A Survey on Gesture Controlled Virtual Mouse and Voice Assistant

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Abstract

With continued growth in digital interaction into all areas of everyday activity, the need for more user friendly, hygienic, and convenient user interfaces is increasing. Conventional input methods like the mouse and keyboard, though ubiquitous, are limiting in some situations—especially for physically disabled users or in settings where physical contact is avoided, such as hospitals or self service terminals. This project solves these issues through the creation of a gesture-based virtual mouse system that is based entirely on computer vision to detect human hand gestures and translate them into regular mouse movements. The system uses real-time webcam video input and advanced frameworks like MediaPipe for hand landmark detection and OpenCV for frame analysis and gesture detection. The system uses these technologies to detect individual hand movements, finger position, and movement and associates these with cursor control, left and right clicks, scrolling, and dragging. The solution has also been made to be as hardware-independent as possible, making it simple to deploy across various platforms without specialized sensors or devices. Our main goal is to improve human-computer interaction by providing a contact less, low-cost substitute for conventional pointing devices and enhancing accessibility for movement-impaired users. Promising accuracy and speed are observed, proving the practicality of gesture-based control as a practical input method in current computing systems.

Keywords -Virtual Mouse, Hand Gesture Recognition, Computer Vision, Human-Computer Interaction (HCI), OpenCV, MediaPipe, TensorFlow, Touch less Human Interface, Real-Time Gesture Tracking, Voice-Enabled Interaction, Camera-Based Control.

Introduction

Over the last few years, the discipline of human-computer interaction (HCI) has evolved dramatically, with emphasis on creating natural and unobtrusive means of user interaction with digital systems. While time-tested devices such as the keyboard and the mouse remain reliable, they are sometimes restrictive or awkward under particular conditions. For example, users with physical disabilities might have difficulty handling these devices. Moreover, the universal pandemic has increased vigilance regarding hygiene and the demand for touch less interaction, especially in public or shared spaces.To meet these changing requirements, developers and researchers are looking at different kinds of input methods that are based on gestures, voice recognition, and facial expressions. Among them gesture-based control systems have attracted a lot of attention because they are intuitive and technologically usable. These systems enable users to control computers through hand gestures, recorded by ordinary webcams and decoded with computer vision and machine learning algorithms.This project

introduces the design and implementation of a gesture-operated virtual mouse, a system that allows users to execute typical mouse actions—such as cursor movement, clicking, dragging, and scrolling—using pre-defined hand movements. Two significant open-source

libraries are used by the system: MediaPipe for high accurate hand tracking through the identification and analysis of major landmarks on the hand, and OpenCV for managing tasks involved in real-time video processing and image manipulation.By avoiding the necessity of physical input hardware, this system provides a cost-saving, hygienic, and accessible touchless solution for engaging with digital devices. The design also takes cross platform compatibility into account, thus being applicable to a variety of devices ranging from desktops and laptops to possibly portable systems.

Literature Review

Aditya Bansal et al. (2023): This paper presents a gesture-controlled virtual mouse system that uses MediaPipe for hand tracking, OpenCV for image processing, and PyAutoGUI to convert gestures into mouse actions (cursor movement, clicks, dragging). Achieving 90% accuracy, it offers a contact less,accessible alternative to traditional mice, particularly beneficial for users with mobility restrictions. While the system performs well in real-time, challenges like cursor jitter and click precision remain. Future improvements aim to enhance stability and expand functionalities, such as integrating virtual keyboards, advancing human-computer interaction.

Akash Singh et al. (2023): This paper presents a real-time virtual mouse system that uses hand gestures captured via a webcam to control computer functions without physical hardware. Leveraging OpenCVfor image processing, MediaPipe for hand tracking, and PyAutoGUI for action mapping, the system translates specific finger movements into cursor navigation, left/right clicks, and dragging. Designed for accessibility and contact less interaction, it benefits users with mobility limitations and public environments like ATMs. While effective, its performance depends on lighting conditions and camera quality. The work demonstrates the potential of vision-based gesture control as an intuitive human-computer interface.

Gayatri Jagnade et al. (2023): This paper presents a hand gesture based virtual mouse system using OpenCV and MediaPipe, enabling contact less computer control through finger movements, eye blinks, and mouth gestures. The system maps specific gestures—like index finger motion for cursor movement, thumb-middle finger proximity for left-click, and yellow object detection for scrolling— while also incorporating voice feedback and virtual keyboard functionality. Designed for accessibility, it aids users with disabilities and reduces physical contact, particularly useful in post-pandemic scenarios.

Dr. Rajesh N Phursule et al. (2023): This paper presents a vision based virtual mouse and gesture-controlled keyboard system that uses facial landmarks to control cursor movement and eye blinks for click events, alongside hand gestures (tracked with OpenCV and MediaPipe) to operate a virtual keyboard via finger pinching. Designed for accessibility and contactless interaction, the system eliminates physical peripherals, leveraging only a webcam and Python-based algorithms. While effective for users with disabilities, its accuracy depends on lighting and user movements. Future enhancements include regional language support and smart TV integration.

Shashwat Srivastava et al. (2023): This paper presents a gesture-based virtual mouse system that uses OpenCV and skin detection techniques to track hand movements and perform mouse functions (cursor control, left/right clicks) via finger count recognition. Implemented in C++ with Raspberry Pi hardware, the system operates

device-free but requires optimal lighting conditions for accuracy. While effective indoors, its performance declines in low-light environments. Future improvements could integrate machine learning for enhanced gesture recognition.

N. R. Sathish Kumary et al. (2024): This paper presents a hand gesture-based virtual mouse system that leverages OpenCV and MediaPipe to enable touchless computer control through realtime hand tracking. The system captures hand movements via a webcam, interprets specific gestures (like finger positions and distances) to perform mouse functions (cursor movement, left/right clicks, scrolling), and operates without physical hardware. Designed for accessibility and hygienic interaction, it addresses challenges like environmental lighting and gesture precision while demonstrating practical applications for users with disabilities and public interfaces.

Yash Gajanan Pame et al. (2023)**:** This paper introduces a CNN-based hand gesture recognition system for virtual mouse control, addressing the common issue of cursor displacement caused by abrupt hand movements. Using MediaPipe and OpenCV, the system tracks hand coordinates to calculate pointer movement based on relative distance rather than absolute position, ensuring smoother navigation. It supports intuitive gestures (e.g., finger raises for clicks, scrolls) and operates via a standard webcam, eliminating the need for external hardware. The solution enhances user experience by providing stable, natural interaction, particularly beneficial for applications requiring precise cursor control.

Sarabjyot Chhatwa et al. (2025): The study analyzes the technology relating to hand gesture recognition (HGR) which consists of three processes: hand localization, feature extraction, and classification of the movement. The work outlines implementations concerning virtual devices such as AI-based mice and keyboards. It draws attention to the use of OpenCV and Mediapipe for real-time libraries, offering solutions to problems of lighting and occlusion. The study also focuses on the development concerning the applied modern machine learning with particular attention given to convolutional neural networks in increasing accuracy and reliability of device control through gestures.

Aarti Karande et al. (2025): In order to achieve precise gesture recognition in unusual settings, such as space stations and underwater exploration, this paper proposes a real-time virtual mouse system that uses hand gestures and OpenCV and MediaPipe. While addressing issues like complex backgrounds and lighting conditions, it emphasizes the system's capability to carry out mouse operations like drag-and-drop, clicks, and cursor movement using predefined gestures. The study highlights how touchless interaction can enhance accessibility and hygiene, especially in situations where conventional input devices are not feasible.

Apoorva et.al. (2024): An important development in touchless human-computer interaction (HCI) that aims to enhance accessibility, hygienic practices, and user friendly control is the implementation of gesture-controlled virtual mouse and finger air writing. Users can carry out actions like cursor control, clicking, dragging, and even writing in the air that is digitally provided on-screen .
In order to increase the accuracy and durability of gesture recognition, researchers have created a variety of implementations of such systems using programs like OpenCV, MediaPipe, skin detection algorithms, and machine learning models.

Iswarya M et al. (2023): The research paper investigates a unique human-computer interaction method which depends on hand gestures to control media through computer vision, machine learning and sensor integration technologies. The research advances current literature by developing an improved color-and hardware-independent gesture recognition system through Python libraries MediaPipe and OpenCV for real-time operation. The research demonstrates the ability of the system to improve media application user experience while pointing out its vulnerability to lighting conditions and device requirements as well as recommending adaptations for general use

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Manish Mishra et al. (2024): The paper "Virtual Mouse Input Control using Hand Gestures" describes a cost-effective and hardware-free solution that uses webcam-based hand gesture recognition with Python libraries MediaPipe and OpenCV for real-time detection. The study extends the findings of by implementing skin-color-based gesture recognition to overcome color dependency and hardware limitations. The system proves useful for Human-Computer Interaction (HCI) through its capabilities to move cursors and perform clicks and volume adjustments despite facing issues from environmental lighting and sound disturbances.

Geetika Saini et al. (2024):In this paper researchers introduce a groundbreaking hand gesture-based virtual mouse system which uses computer vision along with machine learning technology MediaPipe to achieve touch less cursor control. This extends the research to solve problems related to inconsistent lighting conditions and traditional input device limitations. The system focuses on supporting disabled users through accessibility solutions while investigating future features that include lighting adjustment mechanisms together with assistive tool integration.

Mariam Fathima A et al . (2024): The research paper discusses the application of AI technologies which include computer vision and gesture recognition to transform virtual mouse systems by improving accessibility and user experience. The paper identifies conventional input tools as restricted and declares its mission to develop alternative interaction methods for people with disabilities and other users.

U Sairam et al. (2022): Using TensorFlow and OpenCV for real-time hand gesture recognition, the paper introduces a virtual mouse system that uses machine learning and GUI automation to control mouse functions like scrolling, clicking, and movement. It draws attention to the shortcomings of vision-based and glove-based methods while highlighting machine learning's benefits in terms of increased accuracy and reduced latency.

Results/Discussion:

★ Gesture controlled virtual mouse: The system accurately detects the hand gestures using the web cam or sensors.

It recognises specific gestures for mouse functions:

moves cursor, left click, right click, scroll, drag and drop.

It provides real time responses with minimal delay, works in different lighting conditions and against varied backgrounds.

★ Voice Assistant: It successfully captures and processes user voice commands. It Executes basic tasks like:

Opening applications, searching the web, answering the general knowledge questions, controlling system volume, providing time, date, weather info.

It gives voice based responses and understands commands in normal conversational English.

Conclusion

The development of a virtual mouse system using hand gestures offers a solution to improve accessibility and enhance user experience. By utilizing image processing techniques, such as OpenCV and MediaPipe, the system can accurately detect and recognize hand movements, allowing for intuitive control of the virtual mouse. In this research, the system naturally integrates various components, including camera initialization, palm detection, landmark detection, fingertip detection, and mapping of gestures to mouse functions. This complete approach enables users to interact with technology without the need for

physical contact, promoting hygiene and reducing the risk of disease transmission. The results of this broad experiments demonstrate the feasibility and effectiveness of the proposed system. It achieves high gesture recognition accuracy and minimal latency, providing users with an intuitive and touch less means of interacting with digital interfaces underwater.

References

[1] Aditya Bansal, I R Oviya, Natarajan B,"Gesture controlled virtual mouse" (2023).

[2] Akash Singh, Shreya Bhatt, Shrudha Sagar, Trapti Upadhyay, "Real Time Virtual Mouse System using HandTracking Module based on Artificial Intelligence" (2023).

[3] Gayatri Jagnade, Mitesh Ikar, Nikita Chaudhari, and Maithili Chaware,"Hand Gesture-based Virtual Mouse using Open CV" (2023).

[4] Dr. Rajesh N Phursule, Gautami Kakade, Abishek Koul, Shikhar Bhasin,"Virtual mouse and gesture-based keyboard" (2023).

[5] Shashwat Srivastava,Richa Tiwari,AnanyaGarg, RohitTiwari,Rishu "Design and development of gesture recognition based virtual mouse system" (2023).

[6] N.R. Sathish Kumar, A. Venkateswara Reddy, B. Anil Kumar,B. Pavan Kalyan Reddy, and A

Shashank Kumar Reddy,"Hand GestureBased Virtual Mouse with Advanced Controls Using OpenCV

and Mediapipe" (2024).

[7] Yash Gajanan Pame, Vinayak Kottawar," A novel based approach to improves user experience of mouse control using CNN based hand gesture recognition" (2023).

[8] Sarabjyot Chhatwal,Shivam Sharma,"Handcrafted AI: designing virtual hardware for hand gesture-based interaction" (2025).

[9] Neha Sabrin TK,Aarti Karande,"Real-time virtual mouse using hand gestures for unconventional environment" (2023).

[10] Gaurav Bhole,Sakshi Bhegade,"System control using hand gesture" (2023) .

[11] U Sairam,Dharani Kumar Reddy Gowra,"Sai Charan KopparapuVirtual Mouse using Machine Learning and GUI Automation" (2022).

[12] Iswarya M,NaveenKumar R,Abishek K ,Sudhakar C,"Interactive Media Control System Using Hand Gestures" (2023).

[13] Manish Mishra,Abhishek Gupta,Vishwaraj Mehta,Dr.Raju Ranjan," Virtual Mouse Input Control using Hand Gestures" (2024).

[14] Geetika Saini, Reeya Ottalwar,Kriti Upadhyay,Gurpreet Kaur,"Gesture-Driven Interface Redefinition: Enhancing Accessibility with a Virtual Mouse System" (2024).

[15] Mariam Fathima A,Mounica V,M. K. Kirubakaran,"Revolutionary Cursor Control Systems Enhancing Human Computer Interaction" (2024).

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