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Smart Cursor Control Using Hand Gestures

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Abstract- With the growing demand for touchless and intelligent computing systems, hand gesture recognition has emerged as an innovative approach for natural human-computer interaction. This paper presents an AI-based Virtual Mouse system that enables real-time cursor control using hand gestures captured through a webcam. The proposed system utilizes MediaPipe for detecting 21 hand landmarks and OpenCV for real-time video processing, while PyAutoGUI is used to perform mouse operations such as cursor movement, clicking, scrolling, and dragging. The system provides smooth, accurate, and low-latency interaction without requiring additional hardware, making it a cost-effective and user-friendly solution. The proposed model enhances touchless human-computer interaction and has potential applications in smart environments, virtual reality systems, gaming, and assistive technologies.

Keywords: Artificial Intelligence (AI), Virtual Mouse, Hand Gesture Recognition, Human-Computer Interaction (HCI), MediaPipe, OpenCV, PyAutoGUI, Computer Vision, Real-Time Tracking, Touchless Interaction, Webcam-Based Control, Gesture-Based Interface, Smart Computing, Virtual Reality, Assistive Technology.

I. INTRODUCTION

In recent years, the rapid advancement of Artificial Intelligence (AI) and Computer Vision technologies has transformed the way humans interact with computers. Traditional input devices such as mouse and keyboard require physical interaction, which may not be convenient in touchless environments or for individuals with physical disabilities. As a result, there is an increasing demand for intelligent and contactless Human–Computer Interaction (HCI) systems that provide a more natural and user-friendly experience.

This project presents an AI Virtual Mouse system that enables users to control computer cursor operations using hand gestures captured through a standard webcam. The proposed system utilizes MediaPipe to detect and track 21 hand landmarks and OpenCV for real-time image processing. Different hand gestures are mapped to mouse functions such as cursor movement, left click, right click, scrolling, and drag-and-drop operations, while PyAutoGUI performs the corresponding mouse actions in real time.

The major highlight of the proposed system is its ability to provide a completely touch-free, low-cost, and intuitive interaction experience without requiring additional hardware devices. The system improves accessibility for physically challenged users and reduces physical contact with devices, making it suitable for hygienic environments such as healthcare systems, public kiosks, and smart workplaces. Furthermore, the proposed AI Virtual Mouse has potential applications in virtual reality, gaming, smart classrooms, and assistive technologies, demonstrating the future scope of natural and contactless Human–Computer Interaction (HCI).

II. PROBLEM STATEMENT

Conventional computer control methods depend heavily on physical devices such as mouse and keyboard, which may be inconvenient in modern contactless environments and difficult for users with mobility limitations. Long-term usage of these devices can also affect comfort and efficiency during interaction with computer systems.

Many existing gesture-controlled systems require specialized equipment such as sensor gloves or external tracking devices, increasing both implementation cost and system complexity. Hence, there is a need for an efficient virtual mouse system that can interpret hand movements accurately using only a webcam. The proposed solution focuses on enabling smooth cursor navigation and gesture-based control through AI and computer vision techniques, providing a simple, accessible, and touch-free interaction experience.

III. METHODOLOGY

The proposed AI Virtual Mouse system is designed to enable touchless computer interaction using real-time hand gesture recognition. The system captures live video through a webcam and processes the frames using Computer Vision and Artificial Intelligence techniques. Hand movements are detected and analyzed to perform various mouse operations without using a physical mouse device.

Initially, the webcam captures continuous video frames of the user's hand. These frames are processed using OpenCV for image preprocessing and frame enhancement. MediaPipe Hands is then used to identify and track hand landmarks in real time. The detected landmarks are analyzed to recognize different finger positions and hand gestures. Based on the identified gestures, corresponding mouse operations such as cursor movement, clicking, scrolling, and dragging are executed using PyAutoGUI. The system also applies smoothing techniques to ensure stable cursor movement and reduce latency during operation.

1. Real-Time Hand Tracking

The system uses MediaPipe Hands to detect and track 21 hand landmarks, including fingertips, finger joints, and wrist positions. These landmarks help the system understand the orientation and movement of the hand in real time.
OpenCV continuously processes the webcam frames to ensure accurate and efficient hand detection under different operating conditions.

2. Gesture Identification and Analysis

After detecting the hand landmarks, the system analyzes the positions and distances between fingers to identify specific hand gestures. Different finger combinations are mapped to different mouse functions. For example, index finger movement controls the cursor, while specific finger gestures are used for left click, right click, scrolling, and drag-and-drop operations. This gesture-based approach enables natural and touchless interaction with the computer.

3. Virtual Mouse Operation

Once a gesture is recognized, the corresponding mouse action is executed using the PyAutoGUI library. The fingertip coordinates are mapped to the screen resolution for smooth cursor movement. Smoothing algorithms are applied to reduce cursor jitter and improve stability. The system performs all mouse operations in real time with minimal delay, providing an efficient and user-friendly virtual mouse experience

IV. TOOLS USED

1. OpenCV

OpenCV (Open Source Computer Vision Library) is a widely used computer vision and image processing library used for real-time video analysis. In the proposed AI Virtual Mouse system, OpenCV is used to capture live video frames from the webcam and process them for hand detection. It performs operations such as frame conversion, image preprocessing, drawing hand landmarks, and displaying the processed output on the screen. OpenCV enables efficient real-time video processing, which is essential for smooth gesture recognition and cursor control.

2. MediaPipe

MediaPipe is an open-source framework developed by Google for real-time hand tracking and gesture recognition. In this project, MediaPipe Hands is used to detect and track 21 hand landmarks, including fingertips, finger joints, and wrist positions. These landmarks help the system identify finger movements and recognize specific hand gestures accurately. MediaPipe provides high-speed and precise hand tracking, making the gesture recognition process more reliable and efficient.

3. PyAutoGUI

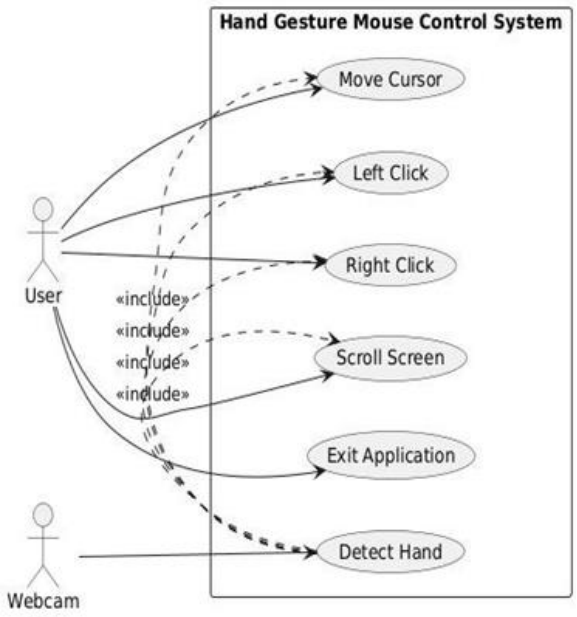
PyAutoGUI is a Python automation library used to control mouse and keyboard operations programmatically. In the AI Virtual Mouse system, PyAutoGUI is used to convert recognized hand gestures into corresponding mouse actions such as cursor movement, left click, right click, scrolling, and drag-and-drop operations. It enables real-time interaction between the gesture recognition system and the computer screen, allowing smooth and responsive virtual mouse control.

V. WHAT IS VIRTUAL AI MOUSE

AI Virtual Mouse is a gesture-based computer control system that enables users to perform mouse operations through hand movements captured by a webcam. Instead of relying on a physical mouse, the system uses Artificial Intelligence (AI) and Computer Vision techniques to recognize hand gestures and convert them into digital commands.The AI Virtual Mouse provides a natural and intuitive method of Human–Computer Interaction (HCI) without requiring additional hardware devices. The system is cost-effective, portable, and capable of operating in real time with minimal latency. It also improves accessibility for users with mobility limitations and supports hygienic computing environments by reducing physical contact with devices.

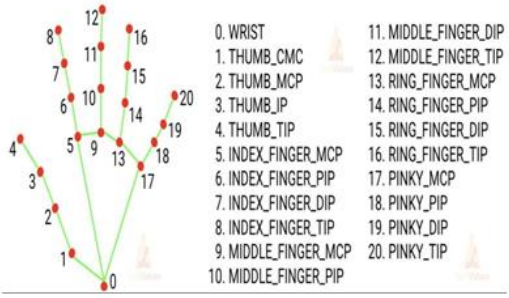
With the advancement of AI-driven gesture recognition technologies, AI Virtual Mouse systems are becoming an important part of modern smart applications such as virtual reality, gaming, smart classrooms, healthcare systems, touchless interfaces, and assistive technologies

VI. USE CASE DIAGRAM



The use case diagram illustrates the interaction between the user and the AI Virtual Mouse system. The user performs different hand gestures in front of the webcam, and the system interprets these gestures to execute corresponding mouse operations.The main functionalities provided by the system include cursor movement, left click, right click, scrolling, hand detection, and application exit control. The webcam continuously captures hand movements, while the gesture recognition module processes the detected hand landmarks to identify specific gestures.The diagram demonstrates how the proposed system enables touchless Human–Computer Interaction (HCI) using computer vision and artificial intelligence techniques.

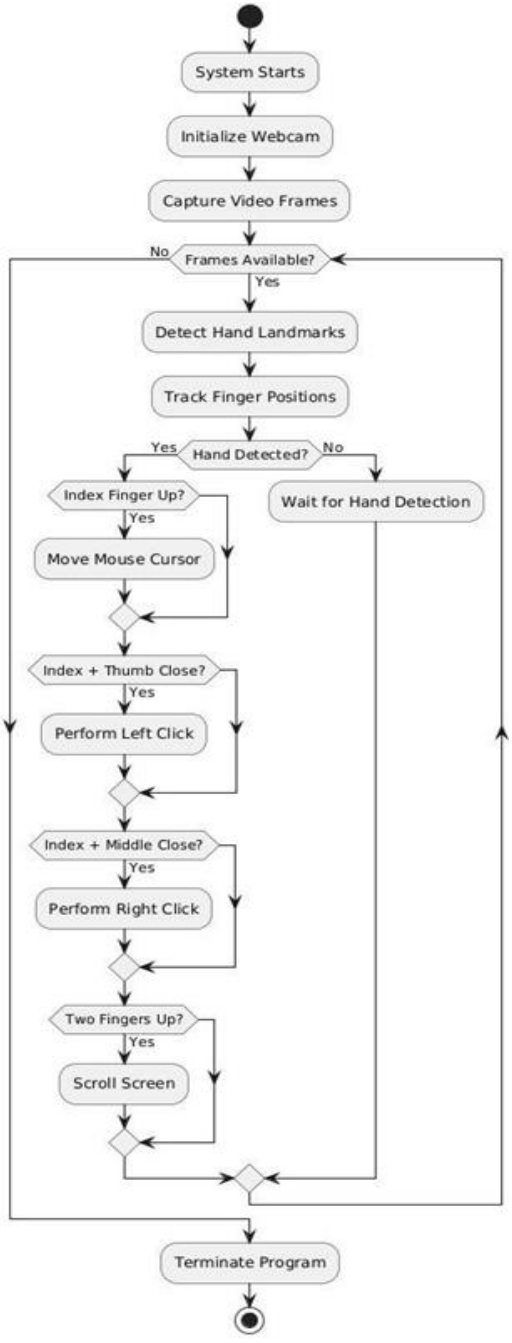
VII. SYSTEM WORKING



The system tracks 21 hand landmarks and recognizes different finger patterns to perform mouse operations such as cursor movement, left click, right click, scrolling, and drag-and-drop actions. Gesture recognition enables touchless and natural Human–Computer Interaction (HCI) without requiring physical input devices.

The proposed system provides smooth, accurate, and real-time interaction with minimal latency. It reduces dependency on traditional input devices and offers a more user-friendly and hygienic computing experience. This technology improves accessibility and convenience, making it suitable for smart systems, virtual reality, gaming, healthcare environments, and assistive technologies

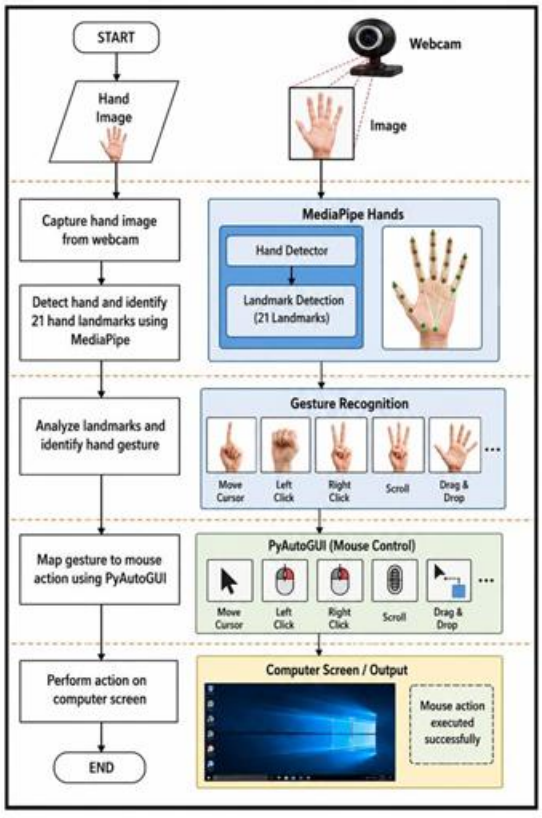
VIII. FLOWCHART



The flowchart represents the working procedure of the AI Virtual Mouse system. Initially, the system starts by activating the webcam and capturing continuous video frames. The captured frames are processed using OpenCV, and MediaPipe is used to detect hand landmarks and track finger positions in real time.

After successful hand detection, the system analyzes finger gestures to perform different mouse operations. When the index finger is raised, the cursor movement operation is activated. If the index finger and thumb are brought close together, the system performs a left-click operation. Similarly, when the index finger and middle finger are detected close together, a right-click operation is executed. The system also supports scrolling functionality when two fingers are raised simultaneously.

If no hand is detected, the system waits for hand detection and continuously processes video frames until gestures are recognized. Finally, the program terminates when the user exits the application.



IX. PROJECT WORKING

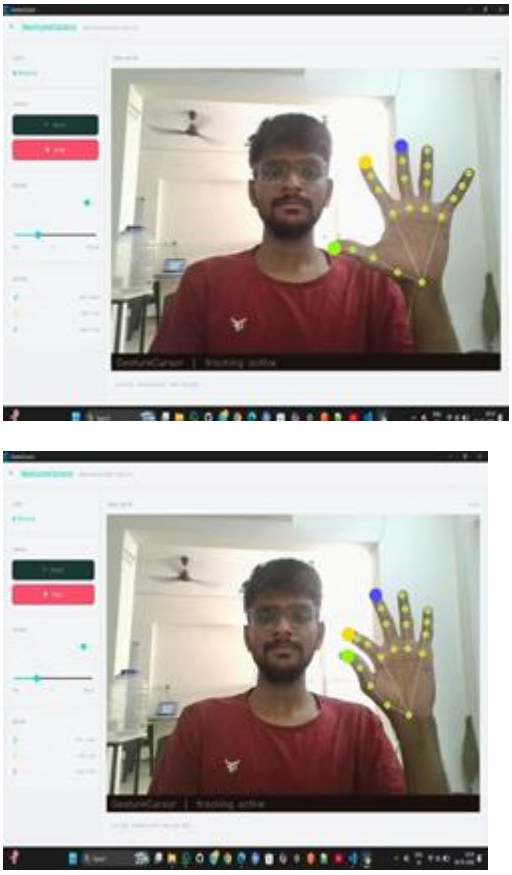


Figure 1 Recognized hand gestures for left and right click actions

The developed system enables users to control computer functions through hand movements detected by a webcam. The webcam continuously captures live video, and the captured frames are processed using OpenCV and MediaPipe for hand tracking and gesture analysis. The detected hand landmarks are analyzed to identify different finger patterns, which are then converted into mouse operations such as pointer movement, clicking, scrolling, and drag-and-drop actions using PyAutoGUI.The implemented model performs real-time gesture detection with good accuracy and responsiveness. The cursor movement remains stable due to smoothing techniques applied during processing, which helps reduce unwanted motion and improves interaction quality. The system effectively eliminates the dependency on traditional input devices and provides a convenient touch-free computing experience.Experimental observations show that the proposed virtual mouse operates efficiently under standard lighting conditions and accurately recognizes multiple hand gestures with low latency. The system demonstrates reliable performance for everyday computer operations and offers practical applications in modern smart systems, interactive environments, assistive technologies, and contactless computing solutions.

X. CONCLUSION

The proposed AI Virtual Mouse system successfully demonstrates a touchless approach for controlling computer operations using hand gestures. The system utilizes Artificial Intelligence (AI), Computer Vision, OpenCV, MediaPipe, and PyAutoGUI to detect hand movements and perform mouse functions such as cursor movement, clicking, scrolling, and drag-and-drop in real time. By tracking 21 hand landmarks through a standard webcam, the system provides accurate and smooth gesture-based interaction without requiring additional hardware devices.

The developed system offers a cost-effective, user-friendly, and accessible alternative to traditional mouse devices. It enhances Human–Computer Interaction (HCI) by enabling natural and contactless communication between users and computers. The project can be effectively used in areas such as healthcare systems, smart classrooms, gaming, virtual reality, public interfaces, and assistive technologies for physically challenged users.

Overall, the AI Virtual Mouse system demonstrates the future potential of gesture-based computing and touchless interaction technologies. Further improvements can enhance gesture accuracy, environmental adaptability, and support for advanced gesture controls in modern intelligent systems

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REFERENCES

1. OpenCV Documentation, “Open Source Computer Vision Library,” Available: https://opencv.org/
2. Google MediaPipe Documentation, “MediaPipe Hands Solution,” Available: https://developers.google.com/mediapipe
3. PyAutoGUI Documentation, “Python GUI Automation Library,” Available: https://pyautogui.readthedocs.io/
4. R. S. Lokhande and S. B. Patil, “Hand Gesture Recognition for Human Computer Interaction,” International Journal of Computer Applications, vol. 180, no. 12, pp. 20–25, 2018.
5. S. Mitra and T. Acharya, “Gesture Recognition: A Survey,” IEEE Transactions on Systems, Man, and Cybernetics, vol. 37, no. 3, pp. 311–324, 2007.
6. D. Zhang, “Computer Vision and Image Processing for Human–Computer Interaction,” Springer Publication, 2019.
7. A. Kapoor and R. Sharma, “Virtual Mouse Control Using Hand Gestures,” International Journal of Innovative Research in Technology, vol. 7, no. 5, pp. 45–49, 2021.
8. Python Software Foundation, “Python Programming Language,” Available: https://www.python.org/
9. Intel Corporation, “Real-Time Gesture Recognition Techniques Using Computer Vision,” Research Paper, 2020.
10. J. Smith and P. Roy, “AI-Based Human Computer Interaction Systems,” International Conference on Artificial Intelligence and Smart Systems, 2022