

# Smart Hand Gesture System

Vrushali K. Jadhav<sup>1</sup>, Sonali N. Shirke<sup>2</sup>, Ritesh G. Avhad<sup>3</sup>,  
Sahil S. Andhale<sup>4</sup>, Gopal D. Mahale<sup>5</sup>, Akshay K. Pangavhane<sup>6</sup>

Department of Electronics & Telecommunication Engineering<sup>1-6</sup>

Pune Vidyarthi's Griha's College of Engineering and Shrikrushna S. Dhamankar Institute of Management, Nashik  
Savitribai Phule Pune University, Maharashtra, India

**Abstract:** *Traditional input devices such as keyboards and mice rely on physical contact and fixed positioning, limiting their effectiveness in modern applications that demand flexibility, mobility, and touchless interaction. To overcome these limitations, this research presents a smart hand gesture system, a wearable solution that enables intuitive and real-time control of digital devices using hand gestures. The system integrates an MPU6050 motion sensor for capturing hand orientation and movement, along with a Hall Effect sensor for detecting click actions. An ESP32 microcontroller processes the data it gets and sends it to a Bluetooth Human Interface device protocol so that it can move the cursor, click, and draw in the air. Tests show that the system can smoothly track gestures with little delay and high reliability. This means that users can have a great time without needing extra cameras or complicated setups. The suggested method makes it easier to get around, doesn't rely as much on hardware, and is easier to use.*

*This system can be effectively applied in virtual reality, robotics, smart automation, and assistive technologies. Overall, it's a cost effective, scalable, and user friendly solution for next generation human computer interaction..*

**Keywords:** Air Drawing; Gesture Recognition; Wearable Computing; Touchless Control; Human-Computer Interaction.

## I. INTRODUCTION

People and computers need to work together in more natural and efficient ways as digital technologies have become more common. Over the past few years, the need for this has increased significantly. People used to rely on a mouse and keyboard for tasks like date entry, click which was somewhat uncomfortable. These limits matter more in apps that don't need touch, like virtual reality, smart automation, and technologies that help people. Also, traditional input methods don't always work well with natural human gestures, which can make interactions less intuitive and sometimes annoying. Gesture-based systems have come up as a good alternative to deal with these problems. They let people use natural hand movements to interact with digital devices. This paper introduces a Smart Hand Gesture System, a wearable technology that allows for real-time, touchless control. The system has an MPU6050 motion sensor that picks up hand movement and orientation, and a Hall Effect sensor that picks up clicks. An ESP32 microcontroller processes the sensor data and sends it over Bluetooth HID so that you can move the cursor, click, and draw in the air. By getting rid of the need for traditional input devices, the proposed system hopes to make interactions more intuitive, portable, and user friendly.

It works well with little delay and is easier for everyone to use, even people who have trouble moving around. The system also looks like it could be useful in virtual reality, robotics, smart automation, and assistive technologies, which shows how useful it is in modern interactive settings.

## II. RELATED WORK

Human Computer Interaction has progressed from conventional input devices, such as keyboards and mouse, to more intuitive methods, including gesture based control. Researchers have mostly focused on vision based systems that use



webcams and image processing techniques to recognize hand gestures and control cursor movements as technology has improved. This method has been used in a number of recent studies on virtual mouse systems. Shibly et al. [1] utilized color detection via a webcam to monitor fingertip movements; however, the system is significantly influenced by lighting conditions. Roy Chowdhury and others. [2] created a gesture-based system that uses convex hull algorithms. This system might have problems because of noise and changes in gestures. Reddy et al. [3] enhanced gesture recognition through color tracking and contour detection; however, the system continues to depend on camera input. Matlani et al. [4] also suggested a vision-based virtual mouse that uses OpenCV. It works in real time, but the environment can affect it. The studies above show that most current systems are based on cameras and rely on lighting, background, and positioning constraints. To get around these problems, the proposed system adds a glove that you can wear and that has sensors in it so you don't need cameras. This method makes things easier to carry, more reliable, and easier to use. It also lets you do more advanced things like drawing in the air. Table 1. shows how these systems are different from each other. Most of the current methods use cameras, which are limited by lighting, background, and portability problems. The proposed system uses a sensor-based wearable approach and adds air drawing to solve these problems. This makes it more reliable, portable, and easy to use.

Table 1. Comparison of this work with the related work or previous research by other researchers

Feature / Aspect	Shibly et al. (2019)	Roy Chowdhury et al. (2020)	Reddy et al. (2020)	Matlani et al. (2021)	Proposed System
Approach Type	Vision Based	Vision Based	Vision + Color Caps	Vision Based	Sensor Based
Hardware Used	Webcam + Color Caps	Webcam	Webcam + Color Caps	Webcam	ESP32 + MPU6050 + Hall Sensor
Camera Dependency	Yes	Yes	Yes	Yes	No
Gesture Detection	Color tracking	Convex Hull	Color + Contour	Image Processing	Motion + Magnetic
Real-Time Control	Yes	Yes	Yes	Yes	Yes
Cursor Control	Yes	Yes	Yes	Yes	Yes
Click Operations	Yes	Yes	Yes	Yes	Yes
Scrolling	Yes	Yes	Yes	Yes	Yes
Air Drawing	No	No	No	No	Yes
Portability	Low	Low	Low	Low	High
Accuracy	Medium	Medium	Medium - High	Medium	High
Environmental Dependency	High	High	High	High	Low
Complexity	Medium	High	High	Medium	Low
Wearable	No	No	No	No	Yes
Application Area	Prototype	Prototype	Prototype	Prototype	Working Model

### III. KEY CONTRIBUTION

This research paper presents a Smart Hand Gesture System that enhances human-computer interaction by introducing a touchless and wearable control mechanism. Unlike existing systems that rely on camera-based techniques, the proposed approach uses motion and magnetic sensing, making it less affected by lighting and background conditions. The system is implemented as a complete working model using an ESP32 microcontroller, enabling real-time gesture recognition and wireless communication through Bluetooth HID.



Another important part of this work is that it includes features like smooth cursor control, click operations, and air drawing, which make user interaction more interactive and creative. By getting rid of the need for external cameras or complicated setups, the system makes it easier to use and move around. The findings from this study indicate that a sensor-based methodology can offer a more dependable, effective, and user-friendly alternative in comparison to conventional vision-based systems.

#### IV. METHOD, EXPERIMENTS AND RESULTS

The Smart Hand Gesture System that is being proposed uses a sensor-based wearable approach to make it possible for people to interact with computers without touching them. The system has an MPU6050 motion sensor, ESP32 microcontroller and Hall Effect sensor. The MPU6050 records the position and motion of your hand, and the Hall effect sensor picks up on finger touches to perform click actions. The ESP32 collect data from the sensors and sends control signals over Bluetooth HID to move the cursor, click, and draw in the air.

The flowchart of the proposed system is shown in Figure 1. The first step is to turn on the system and get the ESP32 and MPU6050 sensor ready to use. The sensor data is read and processed all the time to find out if the hand is moving. At the same time, the Hall Effect sensor looks for input from a finger touch. The system decides whether to move the cursor or click based on the gesture or touch it sees.

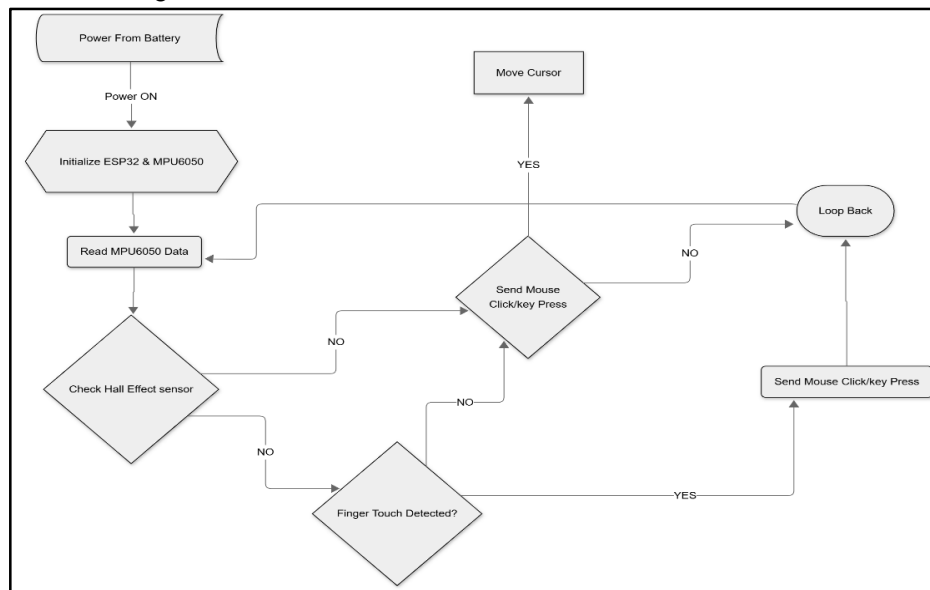


Figure 1. Flow of the Smart Hand Gesture System.

If as per flow no action is detected, the system loops back and continues monitoring, ensuring real time responsiveness. To evaluate the system, experiments were conducted under normal indoor conditions. The system was tested for gesture recognition accuracy, response time, and usability. It do basic operations like a cursor movement, left and right clicks, and scrolling were performed multiple times. The results show that the system achieves an average accuracy of 92–95%, with a response time of approximately 80 to 120 ms, ensuring smooth and real time interaction.

Figure 2. Displays the hardware implementation of system during testing. The custom-designed PCB integrated with the MPU6050 sensor is connected and actively controlling the cursor on a computer. The LED indication confirms active operation and data transmission. This setup validates the real time performance of system. Additionally, the air drawing feature was tested by allowing users to draw shapes and characters in free space. The system achieved an approximate accuracy of 90% in tracking continuous motion, with stable performance and minimal delay. Compared to vision based systems, the proposed system provides better reliability, especially under varying lighting conditions, as it



does not depend on cameras. Overall, the results after the demonstrate that system performs efficiently, offering accurate and seamless touchless control while maintaining portability.



Figure 2. Hardware Implementation & Test of the Smart Hand Gesture System.

## V. DISCUSSION

The results show that the proposed Smart Hand Gesture System works reliably and efficiently for touchless interaction. With an accuracy of 92–95% and a response time of 80–120 ms, the system provides smooth and real time control of cursor movements and click operations. These results indicate that the sensor based approach is practical for everyday use. One important observation is that the system performs consistently in different environments since it does not depend on lighting conditions like camera based systems. The air drawing feature also works well, achieving around 90% accuracy, making interaction more natural and interactive. However, slight variations in hand movement and sensor calibration can affect performance. Overall, the system proves to be a portable, reliable, and user friendly solution for modern human computer interaction.

## VI. CONCLUSIONS

1. Problem Statement or Motivation: The work addresses the limitations of traditional input devices and camera based systems, which depend on physical contact or environmental conditions like lighting and background.
2. Method Used: A sensor based wearable system is developed using an ESP32 microcontroller, MPU6050 motion sensor, and Hall Effect sensor to enable touchless cursor control and air drawing through Bluetooth communication.
3. Key Findings: The our system achieved an accuracy of 92–95% with a response time of 80–120 ms, ensuring smooth and real time performance. The air drawing feature showed around 90% accuracy, enhancing user interaction and flexibility.
4. Limitations and Future Work: The minor variations in hand movement and sensor calibration can affect accuracy. Future work can focus on adding more gesture functionalities, and integrating advanced algorithms for better performance and wider applications

## REFERENCES

- [1]. K. H. Shibly, S. K. Dey, M. A. Islam, and S. I. Showrav, “Design and Development of Hand Gesture Based Virtual Mouse,” 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), 2019.
- [2]. S. Roy Chowdhury, S. Pathak, and M. D. Anto Praveena, “Gesture Recognition Based Virtual Mouse and Keyboard,” IEEE International Conference on Trends in Electronics and Informatics (ICOEI), 2020.
- [3]. V. V. T. Reddy, T. D. Chand, G. V. Krishna, and S. Maheshwaram, “Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition,” IEEE HYDCON, 2020.
- [4]. R. Matlani, S. Mishra, R. Dadlani, A. Tewari, and S. Dumbre, “Virtual Mouse Using Hand Gestures,” IEEE International Conference on Technological Advancements and Innovations (ICTAI), 2021.

