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AI VIRTUAL MOUSE USING COMPUTER VISION TEAM –8

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Abstract

This project presents a hand gesture recognition and control system that utilizes computer vision and machine learning techniques to interpret human hand gestures and perform corresponding actions on a computer. The system employs the MediaPipe framework to detect and track hand landmarks in real-time video feeds, and a custom-built gesture recognition algorithm to classify hand gestures into predefined categories.The project consists of three main modules Hand Recognition Controller, and Gesture Controller. Hand Recognition is responsible for detecting and tracking hand landmarks, classifying hand gestures, and providing gesture information to the Controller module. The Controller module executes actions based on the recognized gestures, while the Gesture Controller module serves as the entry point of the system, capturing video feeds, processing hand landmarks, and passing the information to the Hand Recognition and Controller modules.Overall, this project demonstrates a comprehensive hand gesture recognition and control system.

Keyword : Hand Gesture Recognition, Media Pipe, Computer Vision, Human Computer Interaction, GUI, Python, Cursor control, Image Processing, Voice commands.

1.INTRODUCTION

The rapid advancement of technology has transformed the way we interact with computers. Traditional input devices like mice and keyboards have been the primary means of interaction for decades. However, with the emergence of artificial intelligence (AI) and computer vision, new methods of human-computer interaction (HCI) are being developed. One such innovative approach is the AI-powered virtual mouse, which uses hand tracking and gesture recognition to mimic traditional mouse functionality.

The technology has made the mouse functionality from wired into the wireless to improve the functionality and for the easy movements in hassle free manner. As the technologies started growing there came the speech recognition technique. This recognition is mainly used for the voice recognition purpose for searching something with the help of their voice and for translation purposes but it can take time for recognition to perform mouse functions. Later the human computer interaction evolved with the eye tracking techniques for controlling the cursor of the mouse. The major drawback of this technique is that some may wear contact lens or some may have long eyelashes so it may take some time to capture their eye movement.

Hand gesture controlled virtual mouse using artificial intelligence is a technology that allows users to control the movement of their computer mouse using hand gestures, without the advent of a physical mouse. This technology uses a camera vision based approach to track the movements of the user's hand and to perform mouse functions on the computer screen. The system works by capturing video input from a camera pointed at the user's hand. The computer vision algorithms then analyse the video feed to identify the user's hand and track its movement. This information is given to machine learning models which have been trained to recognize specific hand gestures, such as pointing or swiping, and translate them into corresponding mouse movements.

2.LITERATURE SURVEY

Some work which is related to the AI virtual mouse had been performed previously in that glove were used by the user to recognize and collect data from the system. Later another system used colored pieces of paper which are attached on hands for gesture recognition. But these systems are not very feasible for performing mouse operations accurately.The current gesture controlled virtual mouse uses hand gestures to perform mouse functions, in which we have control over the mouse cursor and perform certain mouse operations like left click, right click, drag and drop, volume control and brightness control etc. Efforts have been made for hand gesture recognition with camera-based detection of the hand gesture interface. Abhilash SS in (2018) proposed "Virtual Mouse Using Hand Gesture" where the model detection is based on colors. But, only few mouse functions are performed. The vision based technique has been tried out in this system. Utilized a webcam for gesture recognition and detection. And no external devices like sensors and gloves were used. Completely focuses on leveraging the YOLOv5 algorithm and Artificial Intelligence (AI) to recognize hand gestures and improve HCI(2022).This study focuses on the advanced study of robots with gesture controls. The first section gives an idea of the art for hand gesture identification as it relates to how they are seen and captured by common video cameras. Based on estimations of the smoothed optical flow, we extract a collection of motion features. Face detection is used to produce a user-centric representation of this data, and an effective classifier is trained to differentiate (2016).The system can create coloured masks utilizing techniques for color variation. Later mouse functions are carried out using hand gestures. This approach is difficult in itsimplementation (2019).A method for performing mouse functions without any electrical equipment like sensors. It requires a webcam alone. And mouse functions like clicking and dragging files are carried out through hand gestures.The suggested model performance is low with accuracy and lacks more mouse functionality (2021).

3.EXISTING SYSTEM

The current landscape of human-computer interaction predominantly relies on traditional input devices such as keyboards and mice, which may pose limitations for users with mobility impairments or those seeking more intuitive ways to interact with technology. While some alternative input methods exist, such as touchscreens and voice commands, they may not fully address the diverse needs and preferences of users. Moreover, standalone chatbots often lack seamless integration with gesture control systems, leading to disjointed user experiences and limited functionality.

4. PROBLEM STATEMENT

The goal of this project is to design and develop an AI-powered virtual mouse system that uses hand tracking and gesture recognition to mimic traditional mouse functionality. The system should be able to accurately track hand movements and recognize gestures in real-time using a webcam and machine learning algorithms. The system should be able to translate hand gestures into corresponding mouse actions, such as left click, right click, double click, and screenshot. The system should also provide a user-friendly and intuitive interface for interacting with computers.The expected outcome of this project is a functional AI-powered virtual mouse system that uses hand tracking and gesture recognition. The system should be able to accurately track hand movements and recognize gestures in real-time, and provide a user-friendly and intuitive interface for interacting with computers.

5.PROPOSED SYSTEM

Our proposed Gesture-Controlled Virtual Mouse with Integrated Chatbot system aims to overcome these limitations by offering a seamless and intuitive user experience that combines gesture control technology with a conversational interface. By integrating gesture recognition capabilities with a robust chatbot framework, users can interact with their computing devices using natural hand gestures and voice commands, enabling greater accessibility, efficiency, and user satisfaction. Through this integrated approach, we seek to provide users with a versatile and inclusive interaction platform that enhances productivity, fosters innovation, and improves overall user experience.

Advantages

Eliminates the need for physical mouse.

Reduces physical strain.

Making the interaction with computers more intuitive and user-friendly.

Hand gestures are more intuitive and can be quickly grasped by users.

6.METHODOLOGY

A. Algorithm Used for Hand Tracking

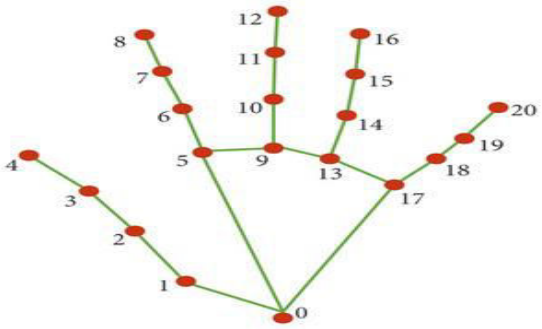
The MediaPipe framework is employed for purposes of identifying the hand gestures and hand tracking, and the OpenCV library is used in the context of computer vision [7–10]. The algorithm employs machine learning notions to track and detect hand gestures and hand tip.

1.MediaPipe

MediaPipe, which is an opensource framework by Google, is a framework which applies in a machine learning pipeline. The MediaPipe framework is useful for cross platform development since the framework is built using time series data. The MediaPipe framework is multimodal, in the framework is applied to different audio image or video. The framework a developer of a system built and analyze while built through graphs, developer also are used for building all the systems for application purposes. Steps can all be applied in the system that used MediaPipe, they are in the pipeline configuration. This pipeline can run in a variety

of platforms, they are scalable methods in mobile or desktop. The MediaPipe framework has three basic parts; performance evaluation, sensor data retrieval framework, and reusable collection of components referred to as calculators. A pipeline is another name for graph, so it could be a graph which contains calculators referred to as components, the calculators are connected in streams and packets of data flow through in data streams. Developers can replace or defined custom calculators anywhere in the graph for their application. The calculators and streams create a data-flow diagram, and below is a graph created in MediaPipe which the calculators are nodes, and the packets of data are flow through each stream.

A single-shot detector model is used to find and identify a hand or palm quickly. This model is used by MediaPipe. First, in the hand detection part, it is trained to recognize palms because it's simpler to train for palms. Also, the non maximum suppression works much better on small things like palms or fists. A hand landmark model involves finding the positions of 21 joints or knuckle points in the hand area.



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

2.OpenCV

OpenCV is a computer vision library that contains image-processing algorithms for object identification. OpenCV, which is implemented in the Python programming language, is the computer vision library that allows real-time computer vision applications to be developed. The OpenCV library was developed for image processing and video processing, along with analysis such as face recognition and object detection.

B. Implementation

Pre-processing, or more specifically, image processing is an earlier step in computer vision which aims to convert an image into a format suitable for further study. Tasks such as brightness correction, color correction, image noise reduction, or sharpening an image have significant importance and can be quite demanding in order to achieve satisfactory results. For this article, I will attempt to present a portion of the standard image processing methods,

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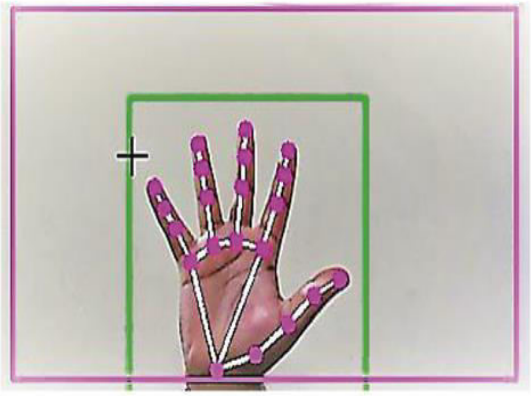
using an exceptionally well-known Computer Vision library (Open-CV). I will try and summarize quickly how each task works and emphasize more on dealing with the topic more practically by giving you all the code you need so you have an engaged experience in the material.

1. The Camera Used in the AI Virtual Mouse System

The suggested AI virtual mouse system is grounded on the frames which are captured by the laptop or PC's web camera. Using the computer vision library of Python OpenCV, the video capture object is created and the webcam will start to capture video .The webcam captures and sends the frames to the AI virtual mouse system.



Capturing the Video and Processing

The AI virtual mouse system uses the webcam where each frame is captured till the termination of the program. The video frames are processed from BGR to RGB color space to find the hands in the video frame by frame as shown in the following code: def findHands(self, img, draw = True):

imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

self.results = self.hands.process(imgRGB)

2. Rectangular Region for Moving through the Window

The virtual mouse system employs the transformation algorithm, where it transforms the fingertip co-ordinates from the webcam screen into the computer window full screen for controlling the mouse. When we detect the hands and all of the information we gained to determine which finger is up to perform the specific mouse function, we then draw a rectangular box with respect to the computer window in the webcam region, where we move throughout the window with the mouse cursor.

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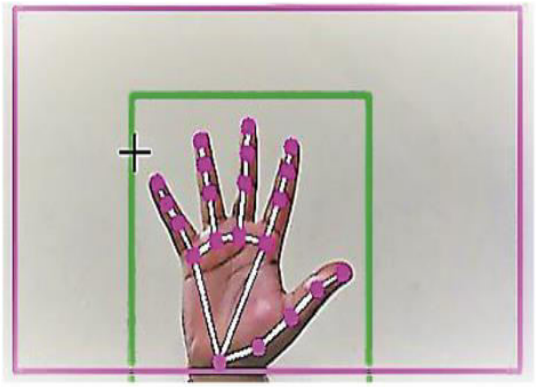
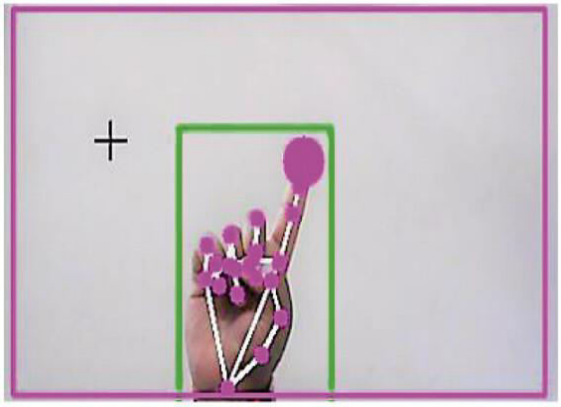


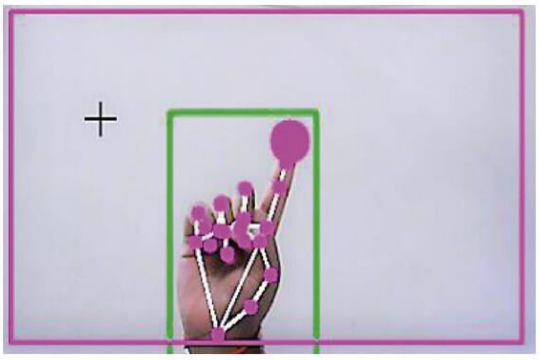
3. Detecting Which Finger Is Up and Performing the Particular Mouse Function

At this stage, we are detecting which finger is up, using the tip Id of the respective finger that we found using the MediaPipe, and the respective co-ordinates of the fingers .Based on that, the respective mouse function would be performed.



4. For the Mouse Cursor Moving around the Computer Window

f an index finger goes up to tip Id=1 or if both the index finger with the tip Id=1 and the middle finger with the tip Id=2 are up, Autopy python library tracks the mouse cursor gets to move around the window.



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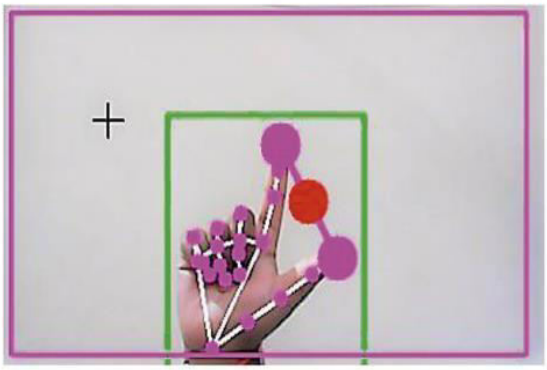
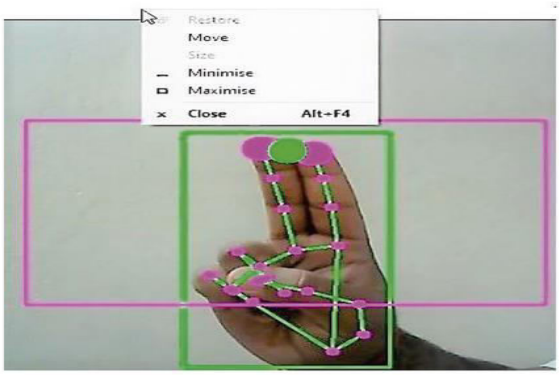
5. For the Mouse to Perform Left Button Click

If both the index finger with tip Id = 1 and the thumb finger with tip Id = 0 are up and the distance between the two fingers is lesser than 30px, the computer is made to perform the left mouse button click using the pynput Python package.



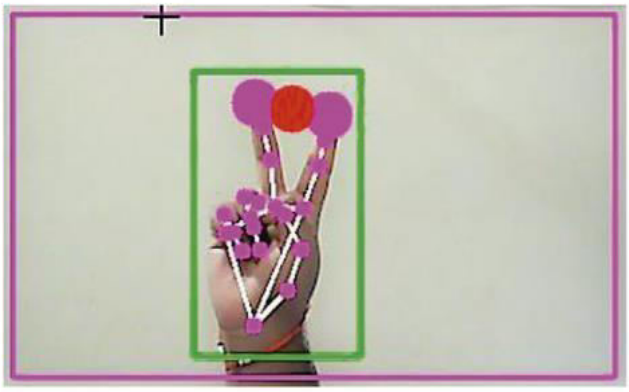
6. For the Mouse to Perform Right Button Click

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is lesser than 40 px, the computer is made to perform the right mouse button click using the pynput Python package.



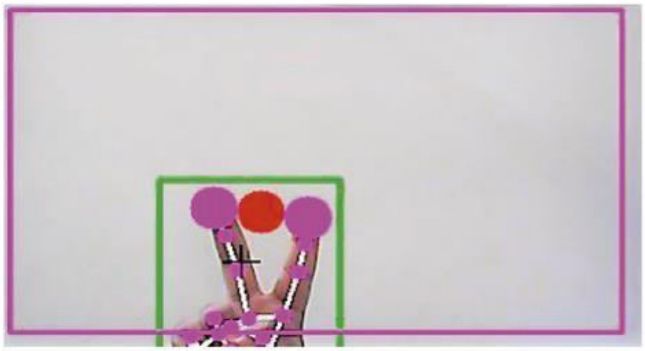
7. For the Mouse to Perform Scroll up Function

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is greater than 40 px and if the two fingers are moved up the page, the computer is made to perform the scroll up mouse function using the PyAutoGUI Python package.



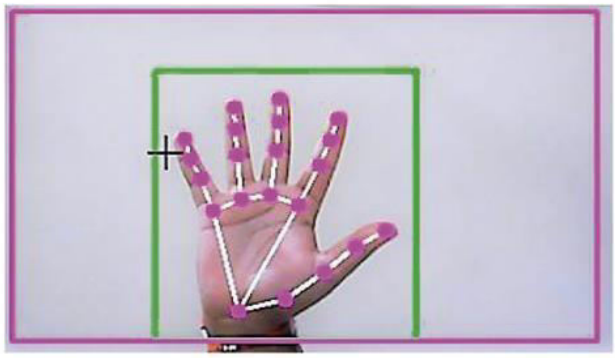
8. For the Mouse to Perform Scroll down Function

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is greater than 40px and if the two fingers are moved down the page, the computer is made to perform the scroll down mouse function using the PyAutoGUI Python package.



For No Action to be Performed on the Screen

If all the fingers are up with tip Id = 0, 1, 2, 3, and 4, the computer is made to not perform any mouse events in the screen.



7.CONCLUSION

The principal purpose of the AI virtual mouse system is to control the mouse cursor functions by utilizing the hand gestures instead of a physical mouse. The proposed system can be

accomplished using a webcam or a built-in camera that detects the hand gesture and hand tip and then integrates those frames into performing the particular mouse functions. From the model's results, we can conclude that the proposed AI virtual mouse system has done quite well and with greater accuracy than the other existing models, and also the model overcomes most of the limitations of the existing models. Since the proposed model has demonstrated to have greater accuracy, the AI virtual mouse can have real life applications, and also it has potential to reduce the transmission of COVID-19 because the proposed mouse system can be accomplished virtually with hand gestures, and thus without using the traditional physical mouse.The model does have limitations, for instance, there was a small reduction in accuracy in the right click mouse function and difficulty in clicking and dragging to select text. Therefore, in the performance. The gesture recognition rate was also acceptable, with the virtual mouse system positively recognizing most hand gestures in controlling mouse movements.

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BIBLIOGRAPHY

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