refinement, aiming to explore novel applications that could profoundly improve the quality of life for individuals facing mobility impairments. As this technology evolves, continued interdisciplinary collaboration will be increasingly essential. By fostering partnerships across diverse fields—ranging from engineering to healthcare—we can leverage collective intelligence to drive the development of innovative solutions.

Moreover, a steadfast commitment to user-centered design principles will be key. Understanding the unique needs and preferences of users with mobility impairments will not only result in more effective devices but also promote a sense of inclusivity and empowerment. In essence, the future of head mouse technology depends on a holistic approach that combines technological innovation, collaborative efforts, and a deep dedication to enhancing the lives of those who stand to benefit the most.

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