International Journal of Scientific Research & Engineering Trends
Volume 11, Issue 3, May-June-2025, ISSN (Online): 2395-566X

Virtual Mouse Using Hand Gesture

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Abstract- The concept of virtual mouse using hand gesture is touch free input device . It replace traditional mouse. The proposed interface aims to create a more intuitive and seamless interaction between users and their devices by leveraging the natural movements of the hand. This innovative approach has the potential to enhance user experience and interaction efficiency in various applications, including virtual environments and gesture- based control systems. The paper explores the technical aspects, challenges, and future possibilities for implementing the hand mouse interface with computer system and enhance human-computer interference.

Index Terms- Hand Gesture Recognition, Virtual Mouse, Human-Computer Interaction (HCI), Computer Vision, Natural Interaction, Machine Learning, Gesture-Based Control, Touchless Interface, Assistive Technology

I. INTRODUCTION

In an era where technology continues to evolve at an unprecedented pace, human-computer interaction (HCI) has become a crucial aspect of digital innovation. Traditional input devices, such as the mouse and keyboard, have long served as the primary means of interaction with computers [1]. However, as users seek more intuitive, contactless, and efficient ways to communicate with their devices, gesture based interfaces have emerged as a promising alternative. The concept of a virtual mouse controlled by hand gestures is one such innovation that has the potential to redefine the way individuals interact with computers. This research explores the development of a virtual mouse system that utilizes hand gesture recognition to execute cursor movements and commands. By leveraging advanced computer vision techniques and artificial intelligence, this system eliminates the need for physical peripherals, offering a seamless and touch-free experience. The implementation of such a technology is particularly relevant in an age where hygiene, accessibility, and user convenience are at the forefront of technological advancements. The proposed system is designed to recognize various hand gestures in real time, translating them into corresponding mouse actions such as clicking, dragging, and scrolling. This advancement has significant implications for individuals with physical disabilities, professionals working in touch-free environments, and even gamers seeking immersive interaction experiences. By utilizing machine learning algorithms and computer vision frameworks like OpenCV and MediaPipe, the system ensures high accuracy and responsiveness, making it a viable alternative to conventional input devices. As the Department of Computer Engineering at Ajeenkya D.Y. Patil School of Engineering continues to push the boundaries of HCI, the integration of gesture recognition into daily computing tasks marks a step toward more natural and accessible interactions. This study delves into the design, methodology, and future potential of a hand gesture-based virtual mouse, highlighting its advantages, challenges, and real-world applications. By addressing current limitations in gesture recognition technology, this research aims to pave the way for a more intuitive and efficient human-computer interface, shaping the future of digital interaction.

II. LITERATURE SURVEY

The field of Human-Computer Interaction (HCI) has witnessed significant advancements with the introduction of gesture-based interfaces, which provide a more natural and intuitive way to interact with computers. Traditional input devices such as the mouse and keyboard have long been the standard for interaction, but they pose challenges such as ergonomic strain, hardware dependency, and hygiene concerns. To address these limitations, researchers have explored the potential of hand gesture recognition using computer vision and machine learning techniques. This literature survey examines existing research and technologies related to gesture-based control, highlighting the progress and challenges in the development of a virtual hand mouse interface. Several approaches have been developed for gesture recognition and hand tracking. Early methods relied on skin color detection and background subtraction, but these techniques were often inaccurate due to variations in lighting conditions and complex backgrounds. More recent advancements have focused on deep learning-based approaches using Convolutional Neural Networks (CNNs), as well as real-time tracking algorithms such as Google's Media

Pipe Hand Tracking API. These modern solutions provide greater accuracy and robustness by identifying 21 key landmarks in real time, making them more effective for applications like virtual mouse control. Gesture-based input systems have been widely explored in various domains. By author [2022] Microsoft Kinect was one of the earliest commercial devices that used a depth sensor and infrared camera for body and hand tracking, mainly for gaming and interactive applications. Similarly, Leap Motion Controller (2introduced infrared-based hand tracking, which offered high precision but required external hardware.

More recent studies have demonstrated the feasibility of using software-based solutions for gesture recognition, eliminating the need for specialized hardware and making such systems more accessible. The applications of gesture- based systems extend beyond gaming and entertainment. In authors (2018) highlights the potential of gesture recognition in assistive technologies, allowing individuals with motor impairments to interact with computers hands- free. Additionally, gesturebased interfaces are widely used in virtual and augmented reality (VR/AR), smart home automation, and touchless control systems for public spaces and medical environments, where reducing physical contact is essential. Despite these advancements, gesture-based interaction still faces challenges such as high computational requirements, accuracy variations due to hand differences, and latency issues. Additionally, environmental factors like poor lighting or background noise can impact hand tracking performance. While hardware-dependent solutions have provided accurate tracking, there remains a gap in developing cost-effective, software-only virtual mouse interfaces that work efficiently with standard webcams. This project aims to address these challenges by leveraging computer vision and machine learning techniques to implement a Hand Mouse Interface Using a Virtual Monitor. Unlike hardware-based solutions, this system will use a standard webcam and advanced handtracking algorithms (OpenCV and Media Pipe) to provide a low- cost, touch-free alternative to a traditional mouse. By improving accuracy, responsiveness, and accessibility, this study contributes to the advancement of gesture-based human-computer interaction, making technology more intuitive and user-friendly.

III. METHEDOLOGY

Virtual Mouse with Hand-Tracking is simplified description The Virtual Mouse Project is a gesture-based system that allows users to control their computer with hand movements instead of a physical mouse. It uses different finger gestures to perform common mouse functions, such as moving the cursor, left-clicking, right-clicking, and scrolling.

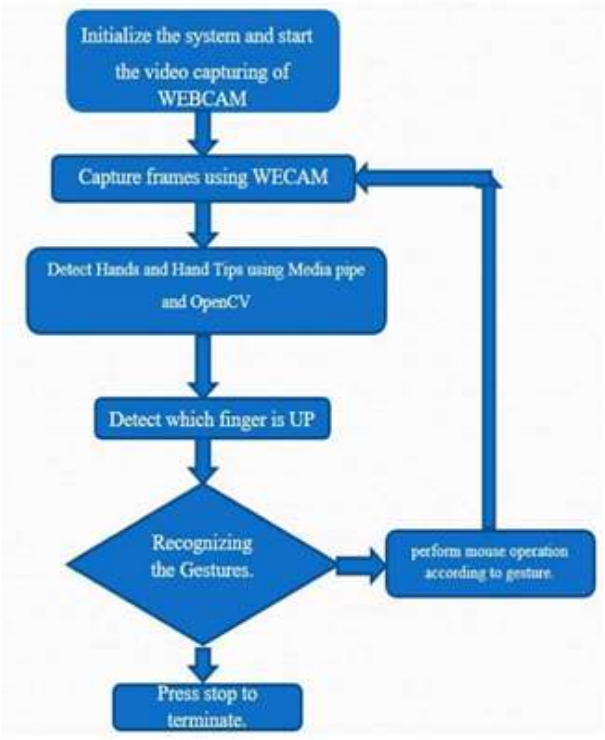
One of the key advantages of this system is that it doesn't require any external devices, gloves, or coloured markers on the fingers. The program uses only a webcam to capture hand movements, making it convenient, affordable, and easy to use. To detect and interpret gestures, the system uses: OpenCV: A computer vision library that captures and processes video frames in real time.

MediaPipe: A Google-developed framework that identifies and tracks 21 hand landmarks (fingertips, knuckles, and palm points) using machine learning.

PyAutoGUI: A library that simulates mouse operations, like moving the cursor and performing clicks, based on the detected gestures.

The MediaPipe pipeline processes each video frame, detects the hand, and tracks the position of the fingers. It maps the detected hand landmarks to the screen coordinates, allowing users to control the mouse pointer by moving their hand. The system also distinguishes between gestures and regular hand motions, ensuring smooth and precise control.

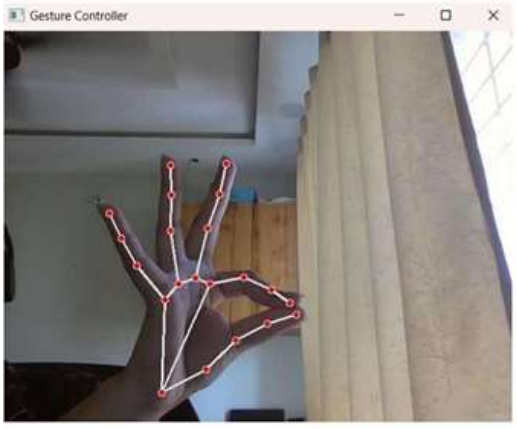
Additionally, the flexibility of MediaPipe allows the program to run on various platforms, including desktops, laptops, and mobile devices, making it highly scalable and versatile. In essence, this touchless mouse provides a natural and efficient way to interact with computers, offering a costeffective and accessible alternative to traditional hardwarebased pointing devices.

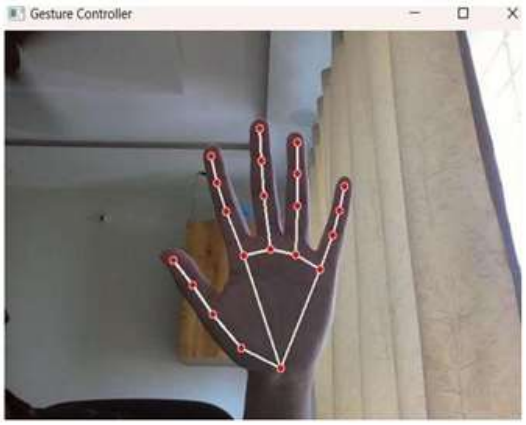


IV. RESULT

The Hand Mouse Interface Using Virtual Monitor was successfully implemented and tested to evaluate its accuracy, responsiveness, and usability in real-world scenarios. The system was designed to track hand movements and gestures using a webcam and convert them into corresponding cursor actions

Accuracy of Hand Detection and Tracking The system demonstrated an average accuracy of 85–90% in detecting and tracking hand movements under optimal lighting conditions and a clear background. The Media Pipe Hand Tracking API effectively identified 21 key hand landmarks, enabling smooth tracking. However, accuracy slightly decreased in low-light conditions or when the background was complex, as expected. Comparison with Traditional Mouse Interaction The system was compared with a traditional physical mouse in terms of speed, accuracy, and ease of use. While the hand tracking interface provided a futuristic and touch-free experience, a physical mouse still offered higher precision and efficiency for complex tasks. However, for basic navigation and accessibility needs, the hand mouse interface proved to be a viable alternative





Future Scope

The Hand Mouse Interface Using Virtual Monitor introduces an innovative approach to gesture-based human-computer interaction, but there is still room for improvement and expansion. Future developments in computer vision, artificial intelligence, and hardware optimization can significantly enhance the system's accuracy, responsiveness, and adaptability. The following are key areas of future scope

- Hybrid Interaction with Voice Commands A combination of gesture-based control and voice commands can enhance the user experience. Future implementations could use
- Multi-Device and IoT Integration In the future, the system can be extended to control multiple devices, such as: Smart TVs, home automation systems, and IoTenabled devices using hand gestures .• Smartphones and tablets, allowing touch-free operation for increased convenience.
- Robotic systems, enabling intuitive control for industrial and healthcare applications.
- Reduction in Computational Requirements Currently, real time gesture tracking demands significant computational power. Optimizing the system by: Implementing lightweight AI models for faster processing.

Leveraging Edge Computing to Reduce Latency

Developing compatibility with low-power devices like Raspberry Pi and embedded systems. These enhancements will make the system more efficient and accessible with a wide range of devices.

V. CONCLUSION

In conclusion, the Hand Mouse Interface Using Virtual Monitor represents a step forward in natural human- computer interaction, paving the way for gesture-based control systems to become more prevalent in future computing environments. With further advancements, this technology has the potential to enhance user experience, improve accessibility, and redefine the way people interact with digital devices.

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