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Navigating Digital World with Open CV Hand Gestures

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ABSTRACT: The mouse is one of HCI's (Human Computer Interaction) incredible inventions. A wireless mouse or a Bluetooth mouse still uses devices because a battery is needed for power and a dongle is needed to connect the mouse to the PC.Therefore, they are not totally device-free. The proposed AI virtual mouse system can solve this problem by using a webcam or built-in camera to record hand motions and identify hand tips using computer vision. The system's algorithm makes use of the machine learning algorithm. The computer can be controlled digitally and can do left-click, right-click, scrolling, and computer cursor functions based on hand motions without the need for a physical mouse. As a result, by eliminating human contact and the requirement for external devices to operate the computer, the suggested strategy will stop the spread of COVID-19.

KEYWORDS: Virtual mouse, AI, Autopy, Opencv, Mediapipe

I.INTRODUCTION

In general, devices are becoming compact in the form of Bluetooth or wireless technologies. This project proposes an AI virtual mouse system that makes use of the hand gestures and hand tip detection for performing mouse functions in the computer using computer vision. Because of advancements in Bluetooth and wireless technology, augmented reality, and other related sectors, the devices we use every day are becoming smaller. In this study, a computer vision-based virtual mouse system that employs hand gestures and hand tip detection to replicate mouse motions was developed. The main objective of the proposed system is to replace the traditional mouse with a web camera or a built-in camera in the computer to perform computer mouse cursor and scroll tasks. The AI virtual mouse technology allows us to conduct mouse cursor actions like scrolling and moving the pointer while also monitoring the fingertip of a hand gesture using a built-in camera or web camera. In this study, the user uses a built-in camera or webcam together with hand gestures to operate a computer mouse, as opposed to using a wireless or Bluetooth mouse, which needs a particular peripheral such as a mouse, a dongle to connect to the PC, and a battery to operate. The suggested system uses a web camera to record, examine, and decipher the captured frames, identify various hand and hand-tip gestures, and then carry out the relevant mouse action.

The Python programming language and the OpenCV package were used to construct the AI virtual mouse system. The suggested AI virtual mouse system leverages the Media Pipe package for hand tracking and hand tricks. Additionally, the desktop window may be moved around and operations like scrolling and left-and right-clicking are carried out using the Pynput, Autopy, and PyAutoGUI packages. The findings of the proposed model demonstrate a very high degree of accuracy, and it can operate in real-world applications using CPU utilization rather than GPU.

OBJECTIVE: The Hand Following Algorithm was used: - To recognize hand gestures and track hands on a laptop, the MediaPipe framework and therefore the OpenCV package are both employed. The application uses machine learning concepts to partially track and detect hand gestures and hand tips.

The first goal of the planned AI virtual mouse system is to form a replacement for the traditional mouse system that can perform and manage mouse functions. This will be finished the help of an internet camera that records hand gestures and hand tips so processes these frames to hold out the mouse functions, like a left click, right click, or scrolling function.

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II.LITERATURE SURVEY

There are traditional approaches for virtual keyboard and mouse systems which are usually based on hand gestures. But few are done using deep learning and few using different algorithms. Our literature review focuses on the research works on virtual keyboard and virtual mouse which were published previously.

In 2016, S. Shetty et al. constructed a virtual mouse system using color detection. They used webcam for detecting mouse cursor movement and click events using OpenCV built-in functions. A mouse driver, written in java, is required as well. This system fails to perform well in rough background. P. C.

Shindhe et al. expanded a method for mouse free cursor control where mouse cursor operations are controlled by using hand fingers. They have collected hand gestures via webcam using color detection principles. The built-in function of image processing toolbox in MATLAB and a mouse driver, written in java are used in this approach. The pointer was not too efficient on the air as the cursor was very sensitive to the motion.

In 2019, K. Hassan et al. presented a system to design and develop a hand gesture based virtual mouse. They captured different gestures via webcam and performed mouse functions according to the gestures. This system achieved 78%-90% accuracy. The system does not work efficiently in the complex or rough background.

In 2021, S. Shriram presented a hand-gesture based virtual mouse system using deep-learning. This system achieved 99% accuracy but didn't develop keyboard and there is less accuracy in right-click function, clicking and dragging operations are less accurate.

In 2010, Y. Adajania et. al developed a Virtual Keyboard Using Shadow Analysis. This system detects keyboard, hands shadow and finger tips using color. This system can analyze 3 frames per second.

In 2011, S. Hernanto et al. built a method for virtual keyboard using webcam. In this approach, two functions are used for finger detection and location. This system used two different webcams which are used to detect skin and location separately. The average time per character of this virtual keyboard is 2.92 milliseconds and the average accuracy of this system is 88.61%.

In 2015, I. Patil et al. constructed a virtual keyboard interaction system using eye gaze and eye blinking. Their system first detects face and then detects eye and nose region to recognize an eye blink. The OpenCV java framework is used in this approach. In 160X120 frame size, this approach achieves 48% accuracy and in 1280X960 frame size, 98% accuracy is achieved.

In 2016, Hubert Cecotti developed a system for disabled people named a multimodal gaze-controlled virtual keyboard. The virtual keyboard has 8 main commands for menu selection to spell 30 different characters and a delete button to recover from error. They evaluated the performance of the system using the speed and information transfer rate at both the command and application levels.

In 2017, S. Bhuvana et al. constructed a virtual keyboard interaction system using webcam. This system can detect the hand position over the virtual keyboard. This system provides a white paper virtual keyboard image and detects which character is pointed. This approach used built-in function of Image Processing Toolbox in MATLAB.

In 2018, Jagannathan MJ et al. presented finger recognition and gesture based augmented keyboard system. As we can see from the reviewed literature, previous systems include either virtual keyboard or virtual mouse. Those systems can't fully eliminate the need of mouse and keyboard completely. This work aims to build an interactive computer system which can be operated without any physical mouse and keyboard by just recognizing hand-gestures with high accuracy.

III.SYSTEM ANALYSIS

EXISTING SYSTEM

A Computer Mouse is an input device that helps to point and to interact with whatever that is being pointed. There are so many types of mouse in the current trend, there's the mechanical mouse that consists of a single rubber ball which can rotate in any direction and the movement of the pointer is determined by the motion of that rubber ball. Later the

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mechanical mouse is replaced by the Optical Mouse. Optical Mouse consists of a led sensor to detect the movement of the pointer. Years Later the laser mouse was introduced to improve the accuracy and to overcome the drawbacks of the Optical Mouse. Later as the Technology has been increased drastically wireless mouse was introduced so as to enable hassle free movement of the mouse and to improve the accuracy. No Matter how much the accuracy of the mouse increases but there will always be limitations of the mouse as the mouse is a hardware input device and there can be some problems like mouse click not functioning properly ad etc., as the mouse is a hardware device like any other physical object even the mouse will have a durability time within which is functional and after its durability time we have to change the mouse

DRAWBACKS

- There will always be limitations of the mouse as the mouse is a hardware input device and there can be some problems like mouse click not functioning properly.
- The mouse is a hardware device like any other physical object even the mouse will have a durability time within which is functional and
- After its durability time we have to change the mouse.

PROPOSED SYSTEM

The proposed AI virtual mouse system can solve this problem by using a webcam or built-in camera to record hand motions and identify hand tips using computer vision. The system's algorithm makes use of the machine learning algorithm. The computer can be controlled digitally and can do left-click, right-click, scrolling, and computer cursor functions based on hand motions without the need for a physical mouse. As a result, by eliminating human contact and the requirement for external devices to operate the computer, the suggested strategy will stop the spread of COVID-19

ADVANTAGES

- Virtual Mouse using Hand gesture recognition allows users to control mouse with the help of hand gestures.
- System's webcam is used for tracking hand gestures.
- Computer vision techniques are used for gesture recognition. OpenCV consists of a package called video capture which is used to capture data from a live video.
- Main thing we need to identify are the applications the model is going to develop so the development of the mouse movement without using the system mouse.

IV.METHODOLOGY

Media Pipe:

A framework known as Media Pipe, that is an ASCII text file framework from Google, is employed to use during a machine learning pipeline. Provided that it is created utilizing statistical data, the Media Pipe framework is useful for cross-platform development. As a multimodal framework, the Media Pipe are often used with a range of audio and video files. The Media Pipe framework is used by the developer to make and analyse systems mistreatments and, similarly, to create systems for application-related purposes. The pipeline configuration is used to hold out the processes in the media pipe-using system. Measurability on desktops and mobile devices is enabled by the pipeline's flexibility to execute on many platforms. The 3 core elements that frame the Media Pipe design are performance evaluation, a system for getting detector data, and a gaggle of reusable items referred to as calculators. A pipeline could be a design made from units referred to as calculators that are connected to at least one another by streams via which knowledge packets pass. Developers will add, remove, or redefine custom calculators anyplace within an application created with Media Pipe, where every node is a calculator, and therefore the nodes are connected by streams, and the streams along generate a data-flow diagram. Detective work and characterization of a hand or palm in real time is finished by employing a single-shot detector model. The Media Pipe uses the single-shot detector model. Since coaching palms is easier than training hands, the hand detection module first trains a model for palm detection. Additionally, for tiny things just like your palms or fists, the non-maximum suppression performs perceptibly better. Placement of joint or knuckle coordinates within the hand region constitutes a model of hand landmark.

OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis. To identify image pattern and its various features we use vector space and perform mathematical operations on these features. The first OpenCV

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version was 1.0. OpenCV is released under a BSD license and hence it's free for both academic and commercial use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. When OpenCV was designed the main focus was real-time applications for computational efficiency. All things are written in optimized C/C++ to take advantage of multi-core processing.

PROPOSED MODEL

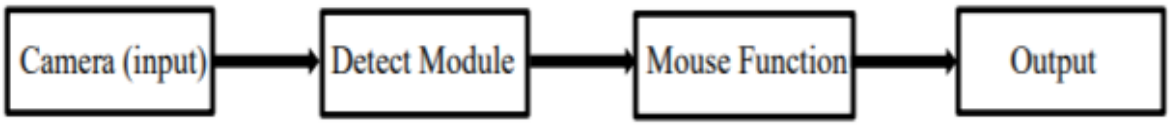

Fig.1 FLOW DIAGRAM

1. **Camera Used in the AI Virtual Mouse System**
   The proposed AI virtual mouse system is based on the frames that have been captured by the webcam in a laptop or PC. By using the Python computer vision library OpenCV, the video capture object is created and the web camera will start capturing video. The web camera captures and passes the frames to the AI virtual system.
2. **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.
3. **(Virtual Screen Matching) Region for moving through the window**
   The AI virtual mouse system makes use of the transformational algorithm, and it converts the coordinates of fingertip from the webcam screen to the computer window full screen for controlling the mouse. When the hands are detected and when we find which finger is up for performing the specific mouse function, the web-cam captures that particular frame and process further operation.
4. **Detecting Which Finger Is Up and Performing the Particular Mouse Function**
   In 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 that are up, and according to that, the particular mouse function is performed.

5. Mouse and keyboard Functions Depending on the Hand Gestures and Hand Tip Detection Using Computer Vision

1. If index finger with tip id 1 is up then the mouse is moved around the window of the computer by using AutoPy package.
2. If both index finger with tip id 1 and middle finger with tip id 2 are up then the Right-click operation is performed by using PyautoGUI package.
3. If middle finger with tip id 2, ring finger with tip id 3 and little finger with tip id 4 are up then the scroll-down operation is performed by using PyautoGUI package.

V.RESULT

This AI virtual mouse system and virtual keyboard can be created totally utilizing open- source software. So, anyone can utilize anywhere with computers, no particular preparing ought to be required to function the framework. They just need to know the hand gestures for particular operation. This project uses the concept of advancing the HCI using computer vision. In this proposed system, there is no drawback of detecting of different skin colors of hand. The proposed systems use the following tools i.e., Python3.8 and above, OpenCV, MediaPipe, Numpy, Autopy, PyAutoGUI and time. This complete process is implemented in the PyCharm platform. Once after running the program, the camera of your device will be automatically accessed and you can start operating your system with different hand gestures. Different hand gestures for computer to perform mouse operations are given below:

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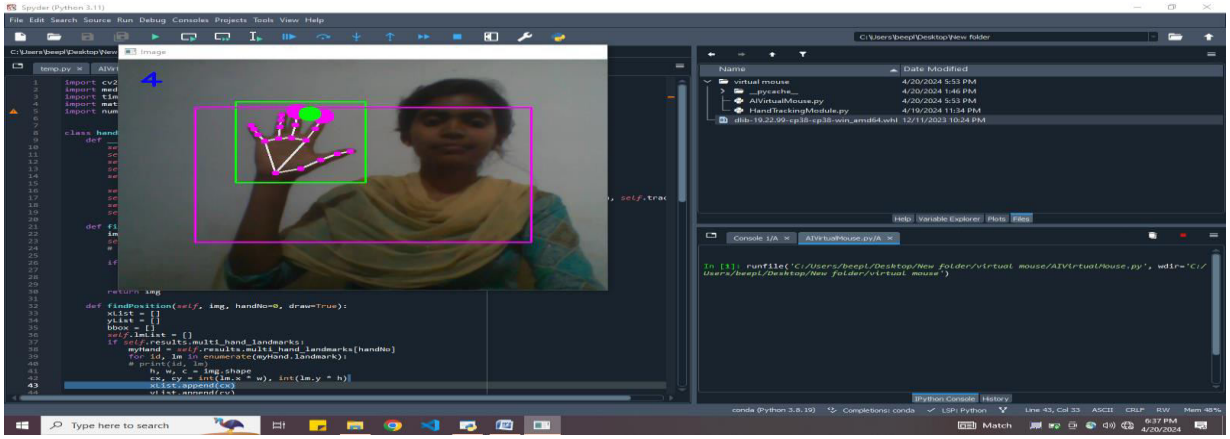

Fig 5.1: Recognizing hand (No operation)

If all tip id's are up then hand is recognized, that can be observed in Fig 5.1.

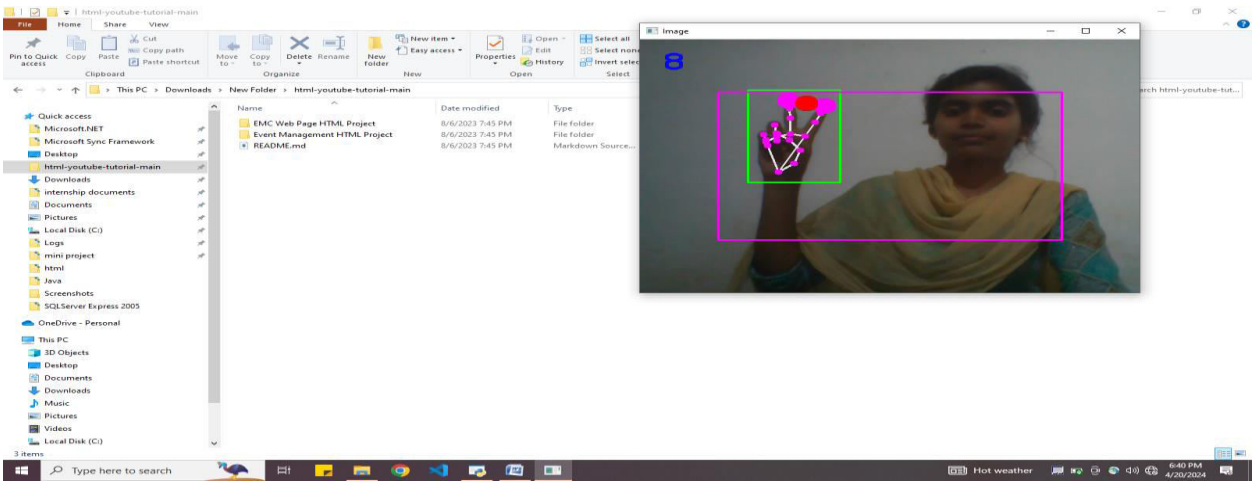

Fig 5.2: Gesture for left click function

If both index finger with tip id 1 and middle finger with tip id 2 are up then the left-click operation is performed by using PyautoGUI package as shown in Fig 8.2.

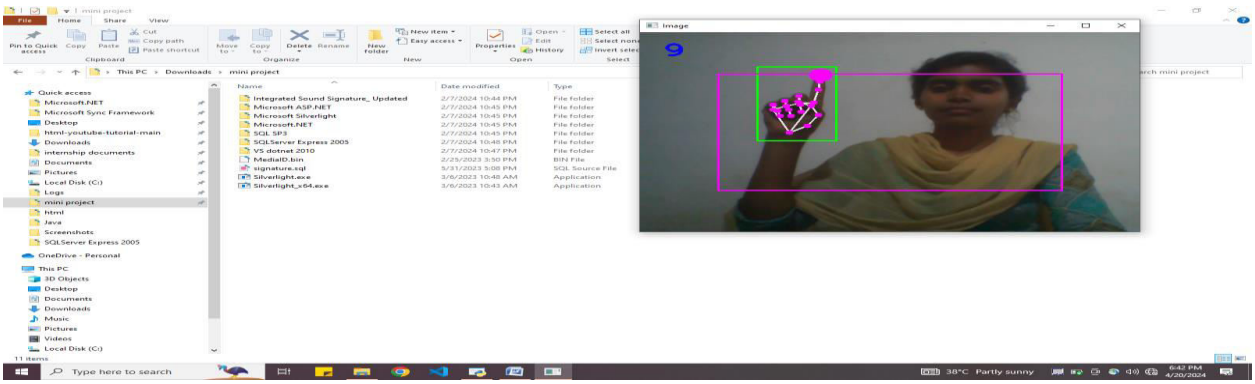

Fig 5.3: Gesture for mouse movement

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If index finger with tip id 1 is up then the mouse is moved around the window of the computer by using AutoPy package as shown in Fig 5.3.

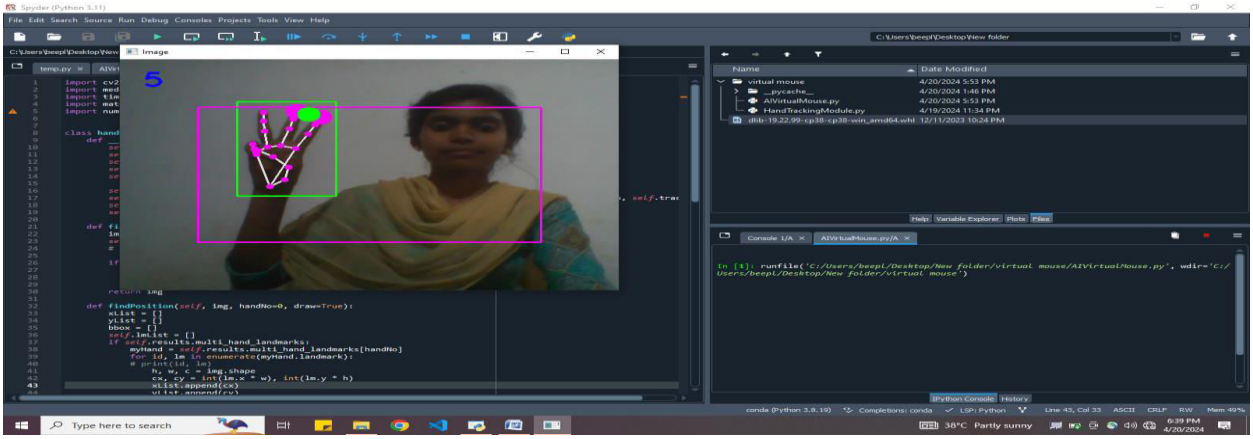

Fig5.4Gesture for scroll up function

If both thumb finger with tip id 0 and index finger with tip id 1 are up then the scroll-up operation is performed by using PyautoGUI package as shown in Fig 5.4

VI.CONCLUSION

In conclusion, the virtual mouse control system using hand class gesture in Python is an innovative solution that enables users to control their computers using hand gestures. This system has numerous potential applications, including assistive technologies for individuals with disabilities, as well as in gaming and entertainment. The development of this system requires expertise in computer vision, machine learning, and Python programming. Several libraries and packages, such as OpenCV, PyAutoGUI, and Mediapipe, are instrumental in enabling the functionality of the system. The input and output design of the system must be carefully considered to ensure that it is intuitive and user-friendly. Additionally, rigorous testing and maintenance processes are critical to ensuring the system's continued functionality and efficiency. Overall, the virtual mouse control system using hand class gesture in Python represents a powerful tool for enhancing computer accessibility and control. While there are still some limitations to the technology, such as challenges with detecting fine-grained hand movements, ongoing research and development efforts are likely to improve the system's accuracy and performance over time.

VII.FUTURE SCOPE

This AI virtual mouse has some drawbacks such as drop in accuracy of some functions like right click operation and inability to perform other mouse functions such as dragging and dropping, and selecting text. Another major limitation is that this model cannot function in the dark or low light settings. These drawbacks can be addressed in the future and can be overcome. Apart from the above-mentioned, additionally key board capability can be incorporated to emulate keyboard functions along with the mouse operations which proves to be the scope for the future.

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