

Research Article

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Gesture-Based Virtual HCI: Enhancing Computer Interaction

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Abstract— In a time when human-computer interaction (HCI) is changing quickly, generating user-friendly interfaces is essential. This paper presents a new technique to HCI using virtual mouse and keyboard systems based on gesture recognition. This system replaces classical input devices by permitting users to control their computers with hand gestures using computer vision techniques. We created an optical mouse and keyboard technique that can recognize hand gestures recorded by a regular webcam by utilizing computer vision algorithms. Different gestures cause corresponding mouse clicks, keyboard inputs, and mouse movements through image processing. The implementation only needs a webcam as hardware and is written in Python using the PyCharm platform. The device works well as a virtual mouse and keyboard, offering smooth control without the demand for cables or other external hardware. The efficiency and user experience of computer interaction can be improved by permitting users to input text using natural hand gestures, navigate interfaces, and execute left and right clicks. This work provides opportunities for more organic and intuitive paradigms in HCI.

Keywords— Gesture Recognition, Virtual Mouse, Virtual Keyboard, Computer Vision, Human-Computer Interaction

I. INTRODUCTION

The tremendous intake and development of technology has made the computer system an extremely potent device. It is intended to facilitate human labor in jobs. As a result, human-computer interaction, or HCI, has grown in significance in our daily lives. The advancement and growth of computer interaction these days Device use has grown to the point where, as humans, we are unable to ignore its effects and it has taken precedence over all other considerations. We use technology for everything from shopping to work to entertainment to communication. It has become so ingrained in our lives. Numerous programs, such as Microsoft Office, Windows Picture Manager, and Media Player, are needed for an intuitive and natural user interface. The majority of users these days communicate with computers via keyboard, mouse, pens, joysticks, and other devices, which are insufficient for them. These current technologies for computing, communication, and display will soon become a bottleneck, and further development in these areas will be necessary to create a system that feels as natural as feasible[7].

Even if researchers and engineers made great strides in the creation of mice and keyboards, there are still some circumstances in which using a keyboard and mouse alone is insufficient to connect with a computer. This is true with the development of portable electronics like smartphones, tablets, and iPods, which are all quite small. Their limited touch screen or keyboard and defined input zones make it very hard to interact with them. Additionally, these gadgets are incompatible with HCI when it comes to interacting with 3D objects[8]. We use our hands to move, alter, and transform objects as well as to point at people or things. We also use them to convey or transmit information. In a similar manner to how we might express concepts through gestures with our hands when speaking[9].

To enable computer interpretation, a method for investigating the use of gestures in HCI must be provided. For the purpose of HCI interpretation, the static and/or dynamic form of human arm, hand, and even some other body part movements must be quantifiable by machine. It has been discovered that careful consideration must go into the design of certain specialized input devices in order to enable and achieve sophisticated interaction between humans and computers. Flexibility is provided in Virtual

Reality (VR), automobile system control, tele-operating, robot control, text editing, gesture recognition, video games, and multimedia interfaces through the combination of conventional devices (e.g., keyboard, mouse, etc.) with newly designed interaction devices like face and gesture recognition, haptic sensors, and tracking devices.

Major progress in the topic of human-computer interaction, gesture recognition-based virtual mouse and keyboard systems offer users an easy-to-use and effective approach to interacting with electronics. These systems allow users to control and navigate computers and other digital devices using hand gestures and motions, eliminating the need for physical input devices like keyboards and mice. The evolution of voice recognition, motion sensing, touchscreens, and other human-computer interaction techniques can be attributed to the development of gesture recognition-based virtual mouse and keyboard technology. The addition of these technologies has had a significant impact on the creation of user interfaces as they aim to enhance computing accessibility and user-friendliness. The rapid evolution of depth, infrared, and camera sensors among other sensor technologies is primarily responsible for the realization of gesture recognition-based systems. These sensors enable the real-time capture and understanding of human movements and gestures, which these systems then use to translate gestures into precise computer commands[10].

II. LITERATURE SURVEY

1.)" Research on the hand gesture recognition based on deep learning " [1] Jing-Hao Sun, Ting-Ting Ji, and Shu-Bin Zhang, the need for human-machine interaction is growing as a result of the quick advancement of computer vision. Hand gesture recognition is frequently utilized in robot control, intelligent furniture, and other areas because hand gestures may convey richer information. By creating a skin color model and an AdaBoost classifier based on haar in accordance with the uniqueness of skin color for hand motions, the paper achieves the segmentation of hand gestures.

2.)" *Gesture-Driven Computing: Pioneering Control with Eye Tracking and Computer Vision* "[2] Rekha KB et al., *Patients with stroke or amyotrophic lateral sclerosis (ALS) are unable to communicate or express their basic wants and desires. Since they can still lift their heads occasionally and use their eyes, they can communicate by using eye trackers. This study offers fresh approaches to enhance eye tracker software's usability and speed.*

3.)" *Algorithm for decoding visual gestures for an assistive virtual keyboard. IEEE Latin America Transactions* "[3] Da Silva RA et al.. *One of the most common computer tasks is writing text, a simple action that can be difficult for people with severe neuromotor illnesses like Amyotrophic Lateral Sclerosis (ALS), which can cause Locked-in syndrome (LIS). Since their main means of communication and engagement with the outside world may be their eye movements, these people require augmentative and alternative communication technologies.*

4.) " *Hand data glove: A new generation real-time mouse for human-computer interaction* " [4] Kumar P et al.,. *One study on human-computer interaction uses a virtual mouse that is equipped with hand motion tracking based on an image from a live camera and fingertip recognition. This study proposes the use of hand motion detection and fingertip identification for virtual mouse control. Two techniques for tracking fingers are used in this study: hand gesture detection and the use of colored caps.*

COMPUTER VISION:

For virtual mouse and keyboard systems, gesture recognition is made possible in large part by computer vision. With the use of computer vision techniques like image processing and machine learning, the system is able to decipher hand gestures and movements from a camera in a live video stream. First, the video feed is preprocessed by the system to improve quality and extract relevant features. Preprocessing can include steps like normalization, resizing, and noise reduction to increase the precision of later processing phases. Afterwards, regions of interest corresponding to the user's hands within the video feed are found and localized by hand detection algorithms. For this, methods like deep learning-based models, contour detection, and background subtraction are frequently employed[5], [6].

SYSTEM DESCRIPTION: Block Diagram Of flow of information thorough virtual mouse and keyboard is shown in Figure 1.

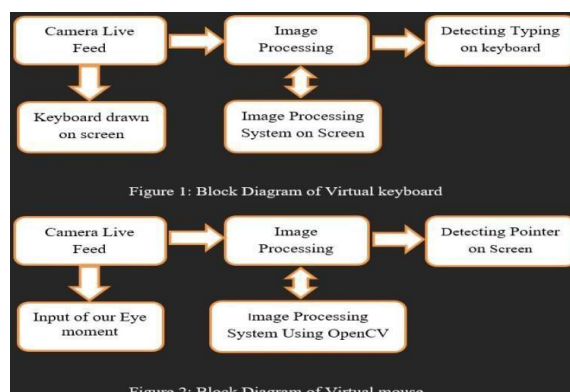


Fig 1: Block Diagram Of virtual mouse and keyboard.

A camera serves as the main input device for the gesture recognition system, recording user hand gestures and facial expressions

on video. The quality of the video feed is enhanced by preprocessing techniques such as noise reduction, normalization, and scaling. Hand detection algorithms use deep learning models or background subtraction to analyze the preprocessed feed and localize hand movements. Then, hand tracking algorithms use techniques like optical flow or Kalman filters to track the positions of hands over time. Gesture recognition algorithms use machine learning models or template matching to interpret tracked hand movements and identify mouse and keyboard gestures. Face recognition algorithms match the user's face against a known database to authenticate while face detection algorithms simultaneously detect the user's face in the video feed. Through a computer monitor or display screen, the user is presented with a virtual mouse cursor, keyboard interface, and visual elements by the system.

RESULT AND DISCUSSION: Virtual keyboard Using Hand Gesture is shown in Figure 2 while eye tracking by mouse is shown in computer window is shown in Figure 3.

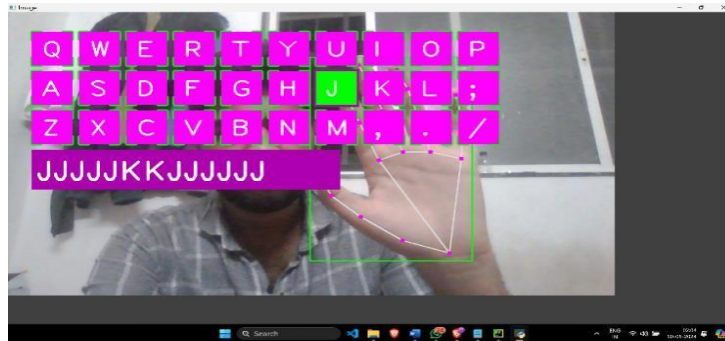


Fig 2: Virtual keyboard Using Hand Gesture

Using computer vision techniques, eye tracking, and hand gesture recognition for a virtual mouse in PyCharm entail detecting and tracking the user's hand and eye movements in real-time video feed. The camera feed is initially set up to record the user's face, hand movements, and eye regions. Several techniques, including contour detection, deep learning models, and Haar cascades, are used to locate and identify the hands and eyes in every frame. Tracking algorithms are used to continuously monitor their positions and movements across frames once they have been detected.

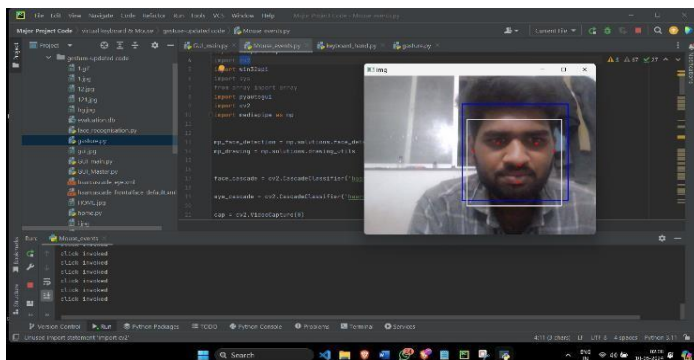


Fig 3: Virtual mouse eye tracking

While hand gesture recognition algorithms examine hand positions and movements to interpret gestures, optical flow or Kalman filters can be used to precisely estimate the trajectory of eye movements for eye tracking. The user can effortlessly control the virtual mouse cursor on the screen by mapping the tracked eye positions and hand gestures to corresponding mouse movements. Users can easily interact with computer interfaces by using their hand and eye movements to navigate the virtual mouse interface that is superimposed on the video feed. The accuracy and responsiveness of the hand gesture recognition and eye tracking systems can be improved through iterative testing, improvement, and parameter tuning, providing users with a simple and effective way to interact with virtual environments.

III.CONCLUSION

The idea behind this project is to develop a system that can identify hand gestures in place of the mouse and keyboard. This includes dragging and clicking with the keyboard and using the mouse to move the cursor as well as other keyboard functions like printing alphabets. Skin segmentation is used to distinguish the color or image of the hand from its surroundings. Eliminating the arm technique efficiently addresses the issue of projecting the entire body into the camera. Generally speaking, the suggested algorithm is able to identify and detect hand gestures in order to control keyboard and mouse functions and generate an actual user interface. 3D printing, architectural designs, and remote medical operations are all possible. This project is simple to implement and has a wide range of applications in medical science, where computation is necessary but cannot be fully realized due to a lack of human-computer interaction.

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