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Virtual Mouse Implementation using OpenCV

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ABSTRACT: The mouse is one of the marvellous inventions of Human - Computer Interaction. (HCI) technology. Currently, wireless mouse or a Bluetooth mouse still uses devices and is not free of devices totally since it uses a battery for power and a dongle to connect it to the PC. This limitation can be overcome by placing webcam or a built-in camera for capturing of hand gestures and hand tip detection using computer vision. So, this project proposes an AI virtual mouse system that makes use of the hand gestures and hand tip. Firstly it will capture then hand gesture and its tip after that, it will proceed to compare the existing gestures within the frames with a list of our gesture combinations, where different combinations include different mouse functions. If the current gesture combination found a match, the program will execute the mouse function, which will be translated into an actual mouse function to the users' machine. The main objective of our proposed system is to perform computer mouse cursor functions using a web camera or a built-in camera in the computer instead of using a traditional mouse device. The proposed system will avoid COVID-19 spread by eliminating the human interaction and dependency of devices to control the computer.

KEYWORDS: Virtual Mouse, Human-Computer Interaction (HCI), OpenCV, Python, MediaPipe.

I. INTRODUCTION

With new changes seen in computer technology day by day, it has become utterly essential for us to find specific new ways of interaction with computer systems as its need is increasing in society every day. Today, every device is making the use of touch screen technology on its systems, which isn't cost-effective to be used in all applications. A specific interactive module like a virtual mouse that makes use of hand gestures and hand tip. That will help us to interact can be another option for the traditional touch screen and the physical mouse. One of the simplest, proficient, and significant ways of human communication is through hand gestures that people tend to make use of even unknowingly and a universally accepted language.

In this project, a virtual hand gesture mouse controlling system is proposed. In our setup of the system, a fixed integrated laptop camera is used to keep the cost at a minimum to implement the system in a cheap way affordable to be used by everyone without the need for any additional equipment.

Python programming language is used for building the AI virtual mouse system, and also, OpenCV which is the library for computer vision is used in the AI virtual mouse system. Model makes use of the MediaPipe package for the tracking of the hands and for tracking of the tip of the hands, and also Autopy package which will allow us to move around with our mouse for performing functions such as left click, right click, and scrolling function.

MediaPipe is a framework which is near in a machine learning pipeline, and it is an open source framework of Google. The MediaPipe framework is useful for cross platform development can be applied to various audios and videos framework is used by the developer for building and analysing the systems through graphs, and it also been used for developing the systems for the implementation purpose. A model of hand landmark consists of locating 21 joint or knuckle co-ordinates in the hand region, as shown in below Figure

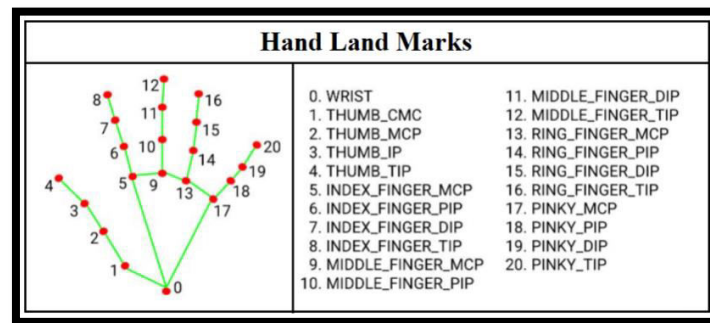


Figure 1.1 Co-ordinates or Landmarks of Hands

OpenCV is a computer vision library which consists of image-processing algorithms for object detection. OpenCV is a library of python programming language, and real-time computer vision applications can be developed by using the computer vision library. The OpenCV library is used in image and video processing and also analysis such as face detection and object detection.

II. RELATED WORK

There are some related works carried out on virtual mouse using hand gesture detection by wearing a glove in the hand and also using color tips in the hands for gesture recognition, but they are no more accurate in mouse functions. The recognition is not so accurate because of wearing gloves; also, the gloves are also not suited for some users especially in this pandemic situation, and in some cases, the recognition is not so accurate because of the failure of detection of color tips.

Kollipara S. Varun, J. Puneeth, Dr. T. Prem Jacob in 2019 [1] proposed “Virtual Mouse Implementation using Open CV” Hand Gesture Recognition plays a key role in human-computer interactions. As we can see that there are so many new Technological advancements happening such as biometric authentication which we can see frequently in our smart phones, similarly hand gesture recognition is a modern way of human-computer interaction i.e., we can control our system by showing our hands in front of webcam and hand gesture recognition can be useful for all kinds of people. Based upon this idea this paper is presented. This paper provides a detailed explanation to the algorithms and methodologies for the color detection and virtual mouse.

J. T. Camillo Lugaresi, in 2019 [2] proposed a “MediaPipe: A Framework for Building Perception Pipelines” The MediaPipe framework addresses all of these challenges. A developer can use MediaPipe to build prototypes by combining existing perception components, to advance them to polished cross-platform applications and measure system performance and resource consumption on target platforms. We show that these features enable a developer to focus on the algorithm or model development and use MediaPipe as an environment for iteratively improving their application with results reproducible across different devices and platforms.

Monali Shetty, Christina A. Daniel, Manthan K. Bhatkar, Ofrin P. Lopes [3] proposed “Virtual Mouse Using Object Tracking” which includes with new changes seen in computer technology day by day, it has become quite essential for us to find specific new ways of interaction with computer systems as its need is increasing in society every day. Today, every device is making the use of touch screen technology on its systems, which isn’t affordable to be used in all applications. A specific interactive module like a virtual mouse that makes use of Object Tracking and Gestures that will help us to interact can be an alternative way for the traditional touch screen and the physical mouse.

Vantukala VishnuTeja Reddy, Thumma Dhyanchand, Galla Vamsi Krishna, Satish Maheshwaram [4] proposed “Virtual Mouse Control Using Coloured Finger Tips and Hand Gesture Recognition” which includes human-computer interaction, virtual mouse implemented with fingertip recognition and hand gesture tracking based on image in a live video is one of the studies. In this paper, virtual mouse control using fingertip identification and hand gesture recognition is proposed. This study consists of two methods for tracking the fingers, one is by using coloured caps and other is by hand gesture detection. This includes three main steps that are finger detection using colour identification, hand gesture tracking and implementation on on-screen cursor. In this study, hand gesture tracking is generated through the detection of the contour and formation of a convex hull around it. Features of hands are extracted with the area ratio of contour and hull formed. Detailed tests are performed to check this algorithm in real world scenarios.

By going through this literature survey paper it is observed that there is need to improve the accuracy in the existing ones by using different algorithm. The next section illustrates the problem definition.

III. PROBLEM STATEMENT

It's no surprised that every technological devices have its own limitations, mostly when it comes to computer devices. After the evaluation of various type of the physical mouse, the problems are identified and generalized. The following describes the general problem that the current physical mouse suffers:

- Place where there is no space to use a physical mouse.
- For the persons who have problems in their hands and are not able to control a physical mouse.
- Also, amidst of the COVID-19 situation, it is not safe to use the devices by touching them because it may result in a spread of the virus by handling the devices.
- More probability of dropping from your desk and break down.
- If it is a Bluetooth mouse, it keeps using the Bluetooth assets of the laptop not allowing you to transfer files via Bluetooth unless disconnected.
- Wired USB mouse is that it has this wire dangling out of it.
- Physical mouse is expose to mechanical wear and tear.
- There was problem in exiting system of colour detection and controlling of mouse by wearing gloves.

So, our aim is to overcome all the above problem statement.

IV. IMPLEMENTATION

The various functions and actions used in the system are explained as below which are used for the real-time AI virtual mouse system.

4.1 The Camera Used in the AI Virtual Mouse System: The present 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, as shown in Figure 5.1 of chapter 5 (Results). The web camera captures and passes the frames to the AI virtual system.

4.2 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 colour space to find the hands in the video frame by frame as shown in the following code:

```
imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
self.results = self.hands.process(imgRGB)
```

4.3 (Virtual Screen Matching) Rectangular 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, a rectangular box is drawn with respect to the computer window in the webcam region where we move throughout the window using the mouse cursor, as shown in Figure 5.2 of Chapter 5 (Results).

4.4 Detecting Which Finger Is Up and Performing the Particular Mouse Function: In this stage, we are detecting which finger is up using the palm 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.

4.5 Mouse Functions Depending on the Hand Gestures and Hand Tip Detection Using Computer Vision:

4.5.1 For the Mouse Cursor Moving around the Computer Window: If the index finger is up with palm Id = 1 is up, the mouse cursor is made to move around the window of the computer using the Autopy package of Python, as shown in Figure 5.3 of Chapter 5.

4.5.2 For the Mouse to Perform Left Button Click:

If both the index finger with palm Id = 1 and the middle finger with palm Id = 2 are up and the distance between the two fingers is lesser than 40px, then the computer is made to perform the left mouse button click using the pynput Python package, as shown in Figure 5.4 of Chapter 5.

4.5.3 For the Mouse to Perform Double Click:

If both the index finger with palm Id = 1 and the middle finger with palm Id = 2 are up and the distance between the two fingers is lesser than 40px, and if this Gesture is performed twice then the Picture will be zoomed.

4.5.4 For No Action to be performed on the Screen:

If all the fingers are up with palm Id = 0, 1, 2, 3, and 4, the computer is made to not perform any mouse events in the screen, as shown in Figure 5.5 of Chapter 5.

V. RESULTS

In this we have included some snapshots of our project so that we could know how our system actually works, and hand gesture for specific function of mouse.

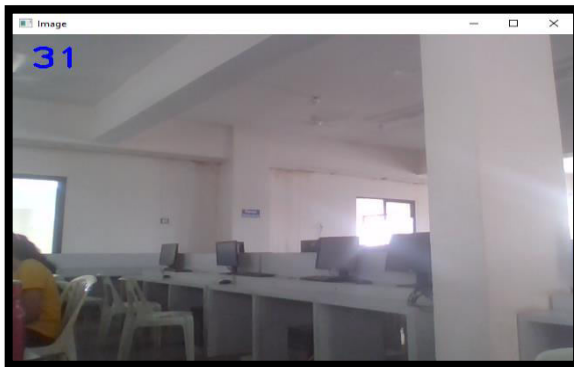


Figure 5.1 Camera Used in the AI Virtual Mouse System



Figure 5.2 Rectangular Region for Moving through the Window

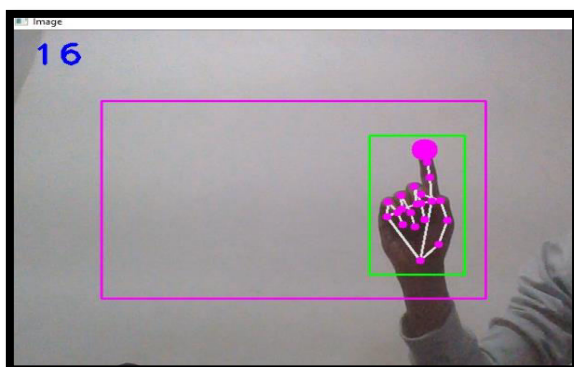


Figure 5.3 Cursor Moving around the Computer Window

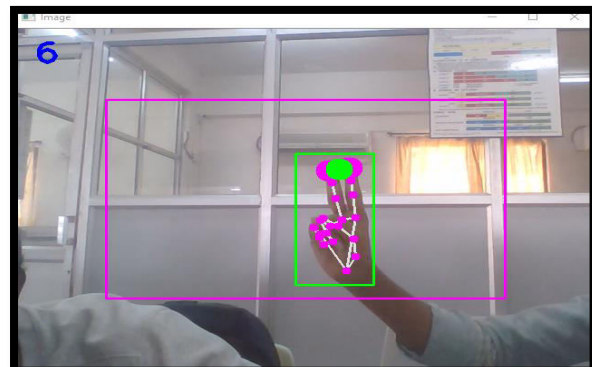


Figure 5.4 For the Mouse to Perform Left Button Click

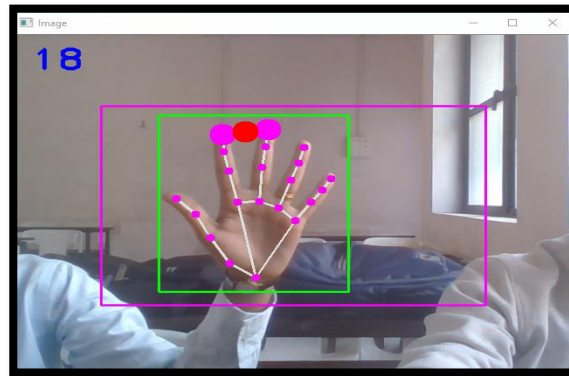


Figure 5.5 No action performed

VI. CONCLUSION AND FUTURE SCOPE

Due to accuracy and regulations plays an important role in making the program as useful as an actual physical mouse, a few techniques had to be implemented. After embedding such type of application there is big replacement of physical mouse i.e., there is no need of any physical mouse. From the results of our model, we can come to a conclusion that the proposed AI virtual mouse system has performed very well. Since our system the virtual mouse can be used for real-world applications, and also, it can be used to decrease the spread of viruses such as COVID-19.

In Overall, the modern technologies have come a long way in making the society life better in terms of work rate and lifestyle, not the other way around. Therefore, societies must not discuss on the past technologies while reluctant on accepting changes of the new one. Instead, it's advisable that they should embrace changes to have a more efficient, and productive lifestyle. The proposed AI virtual mouse has some limitations which will be overcome further such as we can add more functionality such as

- Right click
- Scroll up
- Scroll down
- Drag
- Drop
- Select text

Better Performance: The response time is heavily rely on the hardware of the machine, this includes the processing speed of the processor, the size of the available RAM, and the available features of webcam. Therefore, the program may have better performance when it's running on a decent machines with a webcam that performs better.

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[4] Vantukala VishnuTeja Reddy, Thumma Dhyanchand, Galla Vamsi Krishna, Satish Maheshwaram, “Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition”, Published in 2020 IEEE – HYDCON, Doi: 10.1109/HYDCON48903.2020.9242677

Links:

- <https://en.wikipedia.org/wiki/Webcam>
- <https://en.wikipedia.org/wiki/Laptop>
- <https://www.techtarget.com/searchsoftwarequality/definition/testing>



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