Hand Gesture Based Virtual Mouse

Jitendra A Gaikwad
Department of Instrumentation
Vishwakarma Institute of Technology Pune, India
Email- Jitendra.gaikwad@vit.edu

Shruti Wattamwar
Department of Instrumentation
Vishwakarma Institute of Technology Pune, India
Email- Shruti.wattamwar24@vit.edu

***Abstract* -- The pandemic has brought about a significant change in technology, leading to the creation of a virtual mouse as a substitute for a traditional one. This innovative system utilizes a webcam or built-in camera to capture frames, which are then analyzed through computer vision to enable tracking. Users can control mouse functions by performing gestures, making it a device-free solution, although it does require a battery and a connected dongle. The development and adoption of this virtual mouse represents an active area of research. In basic terms, the system captures images with a camera, processes them for tracking, and responds to user gestures for mouse movement, ultimately eliminating the need for a physical device.**

Keywords— Virtual Mouse, real camera, web camera, media pipe, computer vision, images capture or video.

1.INTRODUCTION

The Gesture Driven Virtual Cursor revolutionizes how we interact with computers by understanding hand gestures. Using sophisticated technologies like CNN models through MediaPipe integrated with pybind11, it employs advanced Machine Learning and Computer Vision algorithms to recognize hand movements. This innovative system consists of two parts: one designed to work seamlessly with gloves of any color and another that responds directly to bare hands. Currently, it operates smoothly on the Windows operating system, providing users with a versatile and efficient interaction experience. This virtual cursor brings a new level of simplicity to human-computer interaction, making tasks more intuitive. Whether you prefer wearing gloves or using your bare hands, the system caters to both preferences. Its compatibility with a wide range of glove colors enhances flexibility, ensuring a personalized experience for users. The integration of cutting-edge technologies ensures accurate and responsive gesture recognition, adding a layer of precision to the interaction process. Overall, the Gesture Driven Virtual Cursor represents a significant leap forward in user-friendly computing, showcasing the potential of advanced Machine Learning and Computer Vision in everyday technology.

2.0 LITERATURE SURVEY

Cursor Control System Using Hand Gesture Recognition - In [1] Patil et al. developed a user interface that uses basic computer vision and multimedia methods to perform hand gesture recognition. However, a significant restriction is that skin pixel detection and hand segmentation from saved frames must be completed before working with motion comparison methods.

Real Time Hand Gesture Recognition System Using Motion History Image- In [2] ChenChiung Hsieh et al. used a motion history image-based hand movement direction detection technique and an adaptive skin tone model. The paper's main shortcoming is its inability to recognize hand motions with greater complexity

Virtual Mouse Implementation using OpenCV- In [3]. In their study, they revealed that interactions between humans and computers depend a lot on detecting hand gestures. They highlighted ongoing technological progress, like biometric authentication commonly found in smartphones. Hand gesture recognition, a modern way of interacting with computers, lets us control systems by waving our hands in front of a webcam. This work is built on this idea, explaining in detail the methods for color recognition and a simulated mouse.

Virtual Mouse Control Using Colored Fingertips and Hand Gesture Recognition- In their study [4], Reddy and team suggested a way to control a virtual mouse using hand movements and fingertip identification. They used two methods for tracking fingers: recognizing hand movements and using colored caps on fingertips. The process involves three main steps: tracking hand gestures, identifying fingers based on their colors, and implementing the cursor movement. To track hand movements, they created a shape around the detected hand contour called a convex hull. This helped in monitoring how the hand moves. By comparing the area of this shape with the detected contour, they gathered information about hand features. The researchers then tested their approach in real-world situations through thorough experiments. This allowed them to assess how well the algorithm worked in practical scenarios. Overall, Reddy et al.'s research provides a practical method for controlling a virtual mouse using hand motions and fingertip identification.

2.1 ACTUAL METHODOLOGY

The main goal of using hand gestures to create a virtual mouse is to make it easier and more natural to use digital devices. For people who find it hard to use a regular mouse and keyboard because of physical challenges, a virtual mouse controlled by hand gestures can be a helpful option. This virtual mouse improves accessibility and productivity by allowing users to switch between using it and typing on the keyboard without needing a physical mouse. The purpose of developing a hand gesture-based virtual mouse is to make technology more friendly and accessible for everyone, no matter their physical abilities.

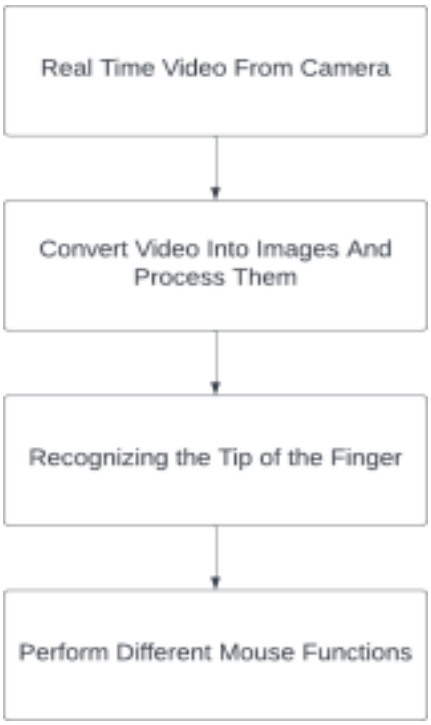

Fig 1: Architectural Design

2.2 PROPOSED ALGORITHM

Step 1: First, we use the webcam on a laptop or PC for the Hand Gesture Based Virtual Mouse System. We rely on a Python library called OpenCV. It helps us capture frames from the camera and initiates the webcam to start recording video.
Step 2: Once the webcam is working, the system captures each frame until the program stops. This is an essential part of the hand gesture-based virtual mouse system,using the computer's camera to continuously capture and process video frames.
Step 3: The AI virtual mouse system uses a formula to move the cursor on the full-screen PC display based on the hand's position captured by the digital camera. Step 4: The system detects when a finger is raised, using Media Pipe to identify finger coordinates, and then translates that into mouse actions on the computer.
Step 5: To click the left mouse button, the system checks if the index and thumb fingers are raised and close together.
Step 6: For a right mouse button click, the system verifies if the middle and thumb fingers are raised and within a certain distance.
Step 7: To scroll up and down, the system checks if the index and thumb fingers are up and close together. **Step 8:** Controlling brightness is achieved by raising the index and thumb fingers and adjusting the distance between them..

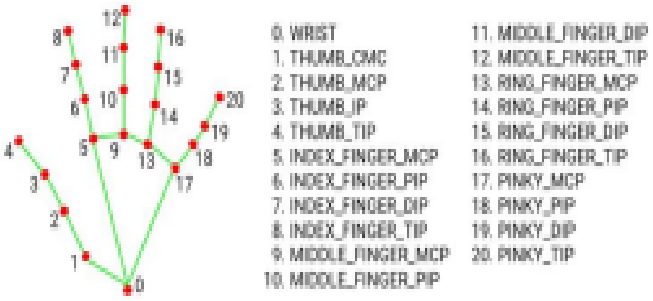

Fig 2. MediaPipe Structure

2.3 WORKING OF THE SYSTEM

Step 1: Utilize the laptop or PC webcam in the hand gesture-based virtual mouse system. Using the OpenCV Python library, initialize the video capture object to start capturing frames.

Step 2: Capture and process video frames continuously from the system camera throughout the program's runtime.

Step 3: Implement a transformational formula to map the hand coordinates from the camera screen to the full screen PC display, enabling mouse control within a designated rectangular region.

Step 4: Detect the raised finger for mouse interaction by analyzing finger tip IDs and coordinates obtained through MediaPipe.

Step 5: Enable left button click when both index finger (tip ID = 1) and thumb finger (tip ID = 0) are raised, with a distance between them less than 30px.

Step 6: Enable right button click when both middle finger (tip ID = 2) and thumb finger (tip ID = 0) are raised, with a distance between them less than 40px.

Step 7: Implement scrolling up and down functionality when both index finger (tip ID = 1) and thumb finger (tip ID = 0) are raised, with a distance between them less than 30px.

Step 8: Enable control over screen brightness when both index finger (tip ID = 1) and thumb finger (tip ID = 0) are raised, with a distance between them less than 30px.

Fig.3 Gesture for Moving the Mouse

Fig 5. Gesture for Double Click

Fig 4. Gesture for Left Click

Fig 6. Gesture for Scrolling

Fig.7 Gesture for Drag and Drop

2.4 APPLIATIONS

Accessibility: People with movement challenges can use a virtual mouse instead of a physical one to control their computer.

Gaming: Gamers can use a virtual mouse for fast and precise movements, especially in action-packed games. **Virtual Reality:** In virtual reality, a virtual mouse helps users interact with the digital world without needing an actual physical mouse.

Presentations: A virtual mouse is handy for controlling slides during presentations, letting the presenter move through slides and emphasize points without being right by the computer.

Medical Use: In medical settings, a virtual mouse is useful where touching a physical mouse might not be safe or clean, like in surgery or sterile environments.

2.5 FUTURE SCOPE

Hand gesture-controlled virtual mouse technology holds immense potential across diverse domains including human-computer interaction, gaming, healthcare, and education. Its intuitive interface offers a natural way for users to interact with computers and devices, enhancing immersion in virtual and augmented reality environments. In healthcare, it aids rehabilitation and touchless interactions with medical equipment. Additionally, it improves productivity in industrial settings and fosters interactive learning experiences in education. Ongoing advancements in algorithms and sensor technology will further refine accuracy and compatibility, driving innovation and widespread adoption. Overall, it promises to revolutionize how we interact with technology, offering seamless and immersive experiences across various applications.

2.6 CONCLUSION

In simple terms, a virtual motion control mouse is a useful system that directs the computer mouse using a real-time camera. However, its abilities are limited to basic actions like selecting, moving, and changing slides. It's suggested to reduce reliance on hand gestures for input. Creating a framework for an autonomous gesture language is crucial for further development. If the webcam has difficulty detecting another colored object, it may impact color recognition. The goal is to design an efficient yet straightforward virtual mouse that overcomes the limitations of a traditional hardware mouse.

2.7 REFERENCES

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