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Hand Gesture Controller (Virtual Mouse) and Voice Assistant using OpenCV, ML, Python

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ABSTRACT- The advancements in artificial intelligence technology have led to the increasing popularity of hand gesture recognition for controlling virtual devices. This paper proposes hand gesture controller (virtual mouse) and voice assistant that utilizes OpenCV for recognizing hand gestures and translating them into mouse movements. The system serves as an alternative interface for individuals who encounter difficulties when using a traditional mouse or keyboard. A camera captures images of the user's hand, which is processed by an AI algorithm to identify the gestures made. The system is scalable and adaptable to different environments and devices. Dynamic/static hand gestures and voice commands can control all input operations without any additional hardware requirements. We use ML and Computer Vision algorithms to recognize hand gestures and voice commands, implementing the model using CNN and the (Gesture-Controlled-Virtual-Mouse) [2]controlled virtual mouse system has potential applications in hazardous environments for enabling hand-free device operation and offering an alternative interface to hardware mouse users. Our proposed system has the potential to enhance user experience and improve accessibility through human-computer interaction [1].

Keywords: Computer vision, hand gesture recognition, Mediapipe, and virtual mouse.

1. INTRODUCTION

In our daily lives, technology has become an integral part. Computer technology is growing rapidly and being used for various tasks that are impossible for humans to perform. Interactions between humans and computers are usually done through output devices like a mouse. However, carrying a hardware mouse everywhere can be inconvenient and may get damaged. This led to the development of wireless mouse and speech recognition techniques for mouse functions. Eye tracking techniques have also been used, but they have certain drawbacks. Developers have attempted to develop human gesture recognition models using expensive gloves and sensors. However, artificial intelligence has emerged as a major technology that makes human life faster and more comfortable. This paper proposes a hand gesture-controlled virtual mouse using artificial intelligence technology. This technology allows users to control the movement of their computer mouse through hand gestures, without a physical mouse. The system uses a camera vision-based approach to track the movements of the user's hand and perform mouse functions on the computer screen. The computer vision algorithms analyze the video feed from the camera and identify the user's hand and track its movement. Machine learning models have been trained to recognize specific hand gestures, such as pointing or swiping, and translate them into corresponding mouse movements. This technology has several advantages, including its potential to improve accessibility for people with disabilities and provide a more natural and intuitive user experience. It can also be useful in situations where a physical mouse or touchpad is not available or practical. The use of hand gestures as a control mechanism eliminates the need for a physical mouse and provides a more intuitive and natural way of interaction with computers. The technology has numerous applications in areas such as gaming, virtual reality, and accessibility [3].

2. LITERATURE REVIEW

Previous work on AI virtual mouse systems involved using gloves or colored pieces of paper attached to the hands for gesture recognition. However, these methods have limitations in terms of accuracy, range of motion, and user comfort. A hardware-based system that relies on a glove severely limits the hand's movement and may cause skin irritation, while colored tips for gesture recognition may not always produce optimal results. Recent contributions have focused on camera-based detection of hand gestures using Google's mediapipe framework[5].

One study developed a hardware-based system that produced accurate results but had limitations in terms of range of motion and user comfort. Another study proposed a machine-user interface that uses computer vision and multimedia techniques for gesture detection, but it requires skin pixel identification and hand segmentation from stored frames before working with gesture comparison techniques. Another study used a mobile phone camera and projector for visual feedback, while other mobile applications can link to their framework for gesture recognition. Another approach used only a webcam for gesture recognition and detection and performed mouse functions using hand gestures[6].

One study focused on robots with gesture controls and used optical flow and motion features to differentiate hand gestures, while another study used the convex hull technique to determine fingertip points for mouse control. Another study utilized the YOLOv5 algorithm and Artificial Intelligence (AI) to recognize hand gestures and improve HCI. A system that creates colored masks for gesture recognition has also been proposed, but its implementation is difficult.

In this study, we propose Hand Gesture Controller (Virtual Mouse) and Voice Assistant that uses AI algorithms to recognize hand gestures and translate them into mouse movements. The system is designed to provide an alternative interface for people who have difficulty using a traditional mouse or keyboard. It uses a camera to capture images of the user's hand, which are processed by an AI algorithm to recognize the gestures being made. The system is trained using a dataset of hand gestures to recognize different gestures, and it can perform various mouse operations like left click, right click, drag and drop, volume control, and brightness control. The model is implemented using CNN and mediapipe framework, and it has potential applications like enabling hand-free operation of devices in hazardous environments and providing an alternative interface for hardware mouse[4].

3. PROBLEM STATEMENT

To track fingertips as a movable object, and to utilize it for mouse functions, the camera should be positioned in a way so that it can see the user's hands in the right positions. This can be used in space-saving situations, for those patients who don't have control over their limbs and for other similar cases. It's a virtual mouse instead of a physical mouse which will work only based on webcam captured frames & tracking colored fingertips.

4. AIMS AND OBJECTIVE

The main objective of the proposed AI virtual mouse system is to develop an alternative to the regular and traditional mouse system to perform and control the mouse functions, and this can be achieved with the help of a web camera that captures the hand gestures and hand tip and then processes these frames to perform the particular mouse function such as left click, right click, and scrolling function.

5. PROPOSED SYSTEM

For hand and finger detection, the project employs the open-source library MediaPipe. Developed by Google and OpenCV, MediaPipe is a cross-platform framework that uses machine learning concepts to detect hand gestures and track their movements in real-time. It provides pre-made tools and components such as object detection, pose estimation, facial recognition, and more, allowing developers to create intricate pipelines that combine multiple algorithms and execute in real-time on various hardware platforms [1].

1. Real-time Video and Audio Processing: MediaPipe offers functionalities like video decoding, filtering, segmentation, and synchronization for processing and analyzing video and audio streams in real-time.

2. Facial Landmark Detection: MediaPipe can detect and track facial landmarks in real-time, including eyes, nose, mouth, and eyebrows. This functionality is useful for

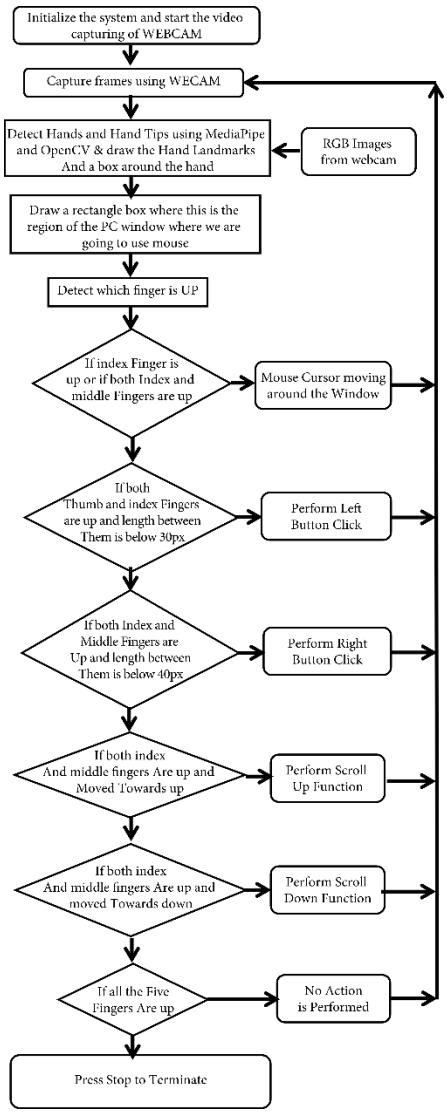
applications like facial recognition, emotion detection, and augmented reality.

3. Hand Tracking: MediaPipe can track hand movements in real-time, making it suitable for hand gesture recognition and interaction with virtual objects.

4. Object Detection: MediaPipe can detect and track objects using machine learning models in real-time. This functionality is useful for applications like robotics, surveillance, and augmented reality.

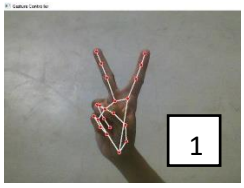
5. Pose Estimation: MediaPipe can estimate the poses of human bodies in real-time, making it useful for applications like fitness tracking, sports analysis, and augmented reality.

Therefore, MediaPipe is an essential library for computer vision and ML tasks, offering functionalities such as video and audio processing, facial recognition, hand tracking, object detection, and pose estimation.

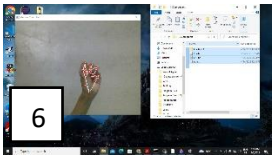


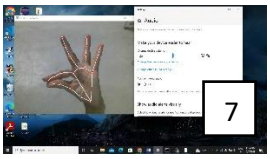
6. IMPLEMENTATION

Mouse Functions Based on Hand Gestures and Hand Tip Detection using Computer Vision:



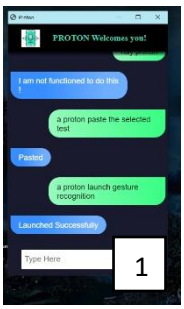
1. Mouse cursor movement around the computer window.
2. To Perform Left Button Click operation
3. To Perform Right Button Click operation
4. To perform a double click operation

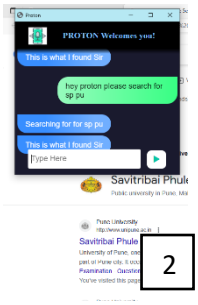


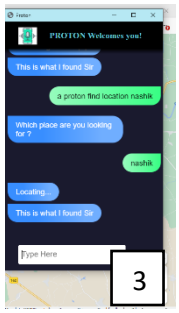


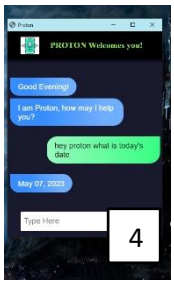
5. To perform drag and drop operation
6. To perform multiple item selection
7. To perform volume controlling
8. For No Action / neutral gesture to be Performed on the Screen

Voice Assistant Features









1. To launch and end the gesture recognition
2. To search for something over internet
3. To find a location what we are looking for
4. To get an idea about Date and time
5. To copy and paste contents
6. To exit voice assistant

7. RESULTS AND EVALUATION

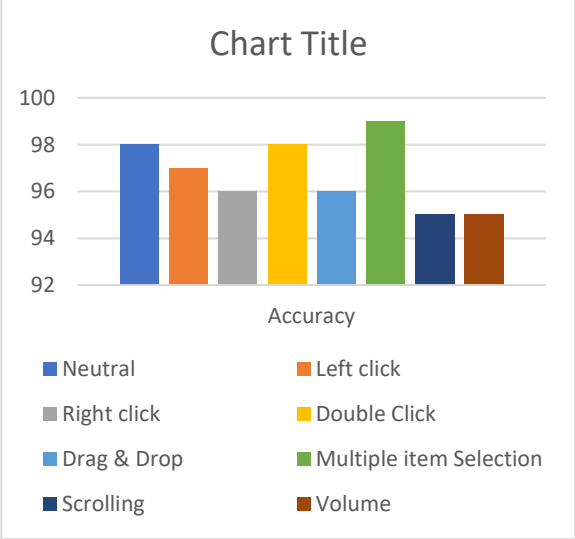
A virtual mouse controlled by hand gestures has the potential to serve as an alternative for people with disabilities who struggle with traditional mouse and keyboard usage. By simplifying their computer interactions, this technology can enhance their ability to engage with devices. Additionally, those who prefer to work or play games without a physical mouse or touchpad can benefit from a hand gesture-controlled virtual mouse. This model eliminates the need for a physical interface, enabling users to control their devices from a distance.

Depending on the technology employed, a hand gesture-controlled virtual mouse may provide greater precision and speed than traditional mice or video editing. The success of this innovation is dependent on the user experience it delivers. If the technology proves to be user-friendly, dependable, and intuitive, it is likely to be well-received. However, if the technology proves to be difficult to use, unreliable, or unintuitive, users are likely to abandon it quickly.

8. CONCLUSION

hand gesture-controlled virtual mouse is an innovative and exciting technology that has the potential to revolutionize the way we interact with computers. Here with the aid of a real-time camera, we have created a system to manage the mouse pointer and carry out its function. It offers users a more natural, intuitive, and accessible way to control the cursor on the screen, without the need for a traditional input device, a mouse.

Furthermore, with additional voice assistant support, AI virtual mouse using hand gestures can further enhance the user experience. Voice assistant which is integrated with the virtual mouse system will provide users with even more control over their devices. Users can given voice commands to do a range of tasks, such as opening applications, navigating through menus, and performing web searches, in addition to controlling the cursor on the screen using hand gestures. As technology continues to evolve, we can expect to see even more innovative solutions that enhance the user experience and improve accessibility for all.



Overall, the hand gesture-controlled virtual mouse has the potential to improve the accessibility of and convenience of computer interaction for users with physical disabilities or for users who prefer an alternative to traditional input devices.

Analysis: Dr. Pratibha V. Waje provides Guidelines for archiving 97% accuracy in Hand Gesture Controller (Virtual Mouse) and Voice Assistant using OpenCV, ML, Python [10].

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