Virtual Mouse Using Hand Gestures

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Abstract- *The development of human-computer interaction (HCI) technologies has led to innovative approaches for controlling devices without traditional input peripherals.*

This research paper presents the design and implementation of a virtual mouse system that utilizes hand gestures for cursor control and click operations. Leveraging computer vision techniques, specifically OpenCV and MediaPipe, the system captures real-time hand movements from a standard webcam and translates them into mouse actions such as movement, left-click, right-click, and scrolling.

The proposed solution is cost-effective, accessible, and does not require specialized hardware, making it suitable for a wide range of users, including those with physical disabilities. Experimental results demonstrate the system's accuracy, responsiveness, and usability in various lighting and background conditions. This work contributes to the advancement of gesture-based HCI and offers a practical alternative for hands-free computer navigation.

I. INTRODUCTION

The rapid advancement of artificial intelligence and computer vision has paved the way for innovative touchless input devices, with the virtual mouse using hand gestures emerging as a promising solution. This technology allows users to control computer cursors and execute mouse functions through intuitive hand movements detected by webcams, thereby eliminating the need for physical mouse hardware. By employing algorithms and frameworks such as OpenCV and MediaPipe, the system captures and interprets hand landmarks in real time, translating specific gestures into mouse commands.

This approach enhances accessibility, hygiene, and user convenience across various environments, including public spaces, medical applications, and remote interactions. The growing interest in gesture-based controls underscores the importance of developing robust, accurate, and responsive systems to facilitate seamless human-computer communication.

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II. IDENTIFY,RESEARCHANDCOLLECT IDEA

Paper Title	Paper concept
Gesture Controlled Virtual Mouse using Artificial Intelligence. (2023)	Human computer interaction, Gestures recognition, Touch-free Control.
Hand Gestures Recognition for Virtual Mouse control using Media pipe in A.I. (2024)	Adaptive Gestures Mapping, Gestures interpreted using Auto-py Python library, Media-pipe framework for real-time recognition.
Virtual Mouse using Hand Gestures. (2022)	The system converts real-time video into frames, detects and tracks gestures and performs actions, Aim is to provide touch-free natural interaction to computers.

III. WRITEDOWNYOURSTUDIESAND FINDINGS

Analyze The collection of research papers all revolve around the core concept of implementing a virtual mouse system controlled by hand gestures, leveraging advances in AI, computer vision, and machine learning to enhance Human-Computer Interaction (HCI).

Gesture Recognition and Computer Vision Techniques

The primary technical approach across these studies is the use of vision-based hand gesture recognition via webcams or cameras. Tools like OpenCV provide image processing capabilities to detect and track hand movement in real-time. MediaPipe, a framework optimized for hand and pose detection, is central to a few papers, allowing landmark identification on the hand to distinguish gestures accurately. Others use Convolutional Neural Networks (CNN) to classify gestures from video input, improving robustness against environmental variations like lighting and background

Mapping Gestures to Mouse Functions

The systems convert recognized gestures into mouse control commands such as moving the cursor, left/right click, double click, scroll, and even controlling volume or brightness. This parallels how a traditional mouse operates but achieves it without any physical device, offering touch-free interaction that can minimize repetitive strain injuries like Carpal Tunnel Syndrome

Benefits and Applications

These virtual mouse systems provide substantial advantages, particularly for accessibility. Physically challenged individuals benefit from alternative input methods that do not require hand dexterity or contact with a physical device. Moreover, in health-conscious environments such as during pandemics, touch-free interfaces help reduce contamination risk. Real-time feedback and learning algorithms in some models further personalize interaction, enhancing usability over time

Writing the review

User authentication is still heavily reliant on the use of passwords, and the security problems associated with passwords are becoming more and more serious.The main causes of these problems are the prevalence of password sniffing and the difficulty of password management due to the increased number of accessible systems. In this paper, we propose a personal password management system called "One Touch Logon", which replaces the annoying password-based authentication systems with a simple touch-and-login method. The effectiveness of the proposed system is demonstrated by implementing it on widely-used legacy systems such as Microsoft Windows and Web site logons. This mechanism is easy to implement and integrate with current password-based systems through the use of an inexpensive consumer electronic device allowing for fingerprint recognition.

Moreover, eliminating the burden of memorizing multiple passwords enables the user to choose hard-to-guess passwords and further increases the utilization of Internet services while improving their accessibility.

IV. SCOPE AND OBJECTIVE

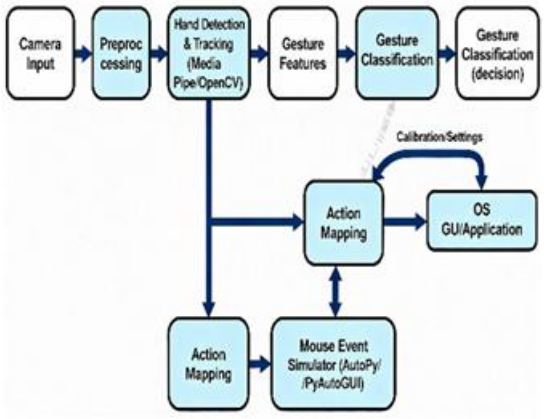
Developing a vision-based computer mouse control system using hand gestures captured via webcam. It focuses on human-computer interaction (HCI) by substituting traditional mouse hardware with intuitive hand gesture recognition using image processing techniques.. It provides facility to share multimedia message more than one social networking sites using single touch. It alerts the all specific contacts by message along with location when the user is in danger.

- Easy to operate:
  The system should be easy operating by any user.

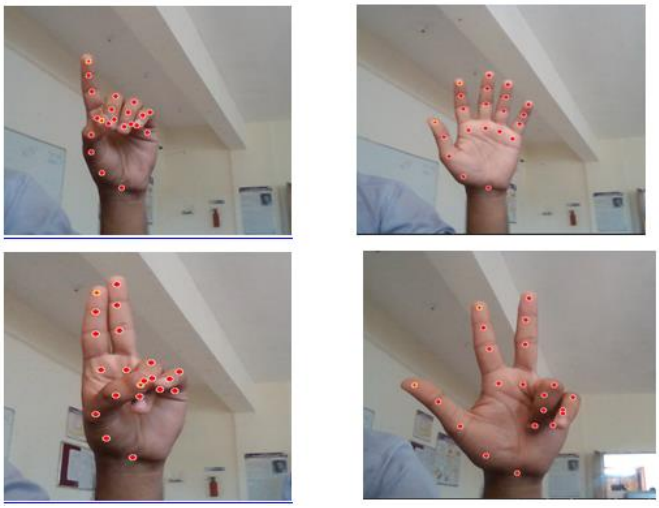
- User friendly:
  The GUI is very attractive and simple which will interest to user to use it.

- No external hardware:
  It is used to remove traditional mouse and replace it with virtual mouse.

V. METHODOLOGY USED



VI. OUTPUTS



VII. CONCLUSION

As in this paper we offered by considering the study demonstrates that a camera-based, touchlesvirtual mouse using MediaPipe/OpenCV for hand tracking and AutoPy/PyAutoGUI for event simulation delivers intuitive, real-time cursor control and core mouse functions such as move, click, drag, and scroll, thereby improving accessibility and hygiene while reducing reliance on physical peripherals. Across implementations, the pipeline of frame capture, landmark detection, gesture mapping, and OS-level event emission proves feasible on commodity hardware and adaptable to varied environments, indicating strong potential for mainstream HCI use cases including education, AR/VR, and assistive technology

However, limitations persist in challenging lighting, occlusions, fine-grained right-click precision, and drag smoothness, with performance dependent on camera quality and compute constraints; these issues invite targetedenhancements in preprocessing, robustness, and adaptive calibration. Future work should incorporate richer gesture sets, two-hand interaction, learned classifiers, and personalization via adaptive mapping, alongside security and privacy safeguards, to elevate accuracy, responsiveness, and user trust in real-world deployments.

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