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AI Virtual Mouse

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Abstract –

One of the wonderful innovations in the area of Human-Computer Interaction (HCI) is the PC mouse. In the modern age of technology, a remote mouse or a contact-less mouse actually uses gadgets and isn't completely free of them because they consume power from the device or possibly external power sources like batteries and take up space and electricity. Similarly, during a COVID pandemic, it is advised to maintain social segregation and avoid interacting with objects that were given by various people groups. This limitation could be overcome in the framework for the proposed AI virtual mouse using hand signals by incorporating a sophisticated camera or sacred camera to recognise hand gestures and fingers using PC machine vision.
The framework's algorithmic rule makes use of artificial intelligence and man-made awareness. By using hand signals, the device may be operated rather easily and execute functions like left and right clicks, seeing over capabilities, and PC device pointer actions without the usage of a real mouse.

This project proposes a novel camera vision-based cursor control system or we can also say “Virtual Mouse”, using hand gestures or symbol captured from a webcam of your laptop through a colour detection technique. The program will allow the user to control the computer cursor using their hand movement or some finger signal.

- Dragging cursor will be performed using hand movement.
- User can use left click or right click by applying some hand gestures.
- It can also take your screenshot by performing hand symbols.
- And also, it performs word typing in the text field.

To performing all these actions or control, you only have to require a sensor that can capture your hand symbols and apply on the system. On your System, a webcam can be act as a sensor for your virtual mouse project. Make sure your hand gesture will be within the better range of the system’s webcam.
The system will be implemented using the python and OpenCV. The hand gesture is the most effortless and natural way of communication. The output of the camera will be displayed on the monitor. Shape and

position information about the gesture will be gathered using detection of colour. The file transferring scheme is implemented by using the python server programming.

Introduction-

A computer mouse is a portable hardware input device used to point, move, and select text, icons, files, and directories on your computer's desktop using a GUI (graphical user interface). A mouse also allows you to access the right-click menu and drag & drop things in addition to these features. This is the definition of a simple computer mouse, which you all must know, but as you know, to prevent the spread of corona virus, we should also avoid touching the mouse, especially in school and public computers.

Therefore, to overcome this, you can use a virtual mouse, in which you will not have the necessity of any kind of physical contact to perform the basic mouse functions.
Hand gestures/symbols are the most effective and expressive form of any communication. These gestures can be acceptable language by all. It is sufficiently expressive for both the deaf and the dumb to understand it. This paper suggests a real-time hand gesture system.

The AI virtual mouse framework is powered by the Python programming language. In addition, Open CV, a library for mobile PC vision, is used at various points in the AI virtual mouse framework. Additionally, datetime, Autopy, and PyAuto GUI packs were used to propel the PC screen and perform verbalizations such as left click, right click, and examining limits inside the projected AI virtual mouse using hand signals. The model uses the Python Media-pipe group for the journey for the hands and for pursuit of the tip of the hands.

The system's experimental design uses a fixed camera on a laptop or a low-cost, high-definition webcam positioned in a fixed location on top of a computer monitor to take snapshots in the Red, Green, and Blue [RGB] colour space from a fixed distance. Feature matching, region extraction, feature extraction, and image preprocessing are the four processes that make up this task. One of the biggest challenges in communicating with the deaf and mute is the understanding and use of sign language.

The preprocessing, background subtraction, and edge detection techniques have been combined to provide an efficient hand gesture segmentation technique in this project.
Pre-processing is the process of preparing data for another process, according to the definition. The fundamental goal of the preprocessing step is to change the data into a format that can be processed more quickly and easily. Pre-processing techniques are developed in the proposed work based on various combinations of the subsequent hand gesture image processing operations, such as image capture, noise reduction, background subtraction, and edge detection. These image processing techniques are discussed in the sections that follow.
When the vision-based camera first records photos of hand motions, the hand gestures may be seen.

with various interfaces, such as "data gloves," which correctly record all digits' positions, wrist positions, optical orientation, and electromagnetic orientation without requiring the user to wear trackers or gloves. The user's comfort and interface time are typically minimized by glove-based interfaces, which even require the user to be attached to the computer. In contrast, vision-based interfaces allow for freer human involvement. With the help of this project, we hope to develop free hand recognition software for laptops and desktop computers that support web cameras. The project focuses on developing a hand recognition tool that can be used to move the mouse pointer, carry out basic actions like clicking, and carry out additional hand gesture operations like moving files between computers using deft socket programming and carrying out basic yet fascinating actions that can be covered by the hand recognition.

Motion Controlled Virtual Mouse simplifies human-PC cooperation by utilizing Hand Signals. The PC does not require any contacts like hardware connection or any type of Bluetooth connection. All I/o tasks can be practically constrained by utilizing static and dynamic hand signals.

Libraries used in project: -

In this project, we used 4 python libraries that will help to apply major role in our Virtual Mouse project. Here we will learn briefly about each of them: -

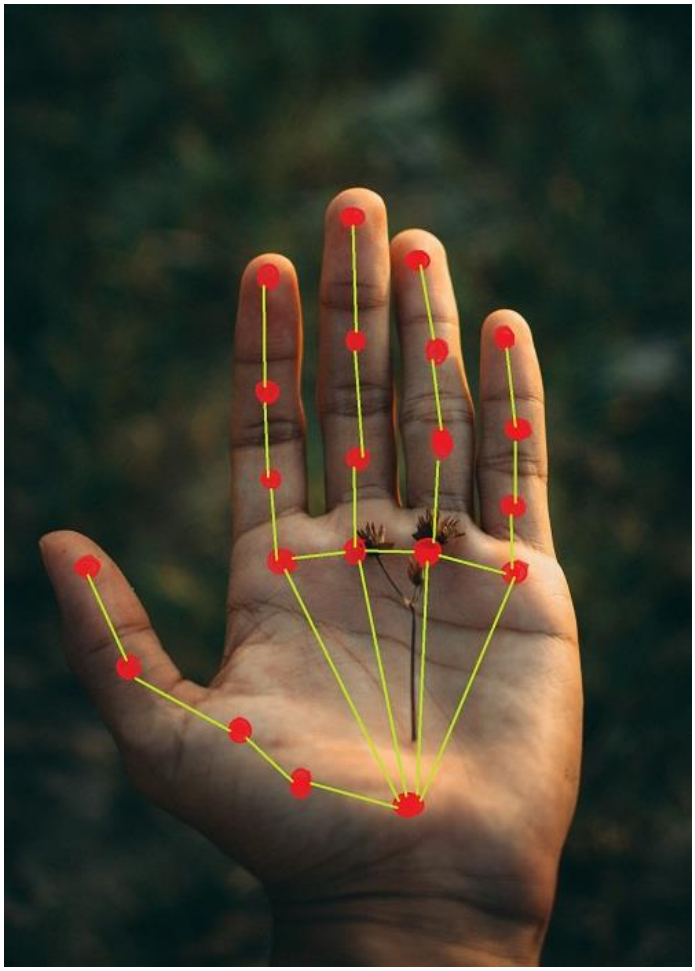
1- Opencv: -

For computer vision applications like video analysis, CCTV footage analysis, and picture analysis, Opencv, an open source library, is highly helpful. More than 2,500 efficient algorithms make up OpenCV, which is written in C++. We can utilise this library to begin concentrating on real-world issues while developing computer vision applications that we don't want to design from scratch. Today, many businesses, including Google, Amazon, Microsoft, and Toyota, use this library. There are numerous researchers and developers. It is simple to instal on any OS, including Windows, Ubuntu, and MacOS.
To install OpenCV on your system: - "**pip install opencv-python**"
Then "import cv2" to access OpenCV library.
Code: -

```
import cv2
cap = cv2.VideoCapture(0)
cv2.waitkey(1)
while True:
    _, frame = cap.read()
    #frame = cv2.flip(frame, 1)
    frame_height, frame_width, _ = frame.shape
    rgb_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
```

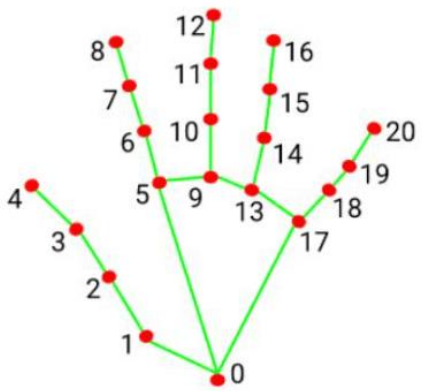
2- Mediapipe: -

The open-source framework MediaPipe allows developers to create pipelines for doing computer vision inference over any type of sensory data, including audio and video. Such a perception pipeline can be created as a graph of modular parts using MediaPipe. You can use MediaPipe on your desktop, server, iOS and Android devices.
The MediaPipe framework is primarily intended for quick development of perception pipelines that include reusable elements and AI models for inferencing. Additionally, it makes it easier to integrate computer vision software into applications and demos running on many hardware platforms. Teams can incrementally enhance computer vision pipelines thanks to the configuration language and evaluation tools.
Here we are using Mediapipe as a hand detection tool. That helps to mark points on the hand to track movements.



Once it marked all the points on your hand then it gives it some numbers to remember. Like in the below image.

Hand Land Marks



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

Apart from Hand detection, you can use Mediapipe as Face detection, object detection, track vehicle, Iris and even more.

3- PyAutogui: -

The automation library PyAutogui for Python supports keyboard and mouse control. Alternately, we could say that it makes it easier for us to automate keyboard and mouse clicks in order to establish interaction with another programme using a Python script. A handful of the many features it offers are listed below.

- It allows mouse movement left to right, right to left, top to bottom and bottom to top.
- You can use right mouse click as well as left mouse click with the help of Pyautogui.
- It also allows to take screen shot or snapshot of your screen.
- You can resize, minimize, cut, copy, exit or open operation with this.
- Even use keyboard combination with this.
- You can also prompt alert messages on your screen.

Some basic functions of PyAutogui: -
moveTo() Method – It allows cursor moves to the X-axis and Y-axis coordinate. You only have to give coordinated values to perform.

Click( ) Method- This allows user to click the mouse buttons on your screen.

Scroll( ) method- This can be sued to scroll page on your system.

Alert( ) method- It can be used to prompt or generate message on your display.

4- Datetime: -

The Python Datetime module offers classes for working with time and date. These classes offer a variety of functions for working with dates, times, and time spans. When you modify date and datetime in Python, you are actually manipulating objects rather than strings or timestamps because they are considered objects. Datetime can be divided into the six types: - Date, Time, datetime, timedelta, timezone and tzinfo.

Eg: -

```
# Python program to
# print current date
Import datetime
from datetime import date

# calling the today
# function of date class
today = date.today()

print("Today's date is", today)
```

Purposed System: -

Even though there are a number of quick access options for the hand and mouse gesture for laptops in the current system, with our project, we could use the laptop or webcam and by recognizing the hand gesture, we could control the mouse and perform basic operations like mouse pointer control, select and deselect using the left click, and a fast-access function for file transfers among computers joined via LAN cables.

The completed project is a "Zero Cost" hand identification system for laptops that assigns an action for each movement of the hand and employs straightforward algorithms to identify the hand.

However, we have mainly focused on mouse pointing and clicking activities as well as a hand movement and action for transferring files between connected devices. Since Python is a simple language, platform independent with flexibility, and portable, the system we are designing will be much more responsive and easier to implement.

This is beneficial in creating a programmed that is centred in such a goal for creating a Virtual Mouse and Hand Recognition system. By specifying actions for the hand movement for carrying out a given action, the system can be expanded much further. By using such activities for the collection of hand motions, it might be altered to any other degree.

Methodology: -

There are multiple ways methods or functions to perform the functions: -

1- The virtual mouse system with AI's camera. The webcam frames from a laptop or PC serve as the foundation for the proposed AI virtual mouse system. The video capture object is constructed using the Python computer vision package OpenCV, and the web camera begins recording footage. The frames are captured by the web camera and sent to the AI virtual system.

2- Processing after video capture. The webcam is used by the AI virtual mouse system to capture each frame till the programme is finished. The video frames are converted from BGR to RGB colour space in order to frame-by-frame locate the hands in the film.

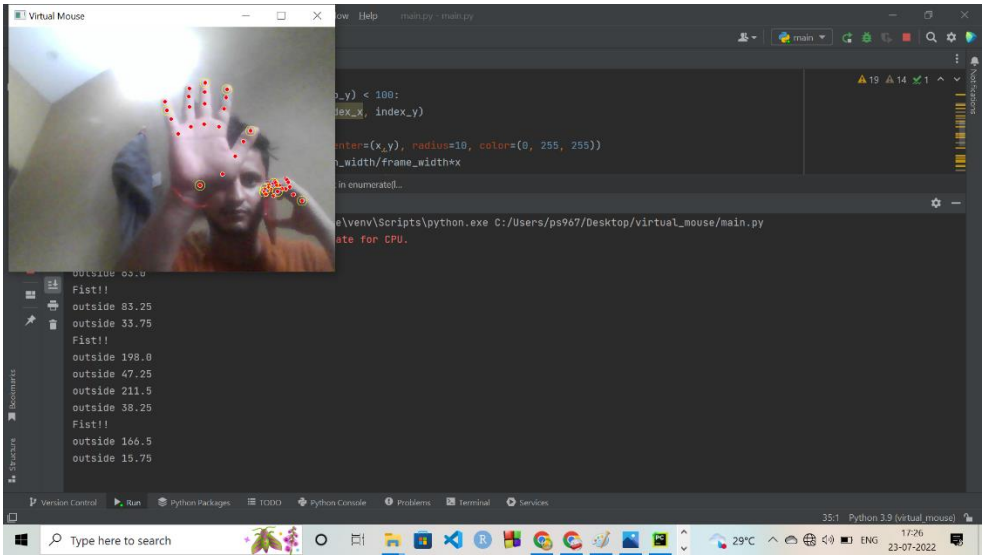
3- Rectangular Region for Moving Through the Window "Virtual Screen Matching". The transformational method is used by the AI virtual mouse system to translate the fingertip coordinates from the webcam screen to the computer window's full screen for controlling the mouse.
A rectangular box is generated in relation to the computer window in the webcam zone where we move the mouse cursor around the window when the hands are identified and we determine which finger is capable of completing the specified mouse operation.

4- Finding the finger that is up and carrying out the specific mouse action. At this level, we are identifying which finger is up by comparing the tip ID of the corresponding finger that we located using the MediaPipe with the corresponding co-ordinates of the fingers that are up.

5- Functions: -

5.1- Mouse movement: -

We must first determine the centres of both red objects that have been spotted, which can be done quickly by averaging the maximum and minimum points of the bounding boxes. Now that we have two coordinates taken from the centres of the two objects, we can compute their average and obtain the red point in the illustration. The detected coordinate is being converted from camera resolution to actual screen resolution. The location was then set as the mouse position. However, it will take some time to reposition the mouse pointer. Therefore, we must wait till the mouse pointer gets to that location. So we started a loop and are just waiting to see if the current mouse location and the assigned mouse location match.

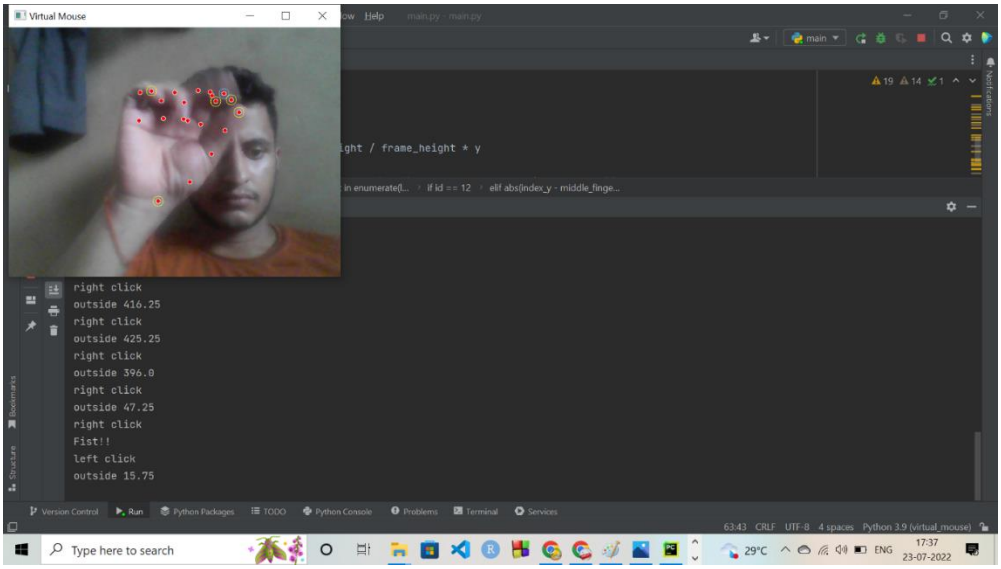


For the computer window's mouse cursor to move about. The AutoPy Python library is used to have the mouse cursor move around the computer's window if all of your fingers (especially your pointer fingers) move across the screen.

5.2 Click ( ): -

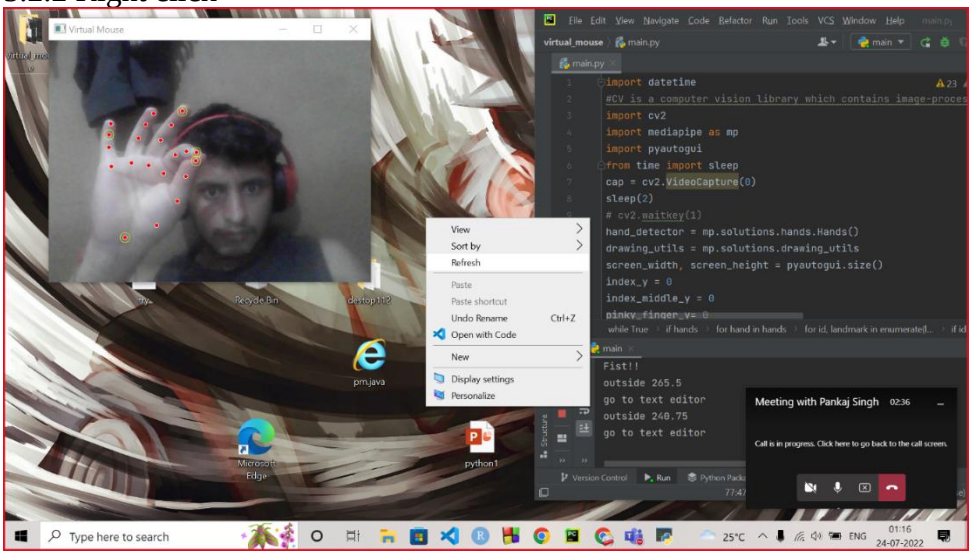
Applying the close gesture is the next stage. The action is carried out by clicking and dragging the object. It is comparable to the open gesture, but since there is only one object present, we simply need to determine its centre. And that will be put in the spot where our mouse pointer will be set. We shall employ a mouse press operation in place of a mouse release operation.

5.2.1 Left Click: -



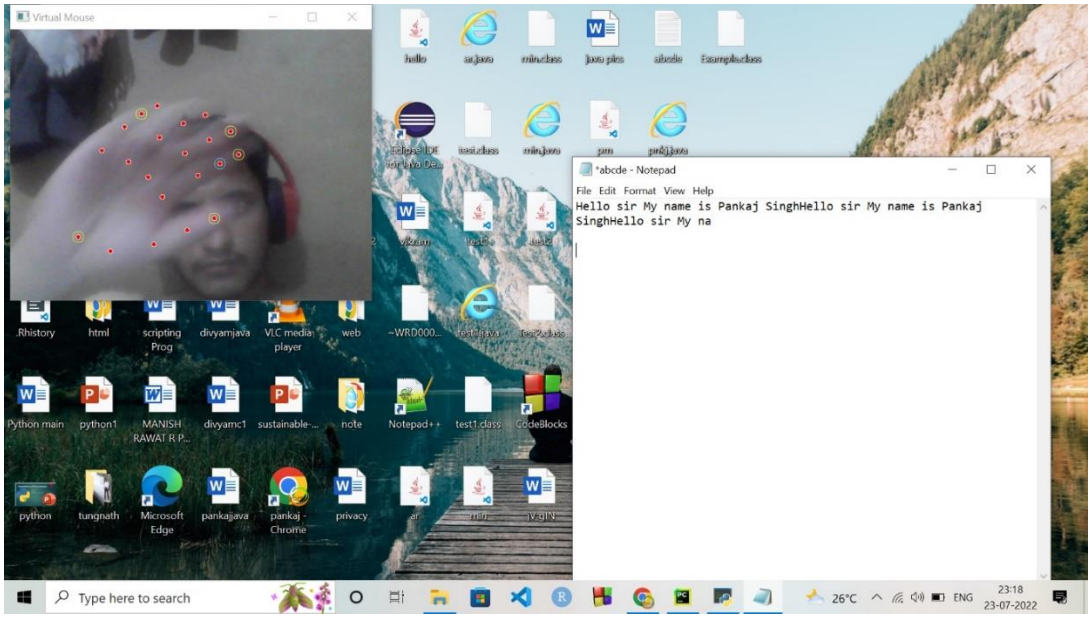
The computer is programmed to operate the left mouse button if both the index finger with tip ID 1 and the thumb finger with tip ID 0 are up and there is less than 30px between the two fingers.

5.2.2 Right click



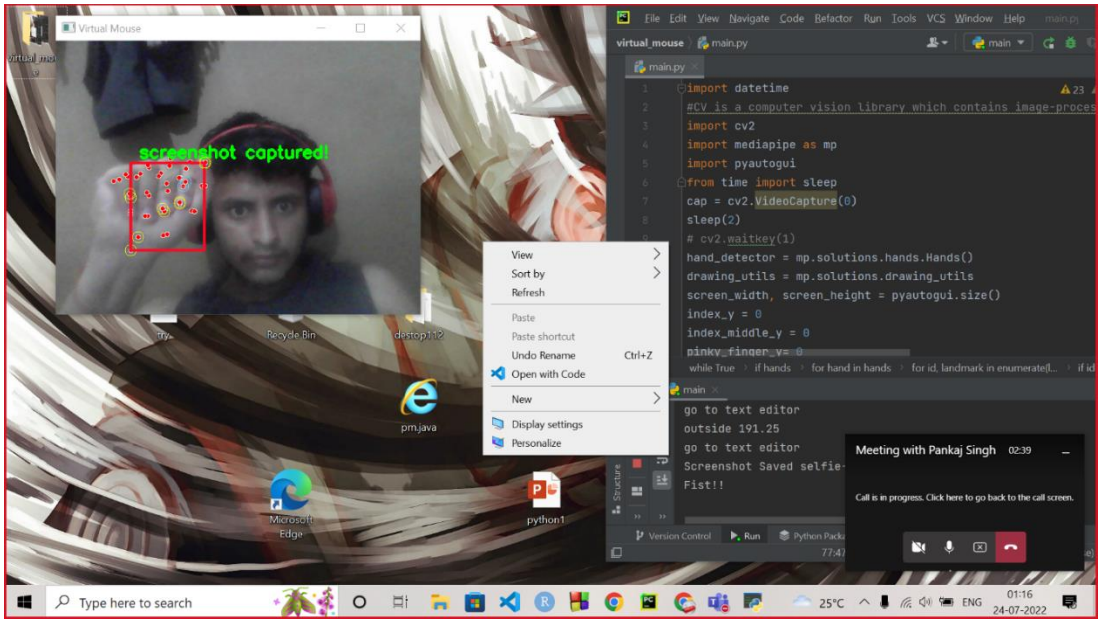
The computer is made to click the right mouse button using the Pyautogui package if the middle finger with tip Id 2 and the index finger with tip Id 1 are both up and the distance between the two fingers is less than 30 px.

5.3 Text



To type any format or words on the text editor you have to make sure that your distance between your pinky finger and thumb distance less than 20 axis.

5.5 Screenshot-



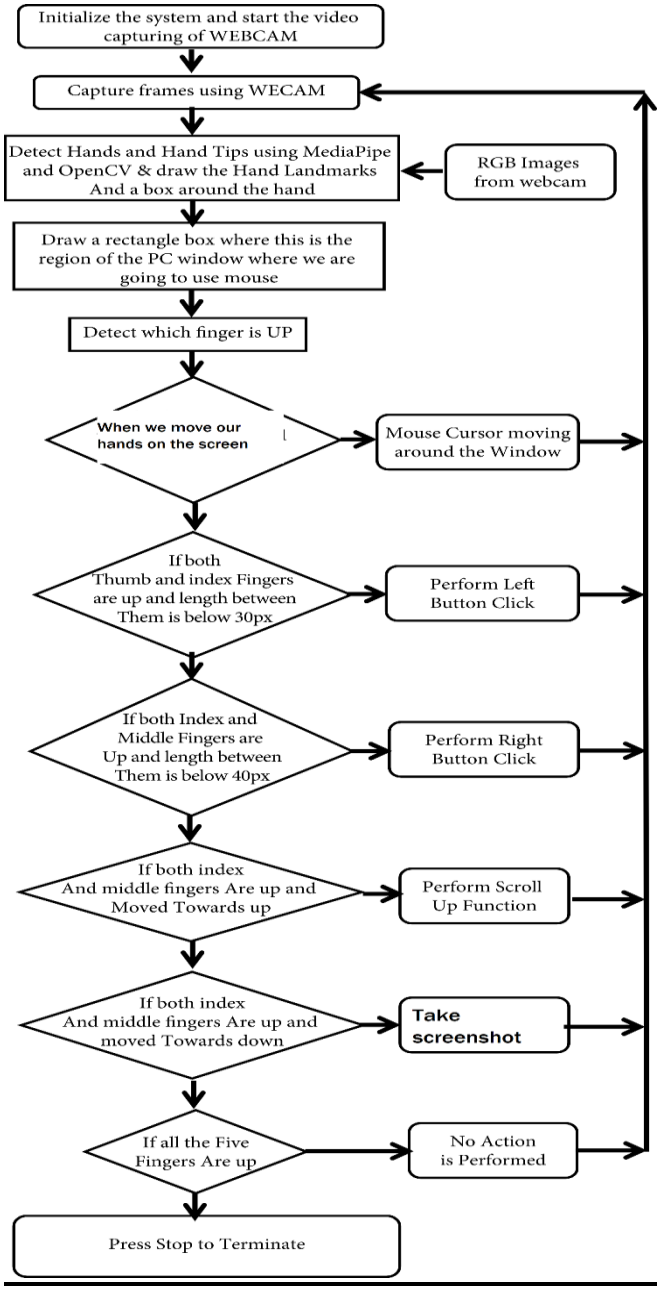
When your distance between your index finger and the wrist (0) will come closer than it performs a screenshot.

5.6 Screen Recording-

For using Screen Recording we are here using few libraries

- Datetime
- Pillow
- Numpy
- CV2 (OpenCV)
- Win32api

Flowcharts: -



Minimum Hardware requirements: -

The minimum hardware requirements to use Virtual mouse on your system are:-

RAM-	Minimum 8 GB required for smooth handling.
Webcam-	Webcam is must.
Webcam megapixels-	At least 3.2 mega pixel for smooth recording and image scanning.
Operating system-	Windows Mac Linux
Processor-	You need above i3 10generation for easy handling and working.
Android OS-	Currently, it does not support android or iOS operating system.
IDE-	Pycharm Visual Studio

Testing: -

The idea of employing computer vision to advance human-computer interaction is presented in the suggested AI virtual mouse system.
Because there are so few datasets available, it is difficult to compare testing of the AI virtual mouse system. For tracking of the hand gesture and hand tip detection, The hand gestures and finger tip detection have been tested under various lighting conditions and at varying distances from the webcam.

Here we perform few test on the project..
We basically perform over 500 times different gestures and symbols on the system in different environment. These graphs basically shows the percentage the total resultant percentage of the action.

1- **At normal conditions (light is perfect, camera works good and even the system is smooth).**

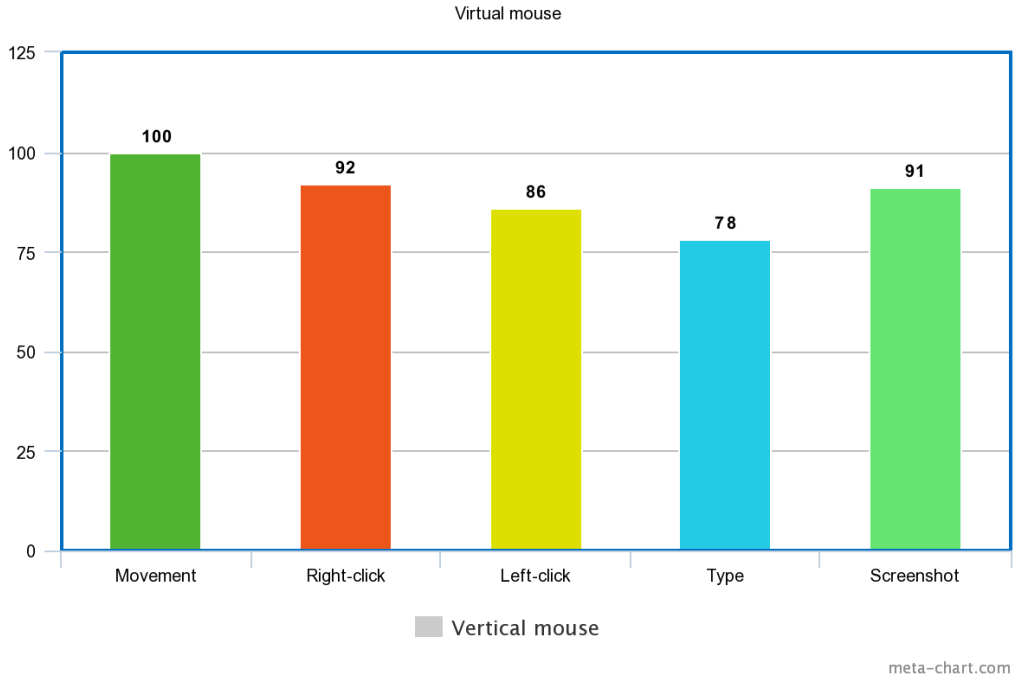
Movement= 100% (movement of cursor work perfectly on this circumstance).

Right- click= 92% (even few times it did not detect the finger correctly, otherwise it works perfect).

Left-click=86%(The system might be confusing while we make the symbol for left click, otherwise it detect perfectly).

Type=76%(Only type method does not work perfectly in our this testing phase, it only get 76% in the result. Which shows that the system does not detect symbol perfectly).

Screenshot=91% (On the other hand, screenshot feature work perfectly without having any issue. Sometimes, it may not work buts till it perform very good).



2- At poor lighting condition (In this condition we used poor lighting environment)

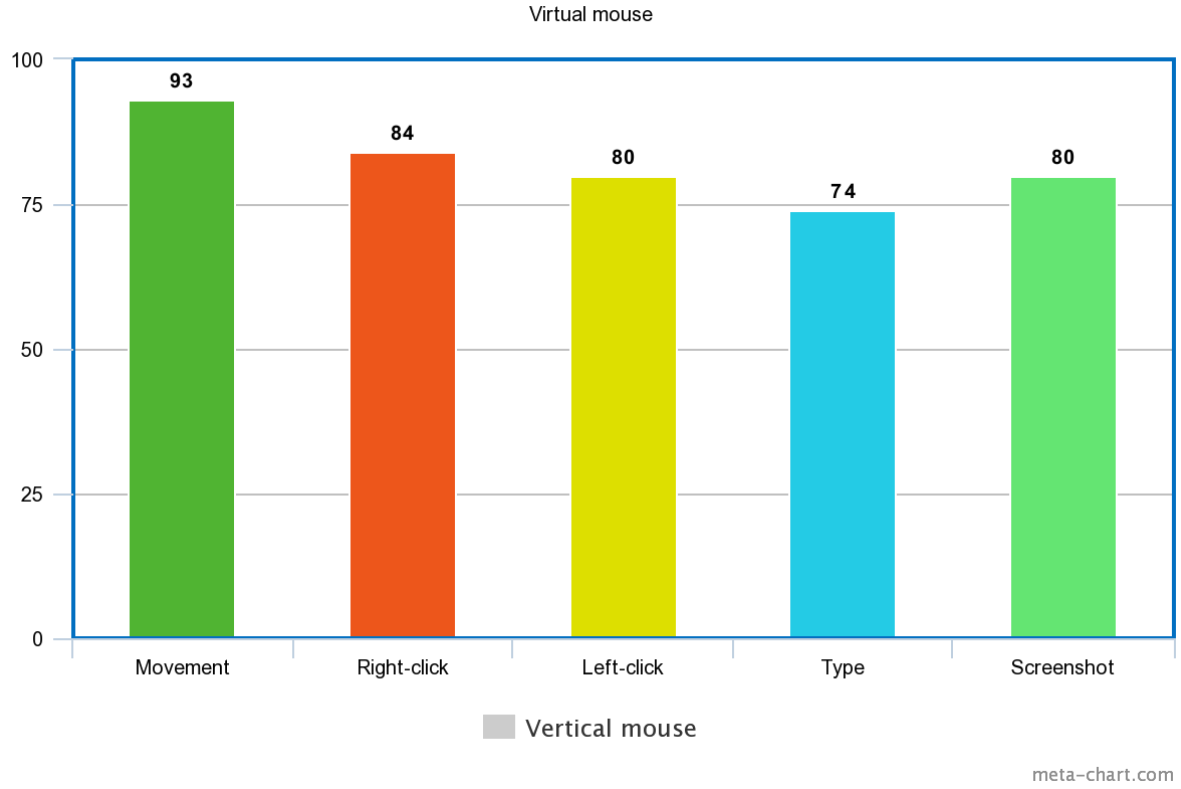
Movement= 93% (movement of cursor get little bit drop due to low light).

Right- click= 84% (It loose around 8% due to low visibility, the system get confused between the index finger).

Left-click=80%(Same happed to the left-click, the system does not detect perfectly).

Type=74%(Type method only loose 2%, which is least among all but still it does not perfectly on that harsh condition).

Screenshot=80% (Screenshot method work good, but in many cases it does not process any funcyion).



Applications: -

Man-made Different uses of consciousness exist in contemporary society. It is becoming essential at our time since it can deal with complex challenges in a variety of endeavours, such as health care, distraction, finance, education, and so forth, in an efficient manner. Our daily lives are becoming easier and faster thanks to computer intelligence.

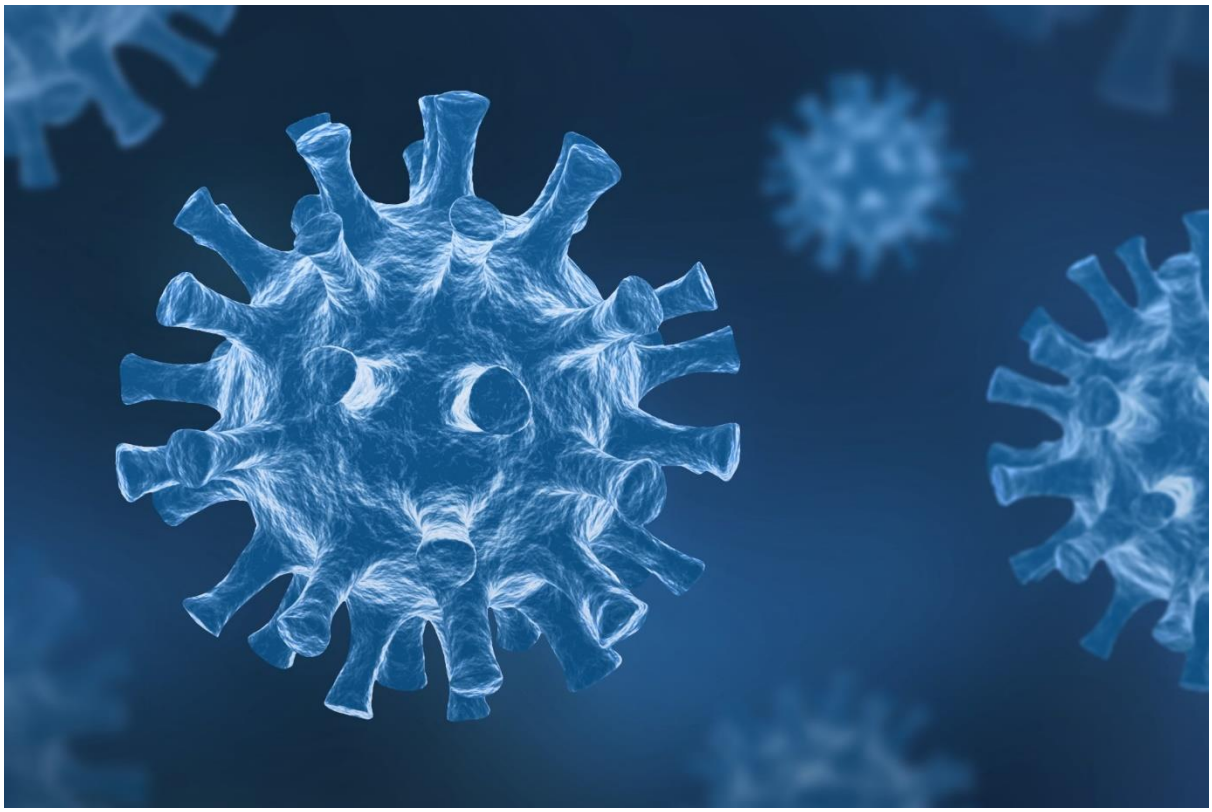
The AI virtual mouse system can be utilized for a variety of purposes, including instances when we cannot use a physical mouse and those where it would be inconvenient to do so. Technology reduces the need for gadgets while enhancing human-computer connection.

Few operations: -

- The proposed model's accuracy of 99% is far higher than that of other virtual mouse models that have also been proposed, and it has various applications.
- The proposed AI virtual mouse may be used to control the PC mouse functions without using the physical mouse during the COVID-19 condition because it is not safe to use the devices by touching them because it may result in a situation where the virus is propagated by touching the devices.
- Without the need for gadgets, the system can be utilized to control robots and automation systems.
- The AI virtual system can draw both 2D and 3D pictures using hand motions.
- Without a wireless or cable mouse, an AI virtual mouse can be utilised to play games based in virtual reality and augmented reality.
- These controls can be used by those with hand issues to use the computer's mouse.
- The proposed technology, like HCI, can be utilised to operate robots in the field of robotics.
- The suggested system can be utilised for virtual prototyping in designing and architecture.

Future Scope: -

The suggested AI virtual mouse has various drawbacks, including a little reduction in right click precision and some issues with the model's ability to click and drag to pick text. These are some of the drawbacks of the suggested AI virtual mouse technology, which we will try to address in our upcoming research.
Additionally, the proposed system can be expanded to virtually handle both the keyboard and mouse operations, which is another potential future use of human-computer interaction (HCI).



We may infer from the model's findings that the suggested AI virtual mouse system has done very well, has better accuracy than the existing models, and also gets beyond the majority of the drawbacks of the latter. The AI virtual mouse can be utilised for real-world applications since the suggested model is more accurate, and it can also be used to stop the spread of COVID-19 because the proposed mouse system can be operated virtually using hand gestures rather than the conventional physical mouse.

Making PC understanding initiatives that can handle ongoing problems and accomplish goals for affiliations, everyday responsibilities, and persons is the work at hand. There is a degree in encouraging computer games, talking machines, language revelation, personal computers, ace systems, advanced mechanics, etc. It is best to understand as much as you can in AI sciences, such as material science or science. Learn about mind science and the practical foundation for controlling artificial intelligence in order to manage it normally. Learn a few Machine slang terms. It makes sense to concentrate on one key machine language. Work is frequently dependent upon learning the programming jargon. It makes sense to concentrate on one key machine language. Work is frequently dependent upon learning the programming jargon. AI hiring decisions will include places for students in the fields of game programming, robotics, computer science, and data analysis.

Conclusion: -

The most effective human-machine interface is provided through gesture recognition. The development of alternative human computer interaction modes depends on gesture recognition.
It makes it easier for people to interact more naturally with machines. Many different applications, including robot control and sign language recognition for the deaf and dumb, can use gesture recognition.

A wide range of industries, including augmented reality, computer graphics, gaming, prosthetics, and biomedical instruments, can benefit from this technology. With the help of our system's Digital Canvas, which is gaining popularity among artists, they may create 2D or 3D images utilising the Virtual Mouse technology, using their hand as a brush and a VR headset or monitor as the display.
Patients who lack control over their limbs can benefit from this device. Modern gaming consoles have integrated computer visuals and gaming technology to create interactive games that track player actions and translate them into commands.

This work can be further extended to make the system more adaptable to various lighting conditions and background complexity. It is possible to create a user interface that is both efficient and complete in terms of mouse functionality. Additionally, it would be excellent to look into cutting-edge mathematical techniques for image processing and look into other hardware options that would produce more precise hand detections. This study illustrated the possibilities for streamlining user interactions with personal computers and hardware systems in addition to illustrating the various gesture operations that users may perform.

Reference: -

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