

# PYTHON PROJECT



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**C.S.E. (Branch Change)**

## **ABSTRACT**

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 colour detection and virtual mouse.

## **INTRODUCTION**

In this high-tech world, it is almost impossible to imagine life without computers. The invention of computers is one of the greatest humankind inventions. Computers have become an essential part of almost every day use for individuals of every age. In daily life, we interact many times with computers to make our work easier. Thus, Human-Computer Interaction (HCI) has become a hot topic for research. In our daily life, vision and gestures are important approaches for communication among human beings, and the same role is played by the mouse in Graphical User Interface (GUI) based computers. So, a combined methodology can be used to make a better interactive system for Human-Computer Interaction. Computer vision techniques can be an alternative way for the touch screen and create a virtual human-computer interaction device using a webcam. In this project, a finger tracking-based virtual mouse application will be designed and implemented using a regular webcam. To implement this, we will be using the object tracking concept of Artificial Intelligence and the OpenCV module of Python.

## **SCOPE**

Eye tracking which is used to control the mouse pointer with the help of our eye. Eye Tracking can replace mouse in the future. Gestures can be in any form like hand image or pixel image or any human given pose that require less computational difficulty or power for making the devices required for the recognitions to make work. Different techniques are being proposed by the companies for gaining necessary information/data for recognition handmade gestures recognition models. Some models work with special devices such as data glove devices and colour caps to develop complex information about gesture provided by the user/human.

## **OBJECTIVE**

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 colour detection and virtual mouse

## **PURPOSE**

As the technology increase everything becomes virtualized such as speech recognition. Speech Recognition is used for recognition and translation of the spoken language into text. Thus, Speech Recognition can replace keyboards in the future, Similarly Eye Tracking which is used to control the mouse pointer with the help of our eye. Eye Tracking can replace mouse in the future. Gestures can be in any form like hand image or pixel image or any human given pose that require less computational difficulty or power for making the devices required for the recognitions to make work. Different techniques are being proposed by the companies for gaining necessary information/data for recognition handmade gestures recognition models. Some models work with special devices such as data glove devices and color caps to develop complex information about gesture provided by the user/human

## **OVERVIEW OF THE SYSTEM**

### **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 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

### **Disadvantages**

- 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**

As the technology increase everything becomes virtualized. Such as speech recognition, Speech Recognition is used for recognition and translation of the spoken language into text. Thus, Speech Recognition can replace keyboards in the future, Similarly Eye Tracking which is used to control the mouse pointer with the help of our eye. Eye Tracking can replace mouse in the future. Gestures can be in any form like hand image or pixel image or any human given pose that require less

computational difficulty or power for making the devices required for the recognitions to make work. Different techniques are being proposed by the companies for gaining necessary information/data for recognition handmade gestures recognition models. Some models work with special devices such as data glove devices and colour caps to develop a complex information about gesture provided by the user/human.

### **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

### **Modules: Implementation**

- Collection information.
- Checking devices (like webcam) working properly or not.
- Collection tape or finger ribbon, which should be fit to the fingers.
- Import packages like NumPy, OpenCV, Autopy, Mediapipe.
- Implement the Open Gesture Operation.

### **ALGORITHM USED FOR HAND DETECTION**

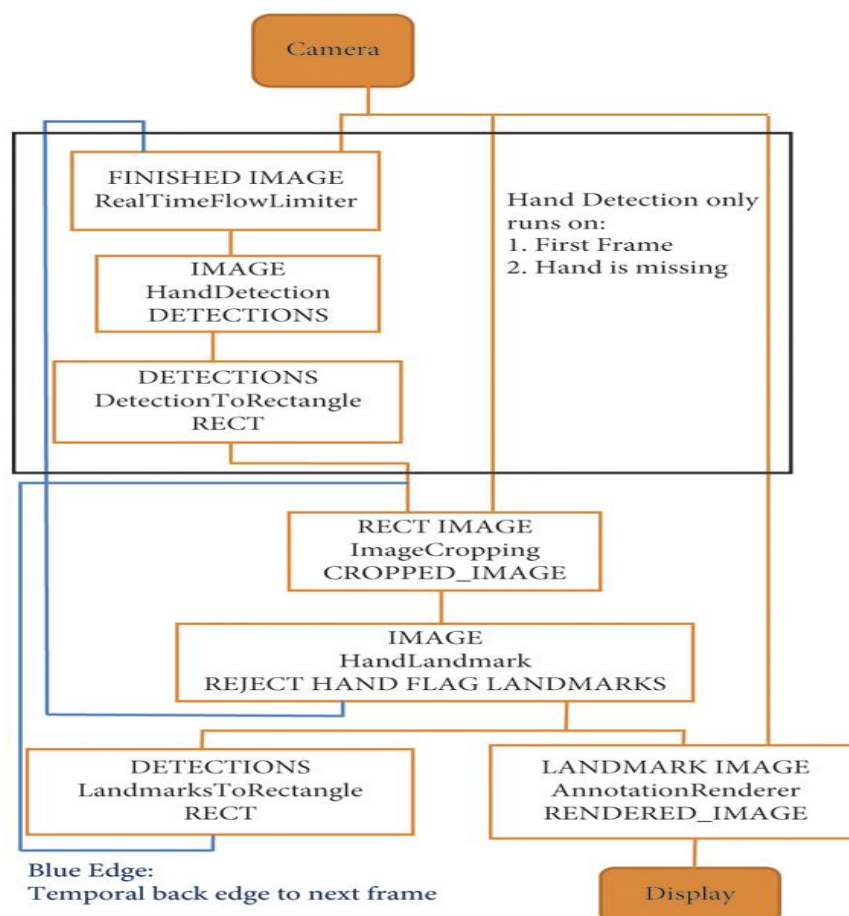
For High-fidelity hand and finger tracking MediaPipe library (on open-source cross-platform framework) and OpenCV library for implementing computer vision are being used. This algorithm utilizes machine learning concepts to track and detect hand gestures and finger tips.

### **MEDIAPIPE**

The MediaPipe framework is used by the developer for building and analyzing the systems through graphs, and it also been used for developing the systems for the application purpose. MediaPipe library is used by developers for architecting and analyzing various models through graphs and many of these have been used for building applications. MediaPipe Hands utilizes an ML pipeline consisting of multiple models working together. The model that incorporated MediaPipe needs to work in a pipeline fashion. It consists of mainly graphs, nodes, streams and calculators. The MediaPipe framework is based on three fundamental parts; they are performance evaluation, framework for retrieving sensor data, and a collection of components which are called calculators , and they are reusable. A pipeline is a graph which consists of components called calculators, where

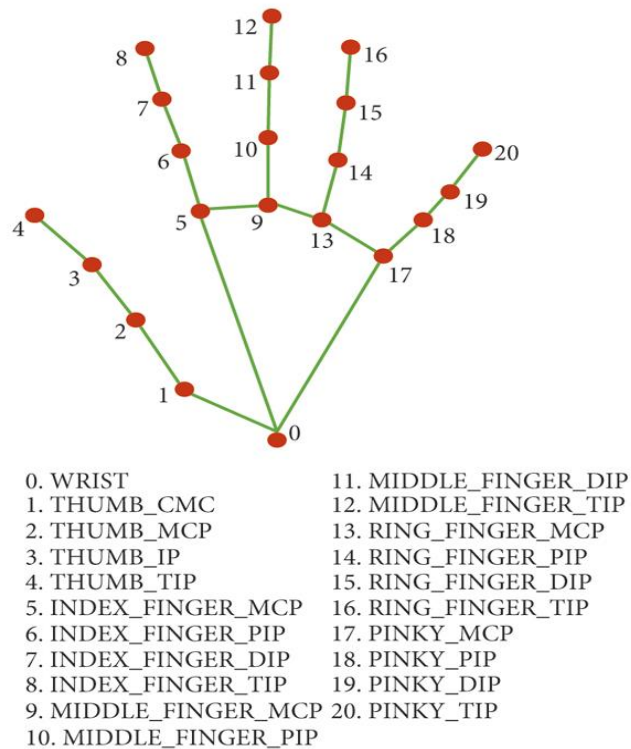
each calculator is connected by streams in which the packets of data flow through. The pipeline is implemented as a MediaPipe graph that uses a hand landmark tracking subgraph from the hand landmark module, and renders using a dedicated hand renderer subgraph. The hand landmark tracking subgraph internally uses a hand landmark subgraph from the same module and a palm detection subgraph from the palm detection module. The calculators and streams combined create a data-flow diagram; the graph is created with MediaPipe where each node is a calculator and the nodes are connected by streams. Mediapipe offers open source cross-platform, customizable ML solutions for live and streaming media. This is helpful in many cases such as:

1. Selfie segmentation.
2. Face mesh
3. Human pose detection and tracking
4. Holistic tracking
5. 3D object detection.



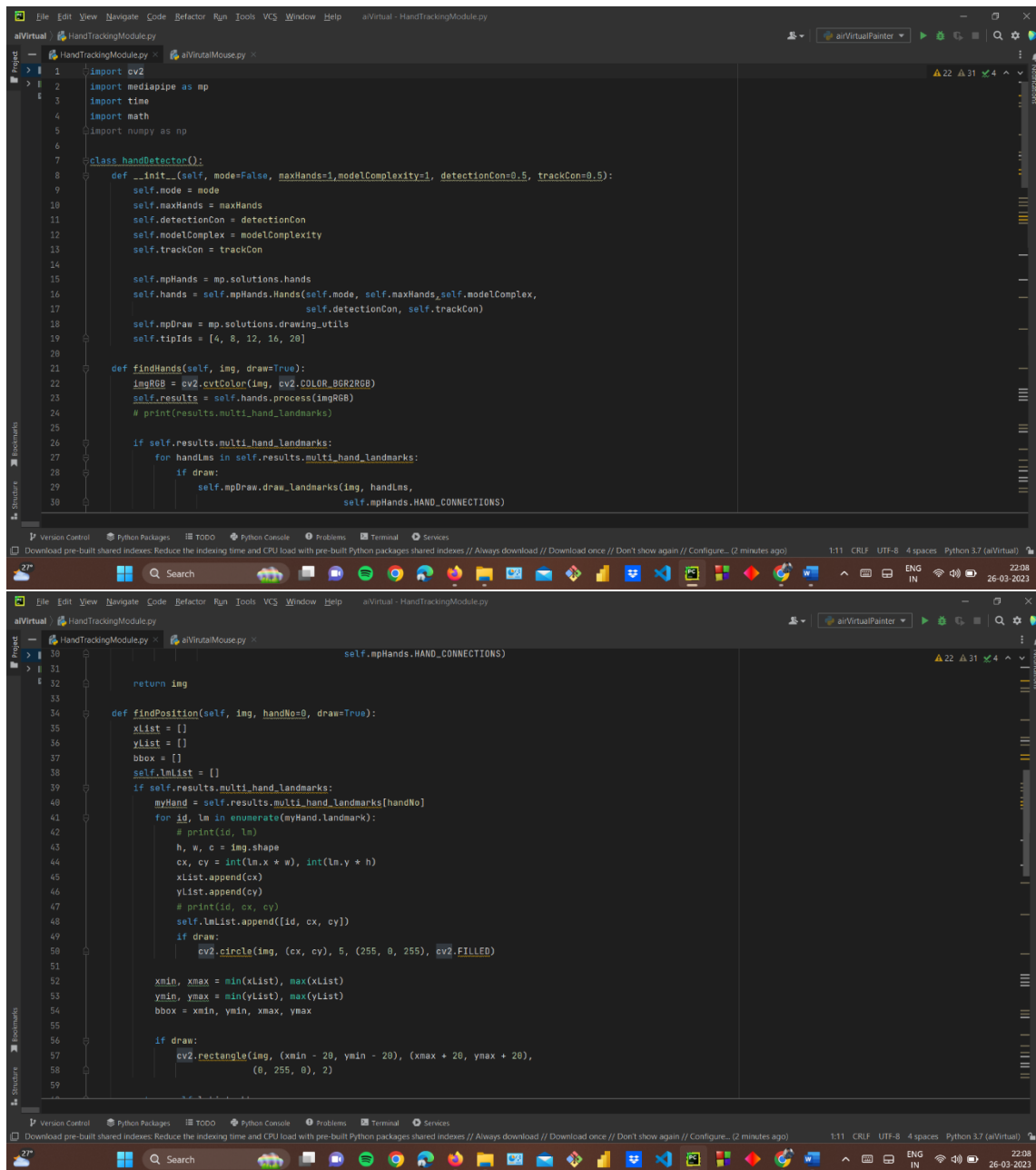
**OPENCV**

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state of-the-art computer vision and machine learning algorithms. This library is written in the python language and it helps in the making of applications that used computer vision. In this model, OpenCV library is utilized for image and video processing and for detecting and analyzing faces and objects. The developing of hand gesture recognition using Python and OpenCV can be implemented by applying the theories of hand segmentation and the hand detection system which use the Haarcascade classifier.



## CODE

### 1. HAND TRACKING MODULE.PY



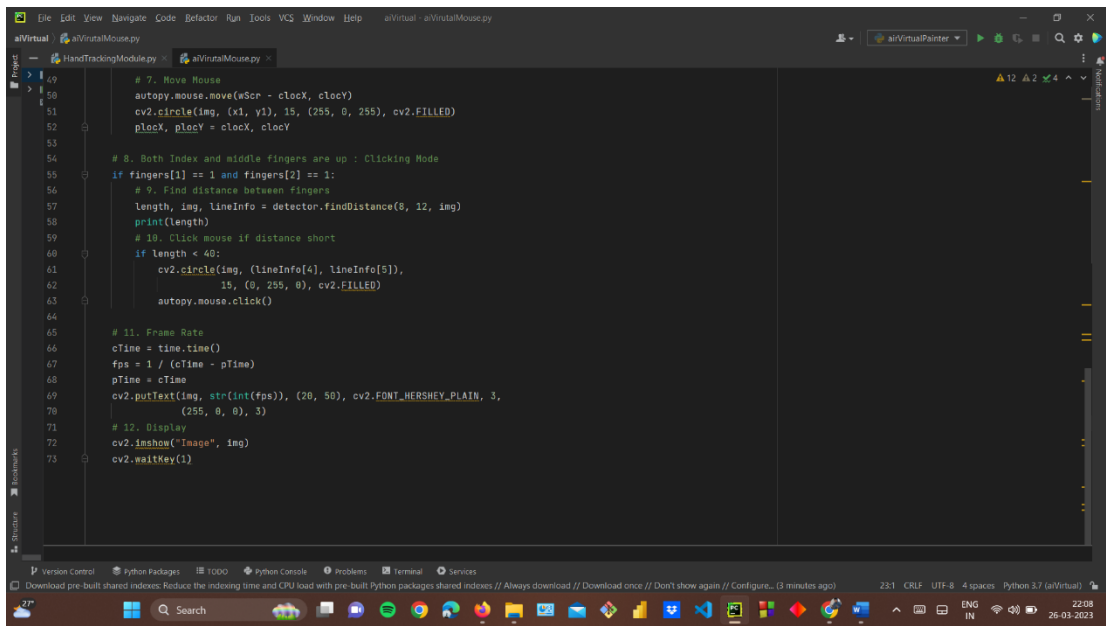
```
File Edit View Navigate Code Refactor Run Tools VCS Window Help aVirtual - HandTrackingModule.py
Project: HandTrackingModule.py
59 return self.lmList, bbox
60
61
62 def fingersUp(self):
63     fingers = []
64     # Thumb
65     if self.lmList[self.tipIds[0]][1] > self.lmList[self.tipIds[0] - 1][1]:
66         fingers.append(1)
67     else:
68         fingers.append(0)
69
70     # Fingers
71     for id in range(1, 5):
72         if self.lmList[self.tipIds[id]][2] < self.lmList[self.tipIds[id] - 2][2]:
73             fingers.append(1)
74         else:
75             fingers.append(0)
76
77     # totalFingers = fingers.count(1)
78     return fingers
79
80 def findDistance(self, p1, p2, img, draw=True, r=15, t=3):
81     x1, y1 = self.lmList[p1][1:]
82     x2, y2 = self.lmList[p2][1:]
83     cx, cy = (x1 + x2) // 2, (y1 + y2) // 2
84
85     if draw:
86         cv2.line(img, (x1, y1), (x2, y2), (255, 0, 255), t)
87         cv2.circle(img, (x1, y1), r, (255, 0, 255), cv2.FILLED)
88         cv2.circle(img, (x2, y2), r, (255, 0, 255), cv2.FILLED)
89         cv2.circle(img, (cx, cy), r, (0, 0, 255), cv2.FILLED)
90     length = math.hypot(x2 - x1, y2 - y1)
91
92     return length, img, [x1, y1, x2, y2, cx, cy]
93
94
95 def main():
96     pTime = 0
97     cTime = 0
98     cap = cv2.VideoCapture(0)
99     detector = handDetector()
100     while True:
101         success, img = cap.read()
102         img = detector.findHands(img)
103         lmList = detector.findPosition(img)
104         if len(lmList) != 0:
105             print(lmList[4])
106             cTime = time.time()
107             fps = 1 / (cTime - pTime)
108             pTime = cTime
109             cv2.putText(img, str(int(fps)), (10, 70), cv2.FONT_HERSHEY_PLAIN, 3,
110                         (255, 0, 255), 3)
111             cv2.imshow("Image", img)
112             cv2.waitKey(1)
113
114 if __name__ == "__main__":
115     main()
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```
File Edit View Navigate Code Refactor Run Tools VCS Window Help aVirtual - aiVirtualMouse.py
Project
  HandTrackingModule.py
  aiVirtualMouse.py
1 import cv2
2 import numpy as np
3 import HandTrackingModule as htm
4 import time
5 import autopy
6
7 #####
8 wCam, hCam = 640, 480
9 frameR = 100 # Frame Reduction
10 smoothening = 7
11 #####
12
13 pTime = 0
14 plocX, plocY = 0, 0
15 clocX, clocY = 0, 0
16
17 cap = cv2.VideoCapture(0)
18 cap.set(3, wCam)
19 cap.set(4, hCam)
20 detector = htm.handDetector(maxHands=1)
21 wScr, hScr = autopy.screen.size()
22 # print(wScr, hScr)
23
24 while True:
25     # 1. Find hand Landmarks
26     success, img = cap.read()
27     img = detector.findHands(img)
28     lmList, bbox = detector.findPosition(img)
29     # 2. Get the tip of the index and middle fingers
30     if len(lmList) != 0:
```

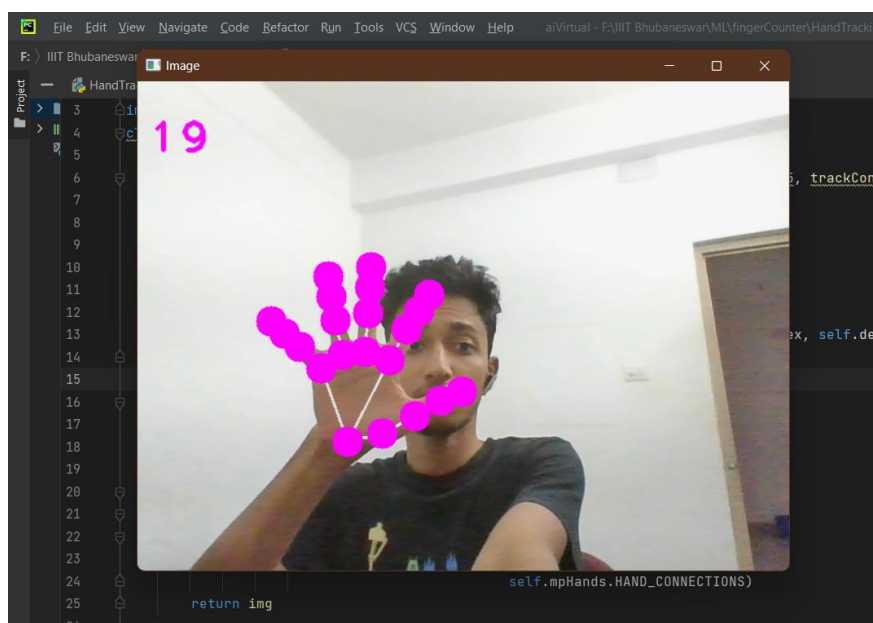
```
31     x1, y1 = lmList[8][1:]
32     x2, y2 = lmList[12][1:]
33     # print(x1, y1, x2, y2)
34
35     # 3. Check which fingers are up
36     fingers = detector.fingersUp()
37     # print(fingers)
38     cv2.rectangle(img, (frameR, frameR), (wCam - frameR, hCam - frameR),
39                 (255, 0, 255), 2)
40     # 4. Only Index Finger : Moving Mode
41     if fingers[1] == 1 and fingers[2] == 0:
42         # 5. Convert Coordinates
43         x3 = np.interp(x1, (frameR, wCam - frameR), (0, wScr))
44         y3 = np.interp(y1, (frameR, hCam - frameR), (0, hScr))
45         # 6. Smoothen Values
46         clocX = plocX + (x3 - plocX) / smoothening
47         clocY = plocY + (y3 - plocY) / smoothening
48
49         # 7. Move Mouse
50         autopy.mouse.move(wScr - clocX, clocY)
51         cv2.circle(img, (x1, y1), 15, (255, 0, 255), cv2.FILLED)
52         plocX, plocY = clocX, clocY
53
54     # 8. Both Index and middle fingers are up : Clicking Mode
55     if fingers[1] == 1 and fingers[2] == 1:
56         # 9. Find distance between fingers
57         length, img, lineInfo = detector.findDistance(8, 12, img)
58         print(length)
59         # 10. Click mouse if distance short
60         if length < 40:
```



```
49 # 7. Move Mouse
50 autopy.mouse.move(sScr - clocX, clocY)
51 cv2.circle(img, (x1, y1), 15, (255, 0, 255), cv2.FILLED)
52 plocX, plocY = clocX, clocY
53
54 # 8. Both Index and middle fingers are up : Clicking Mode
55 if fingers[1] == 1 and fingers[2] == 1:
56     # 9. Find distance between fingers
57     length, img, lineInfo = detector.findDistance(8, 12, img)
58     print(length)
59     # 10. Click mouse if distance short
60     if length < 40:
61         cv2.circle(img, (lineInfo[4], lineInfo[5]),
62                     15, (0, 255, 0), cv2.FILLED)
63         autopy.mouse.click()
64
65 # 11. Frame Rate
66 cTime = time.time()
67 fps = 1 / (cTime - pTime)
68 pTime = cTime
69 cv2.putText(img, str(int(fps)), (20, 50), cv2.FONT_HERSHEY_PLAIN, 3,
70            (255, 0, 0), 3)
71 # 12. Display
72 cv2.imshow("Image", img)
73 cv2.waitKey(1)
```

## The 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, as shown in Figure. The web camera captures and passes the frames to the AI virtual 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:

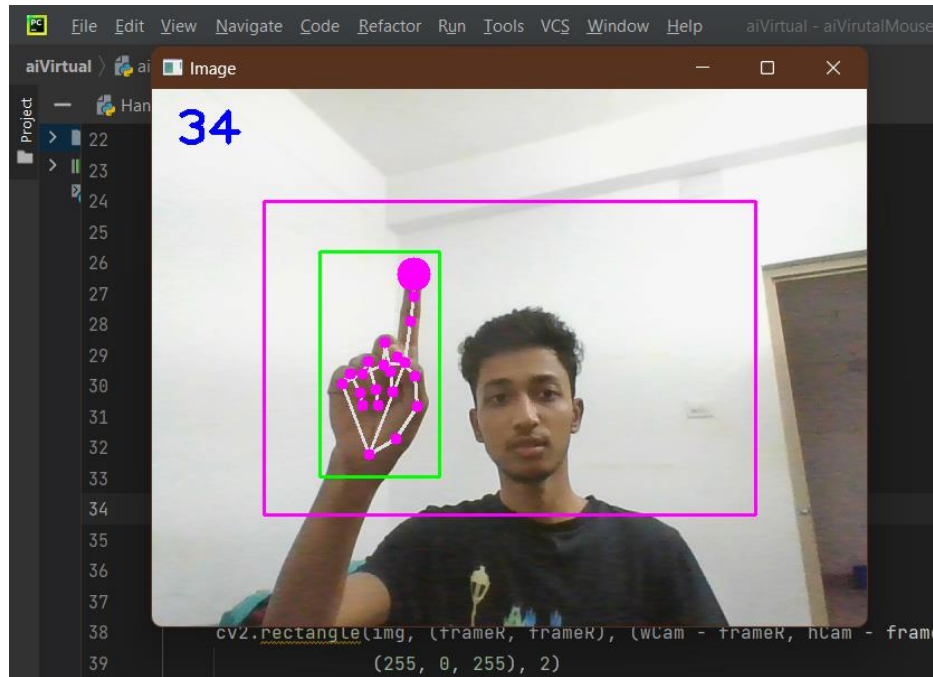
```
def findHands(self, img, draw = True):  
    imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)  
    self.results = self.hands.process(imgRGB)
```

## **(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 co-ordinates 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,

## **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, as shown, and according to that, the particular mouse function is performed.



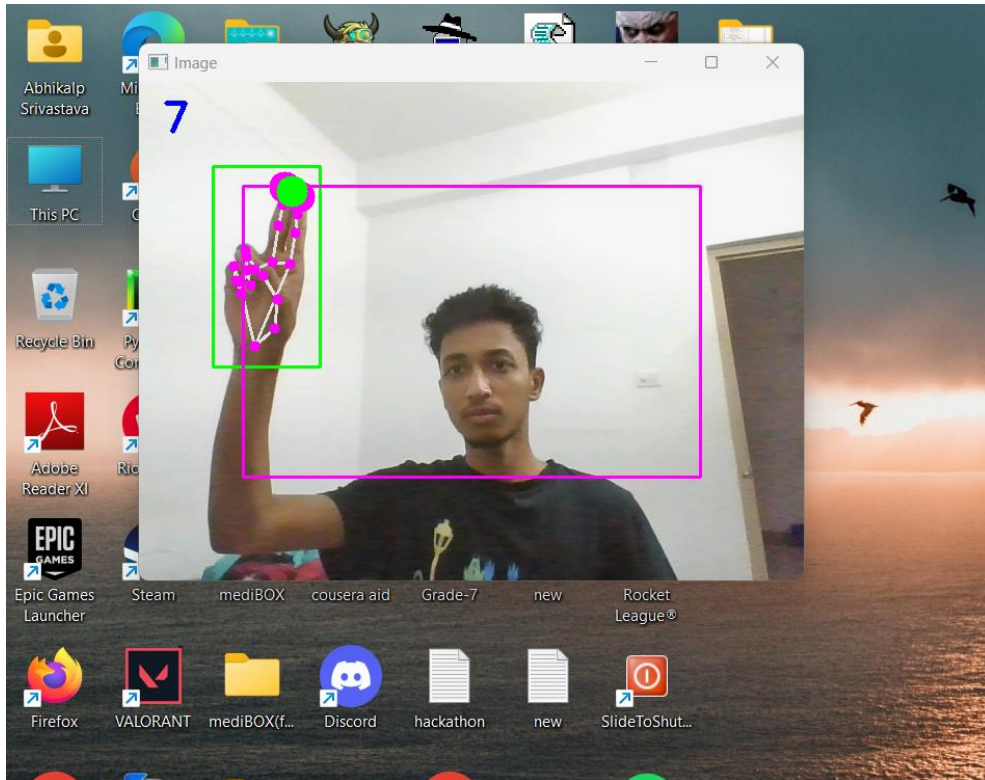
## **Mouse Functions Depending on the Hand Gestures and Hand Tip Detection Using Computer Vision**

### **For the Mouse Cursor Moving around the Computer Window**

If the index finger is up with tip Id = 1 or both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up, the mouse cursor is made to move around the window of the computer using the AutoPy package of Python.

### **For the Mouse to Perform Left 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 30px, the computer is made to perform the left mouse button click using the Autopy Python package

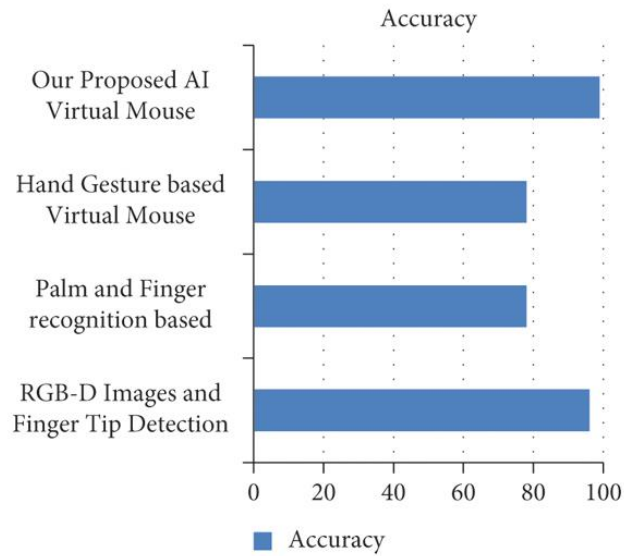


## **Experimental Results and Evaluation**

In the proposed AI virtual mouse system, the concept of advancing the human-computer interaction using computer vision is given.

Cross comparison of the testing of the AI virtual mouse system is difficult because only limited numbers of datasets are available. The hand gestures and finger tip detection have been tested in various illumination conditions and also been tested with different distances from the webcam for tracking of the hand gesture and hand tip detection.

From Table , it is evident that the proposed AI virtual mouse has performed very well in terms of accuracy when compared to the other virtual mouse models. The novelty of the proposed model is that it can perform most of the mouse functions such as left click, right click, scroll up, scroll down, and mouse cursor movement using finger tip detection, and also, the model is helpful in controlling the PC like a physical mouse but in the virtual mode.



## **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.

## **APPLICATIONS**

The artificial-intelligence based virtual mouse has a plethora of application use cases. It could be used where there is restricted space for a conventional mouse and can be utilized in cases where the use of a traditional mouse device is not possible. This system rids of the need for a physical mouse and it can be used in its absence. Some Applications:

- i. The proposed AI virtual mouse has an accuracy of approximately 98% which is larger than other systems that have been previously implemented.
- ii. It can be utilized in the areas of automation for robots and other systems without the need of a physical device.
- iii. The same system can be used for creating drawings both in two dimensions and three dimensions.
- iv. People who cannot use a physical mouse can make use of this system to perform mouse like functions.
- v. In the areas of virtual reality and augmented reality, the current system can be extended to work with such upcoming technologies.

## **CONCLUSION**

The main objective of the proposed virtual AI mouse is to furnish an alternative to the conventional physical mouse that provides mouse functions with the help of computer vision enabled computer that houses a web camera which recognizes fingers and hand gestures and processes the captured frames and uses a machine learning algorithm to execute the defined mouse functions like moving the cursor, left click function. After testing we have concluded that the proposed virtual mouse system has worked exceedingly well and with greater accuracy when compared to previously proposed models mentioned in the related work and the current system has overcome the drawbacks of the other systems. As such, this proposed AI based virtual mouse system can be used in real-time and in real-world applications.

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