Abstract

Artificial beings with intelligence appeared as storytelling devices in antiquity, and have been common in fiction, as in Mary Shelley's Frankenstein or Karel Čapek's R.U.R. These characters and their fates raised many of the same issues now discussed in the ethicsof artificial intelligence.

The study of mechanical or "formal" reasoning began with philosophers and mathematicians in antiquity. The study of mathematical logic led directly to Alan
Turing's theory of computation, which suggested that a machine, by shuffling symbols assimple as "0" and "1", could simulate any conceivable act of mathematical deduction.
This insight that digital computers can simulate any process of formal reasoning isknown as the Church–Turing thesis. This, along with concurrent discoveries
in neurobiology, information theory and cybernetics, led researchers to consider the possibility of building an electronic brain. The first work that is now generally recognizedas AI was McCullouch and Pitts' 1943 formal design for Turing-complete "artificial neurons".

The term "artificial intelligence" had previously been used to describe machines that mimic and display "human" cognitive skills that are associated with the human mind, such as "learning" and "problem-solving". This definition has since been rejected by major AI researchers who now describe AI in terms of rationality and acting rationally,which does not limit how intelligence can be articulated.

AI applications include advanced web search engines (e.g., Google), recommendationsystems (used by YouTube, Amazon and Netflix), understanding human speech (such
as Siri and Alexa), self-driving cars (e.g., Tesla), automated decision-making and competingat the highest level in strategic game systems (such as chess and Go). As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect.

AI virtual mouse is the technology based on the Artificial intelligence. AI virtual mousedo the functionalities of the physical mouse without the use of physical mouse.

The Virtual Mouse provides an infrastructure between the user and the system using only a camera. It allows users to interface with machines without the use of mechanicalor physical devices, and even control mouse functionalities. This study presents a method for controlling the cursor’s position without the need of any electronic equipment. While actions such as clicking and dragging things will be carried out usingvarious hand gestures.

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INTRODUCTION

Hand gestures are the most natural and effortless manner of communicating. Thecamera's output will be displayed on the monitor. The concept is to use a simple camera instead of a classic or standard mouse to control mouse cursor functions.

The Virtual Mouse provides an infrastructure between the user and the system using only a camera. It allows users to interface with machines without the use of mechanicalor physical devices, and even control mouse functionalities. This study presents a method for controlling the cursor's position without the need of any electronic equipment. While actions such as clicking and dragging things will be carried out usingvarious hand gestures.

Python programming language is used for developing the AI virtual mouse system, andalso, OpenCV which is the library for computer vision is used in the AI virtual mouse system. In the proposed AI virtual mouse system, the model makes use of the MediaPipe package for the tracking of the hands and for tracking of the tip of the hands.

For the purpose of detection of hand gestures and hand tracking, the MediaPipe framework is used, and OpenCV library is used for computer vision. The algorithm makes use of the machine learning concepts to track and recognize the hand gesturesand hand tip.

An AI virtual mouse system that makes use of the hand gestures and hand tip detectionfor performing mouse functions in the computer using computer vision, Computer vision is an interdisciplinary scientific field that deals with how computers can gain high- level understanding from digital images or videos. From the perspective of engineering,it seeks to understand and automate tasks that the human visual system can do.

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions. Understanding in this context means the transformation of visual images (theinput of the retina) into descriptions of the world that make sense to thought processes and can elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory

The main objective of the proposed AI virtual mouse system is to develop an alternativeto the regular and traditional mouse system to perform and control the mouse functions,and this can be achieved with the help of a web camera that captures the hand gestures and hand tip and then processes these frames to perform the particular mouse function such as left click, right click, and scrolling function.

ADVANTAGES & DISADVANTAGES

Advantages

- The AI virtual mouse system is useful for many applications; it can be usedto reduce the space for using the physical mouse.
- Virtual mouse allow user to interact with machines without the use ofphysical device.
- It can be used in situations where we cannot use the physical mouse.
- The system eliminates the usage of devices, and it improves the human-computer interaction.
- It can save our time.
- The concept is to use a simple camera instead of a classic or standardmouse to control mouse cursor functions.
- Hand gestures are the most natural and effortless manner of communicating.

Disadvantages

- If the camera is not properly fixed to the device so it will not detect anygestures of the hands.
- This device is not workable in darkness.
- You should remember the hand gestures for controlling the AI virtualmouse.

PROPOSE SYSTEM

While using a wireless or a Bluetooth mouse, some devices such as the mouse, the dongle to connect to the PC, and also, a battery to power the mouse to operate are used,but in this paper, the user uses his/her built-in camera or a webcam and uses his/her hand gestures to control the computer mouse operations. In the proposed system, the web camera captures and then processes the frames that have been captured and then recognizes the various hand gestures and hand tip gestures and then performs the particular mouse function.

For the purpose of detection of hand gestures and hand tracking, the MediaPipe Framework is used, and OpenCV library is used for computer vision. Webcam detectour hand gestures (which we are trying to do to control the cursor) and according tothe command given by us through hand gestures, algorithm understand our hand gestures command and do the functions.

REQUIREMENT

System/Hardware requirement for the AI virtual mouse:

Requirements	**Specification**
Laptop/ Computer	Windows 7 +
Camera	Necessary
Ram	2+ GB
Processor	Intel(R) Pentium(R) or latest one also

System/Hardware requirement for the development of AI virtual mouse:

Requirements	**Specification**
Python IDE	Latest version or closer
Pycharm	Latest version or closer

Processor:	Intel(R) Pentium(R) or latest one
Ram:	minimum 4GB
System type:	64-bit operating system, x64-based processor
Pen and touch:	No pen or touch input is available for this display
Edition:	Windows 7/8/10 +
Programming language:	python

- Pycharm environment (pycharm community 2022.1.3)
- Webcam
- OpenCV library
- MediaPipe library
- Autopy library
- Pyautogui

Pycharm is a dedicated Python Integrated Development Environment (IDE) providing awide rangeof essential tools for Python developers, tightly integrated to create a convenient environment for productive Python, web, and data science development.

For this project I am using Pycharm environment, version is community 2022.1.3.Pycharmcommunity is free to use.

Webcam: -

A webcam is a video camera that feeds or streams an image or video in real time to or through a computer network, such as the Internet. Webcams are typically small cameras that sit on a desk, attach to a user's monitor, or are built into the hardware. Webcams canbe used during a video chatsession involving two or more people, with conversations that include live audio and video.

OpenCV: -

OpenCV is a huge open-source library for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Python, C++, Java,etc. It can process images and videos to identify objects, faces, or even the handwriting of a human.

Application of OpenCV:

OpenCV's application areas include:

- 2D and 3D feature toolkits
- Egomotion estimation
- Facial recognition system
- Gesture recognition
- Human–computer interaction (HCI)
- Mobile robotics
- Motion understanding
- Object detection
- Segmentation and recognition
- Stereopsis stereo vision: depth perception from 2 cameras
- Structure from motion (SFM)
- Motion tracking
- Augmented reality

MediaPipe: -

MediaPipe is Google's open-source framework, used for media processing. It is cross- platform or we can say it is platform friendly. It is run on Android, iOS, web, and YouTubeservers that's what Cross-platform means, to run everywhere.

we will use mediapipe python library to detect face and hand landmarks. We will be using a Holistic model from mediapipe solutions to detect all the face and hand landmarks. We will be also seeing how we can access different landmarks of the face and hands which

can be used for different computer vision applications such as sign language detection,drowsinessdetection, etc.

AutoPy: -

AutoPy is a simple, cross-platform GUI automation library for Python. It includes functions for controlling the keyboard and mouse, finding colours and bitmaps on-screen,and displaying alerts. Currently supported on macOS, Windows, and X11 with the XTest extension.

Pyautogui: -

Python pyautogui library is an automation library that allows mouse and keyboard control.Or we can say that it facilitates us to automate the movement of the mouse and keyboard to establish the interaction with the other application using the Python script. It provides many features, and a few are given below.

- We can move the mouse and click in the other applications' window.
- We can send the keystrokes to the other applications. For example - filling out theform,typing the search query to browser, etc.
- We can also take snapshots and give an image.
- It allows us to locate a window of the application, and move, maximize, minimize, resizes, or close it.
- Display alert and message boxes.

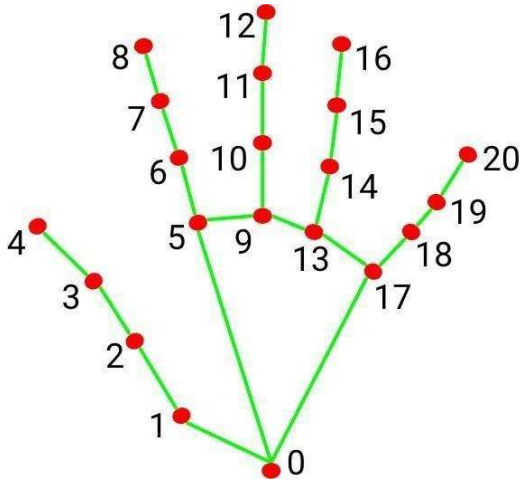
PROTOTYPE

- Virtual Mouse is AI related project as well as Computer Vision (CV).
- Python language is used for making Virtual mouse.
- For make this project we required one computer or laptop, webcam, and in systempython IDE should be install, it may be pycharm (version: - pycharm community 2022.1.3) or youcan also use IDLE (python 3.10 64-bit).
- Many python libraries are used for make the project.
- For python environment python IDE is used to make this project.
- Python is a very popular general-purpose interpreted, interactive, object-oriented,and high-level programming language. Python is dynamically-typed and garbage-collected programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License (GPL).
- Python is commonly used for developing websites and software, task automation,data analysis, and data visualization.
- For the AI virtual mouse project one of the powerful library is used i.e. PyAutoGUI.
- Python pyautogui library is an automation library that allows mouse and keyboard control. Or we can say that it facilitates us to automate the movement of the mouseand keyboard to establish the interaction with the other application using the Python script.

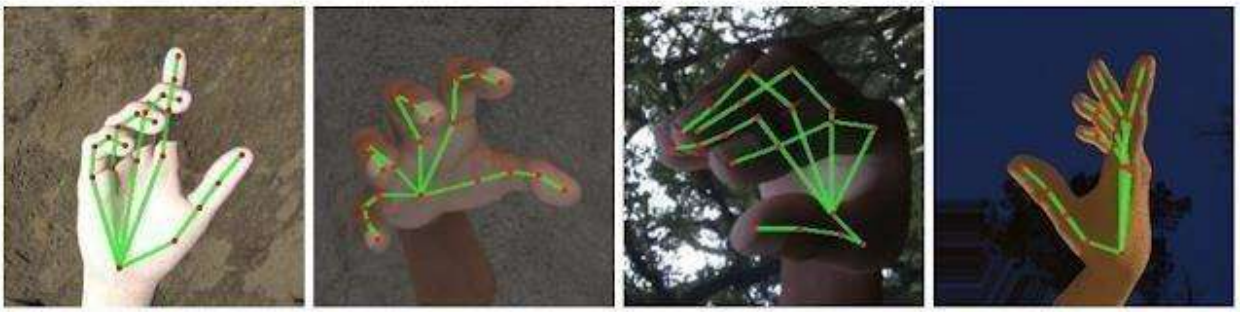
Event Table

DESCRIPTION	TRIGGER	SOURCE	ACTIVITY	RESPONSE	DESTINATION
Start the AI virtual mouse	Opening Webcam	User	Start	Webcam is open	User
Identify the landmarks of the hand.	Showing the landmarks	User	Show your hand in front of the webcam.	On hand landmarks are showingin video camera on Screen	User
Cursor move without the useof physical mouse.	Movingcursor	User	Move your index fingerin front of the webcam.	Cursor is moving along with your index finger.	User
Click on something(e.g. chrome) without the use of physical mouse.	Click on app	User	Now, take your index finger to the chrome, then take your thumbclose to your index finger.	Chrome is open.	User
Navigation on navigation barof amazon website	Navigating on nav bar	User	Move the index finger on navigation bar.	Categories which are present on nav bar are showing.	User

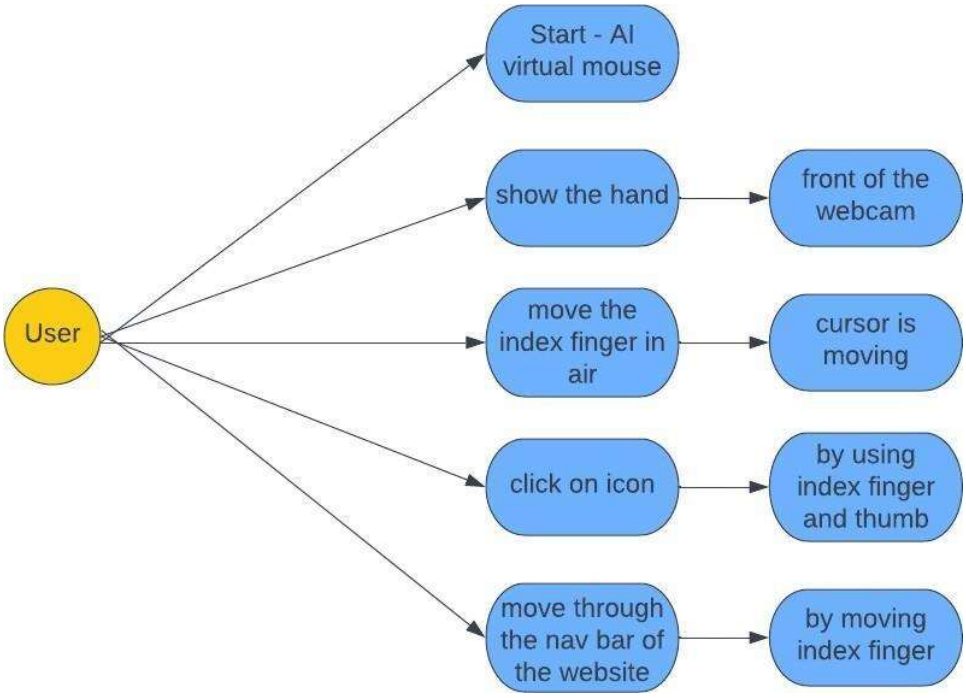
Hand landmarks Diagram: -

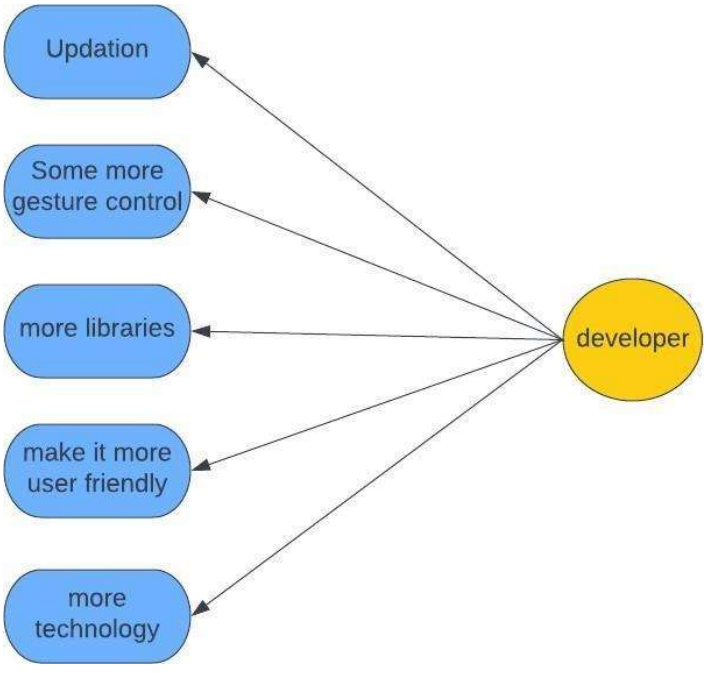


0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP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

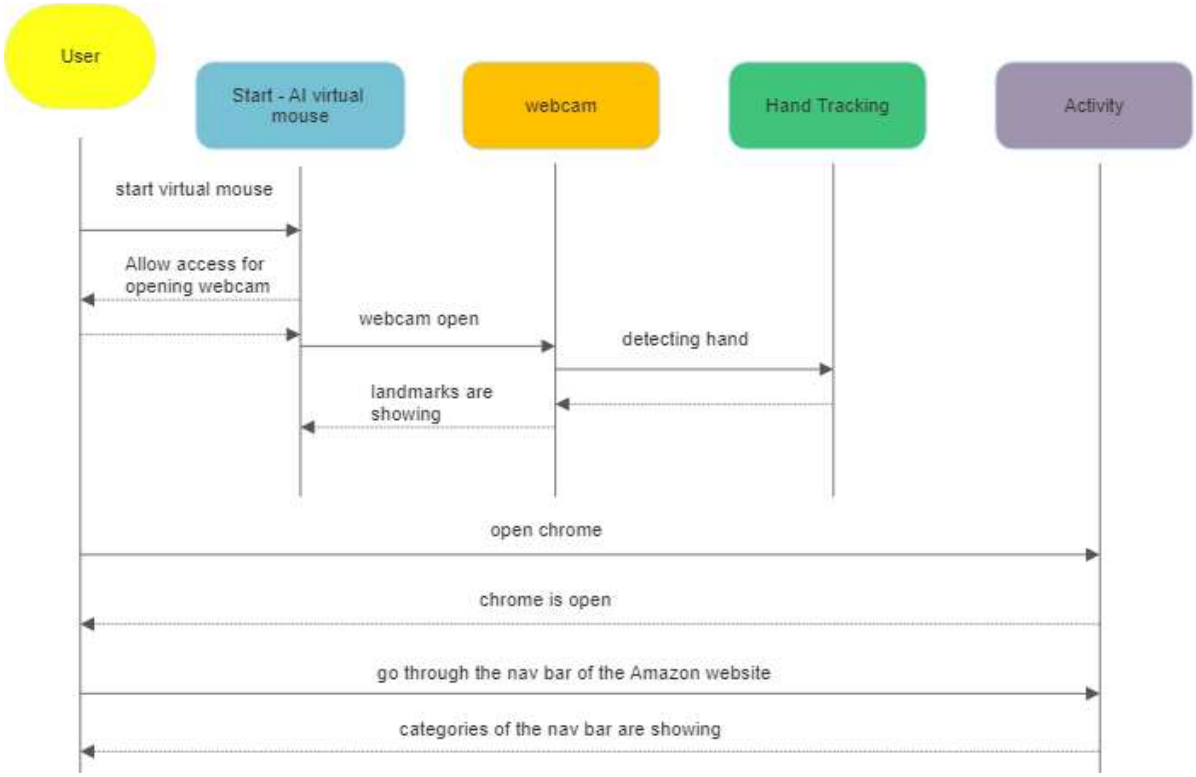


Use case diagram:

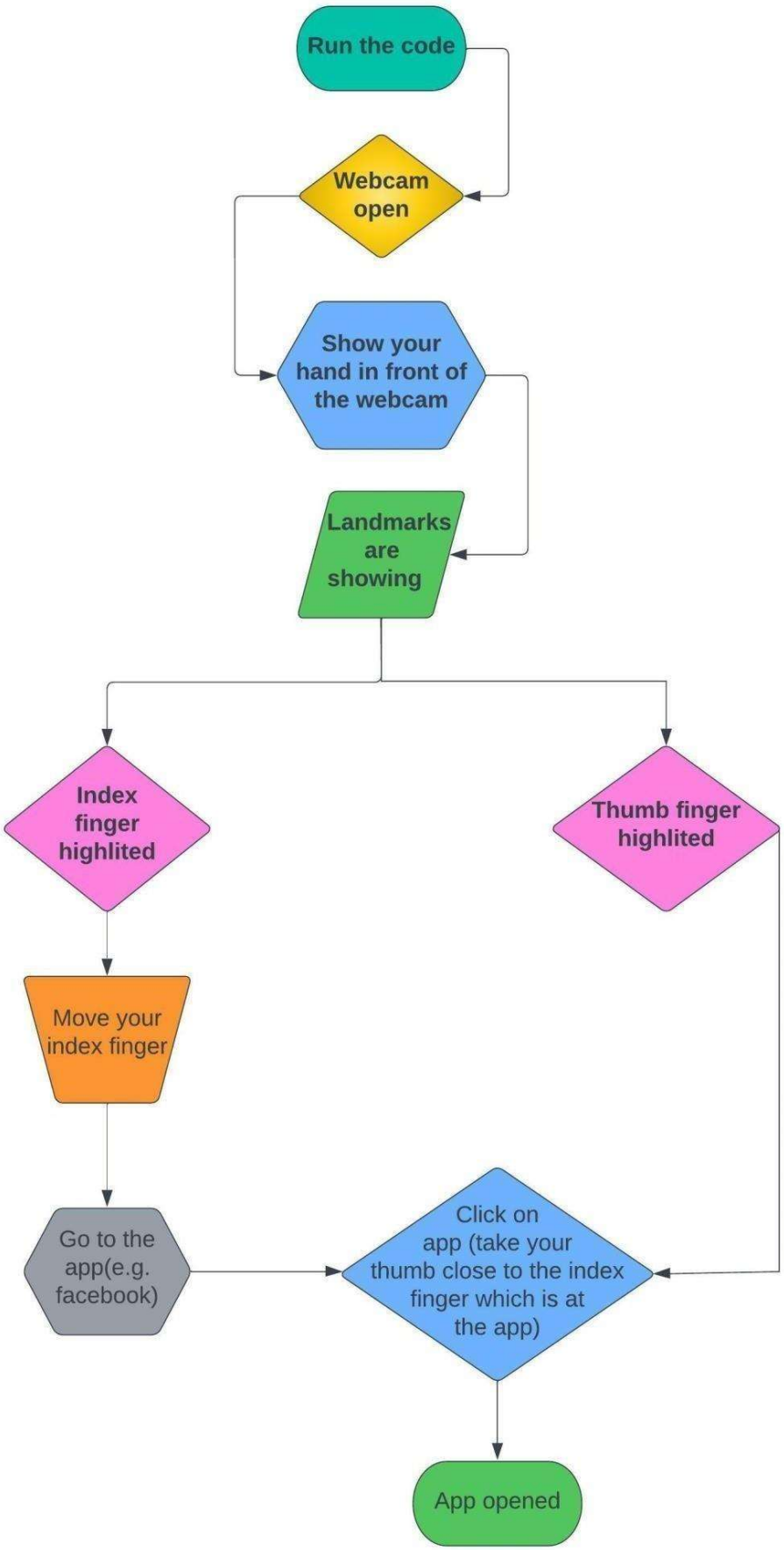




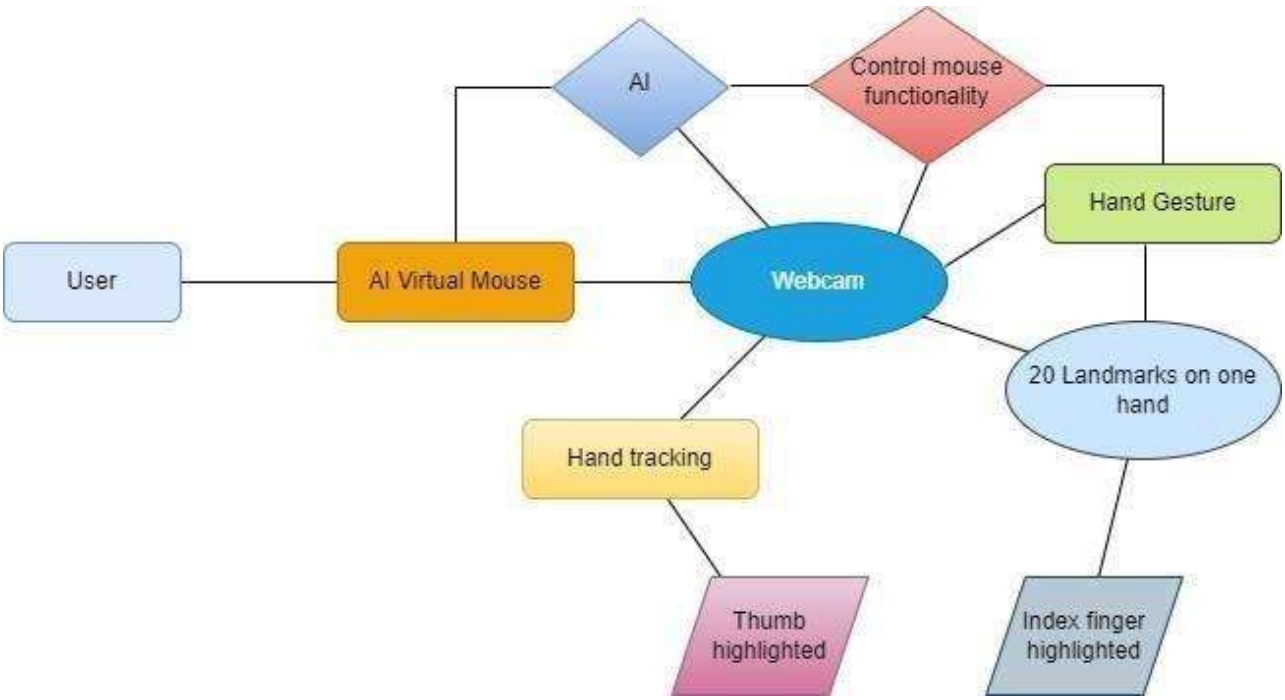
Sequence Diagram:



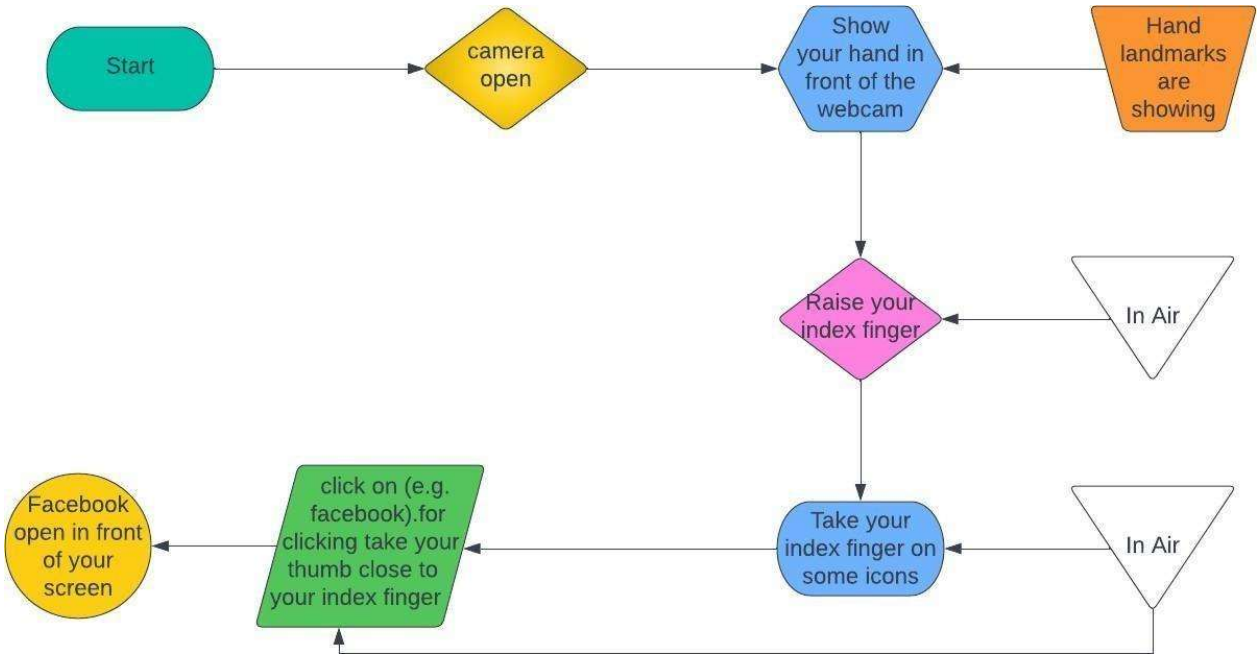
Flowchart:


Run the code
Webcam open
Show your hand in front of the webcam
Landmarks are showing
Index finger highlited
Thumb finger highlited
Move your index finger
Go to the app(e.g. facebook)
Click on app (take your thumb close to the index finger which is at the app)
App opened

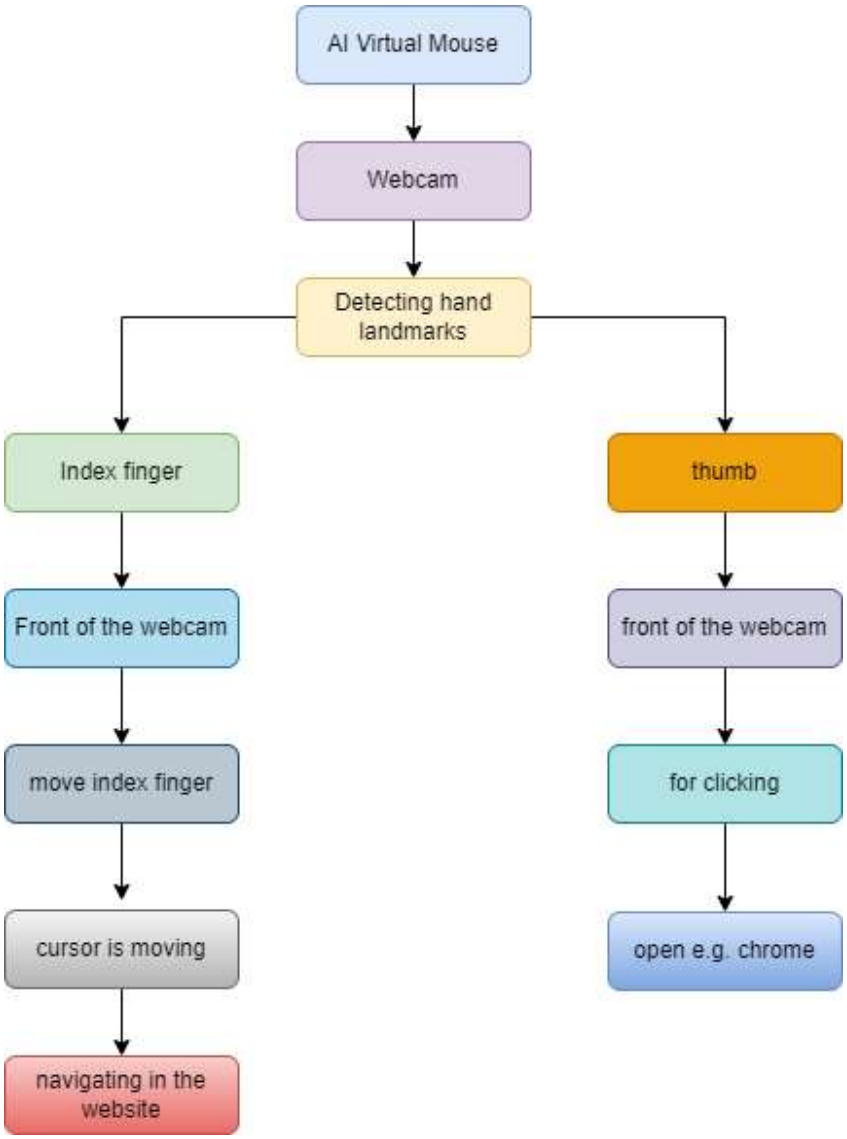
ER Diagram:


AI
Control mouse functionality
Hand Gesture
User
AI Virtual Mouse
Webcam
20 Landmarks on one hand
Hand tracking
Thumb highlighted
Index finger highlighted

Activity Diagram:



Menu Tree:


AI Virtual Mouse
Webcam
Detecting hand landmarks
Index finger
Front of the webcam
move index finger
cursor is moving
navigating in the website
thumb
front of the webcam
for clicking
open e.g. chrome

Test Cases									
Test case_ID	**Test case objective**	**Precondition**	**Step ID**	**Step description**	**Input data**	**Expected result**	**Actual result**	**Status Pass/Fail**	**Remarks**
TC001	To check webcam isopening properly ornot.	. Webcam should be in front of the screen.	1	Click on th estart button	NA	Webcam should beopen.	Webcam isopen properly	**Pass**	**Success**
TC002	To check the Landmarks of the hand visible on thescreen of the webcam.	Hand landmarks should be visible in frontof the screen.	2	Show your hand in frontof the webcam	NA	Landmarks of the hand shouldbe visible	Hand Landmarksare visible onboth ofthe hands	**Pass**	**Success**
TC003	To chec kthe Index finger is highlighted.	1. Index finger shoul dbe visibl ewith yello w circle 2. On moving of index finger the cursor on the screen should be move	3	Move indexfingerin front of thewebcamin air.	NA	Index finger should be visible with yellow circle and cursor should be move Without the usephysical mouse.	Index finger shown in yellow circle and cursor is moving.	**Pass**	**Success**
		Click functio n				Chrome shouldbe open			

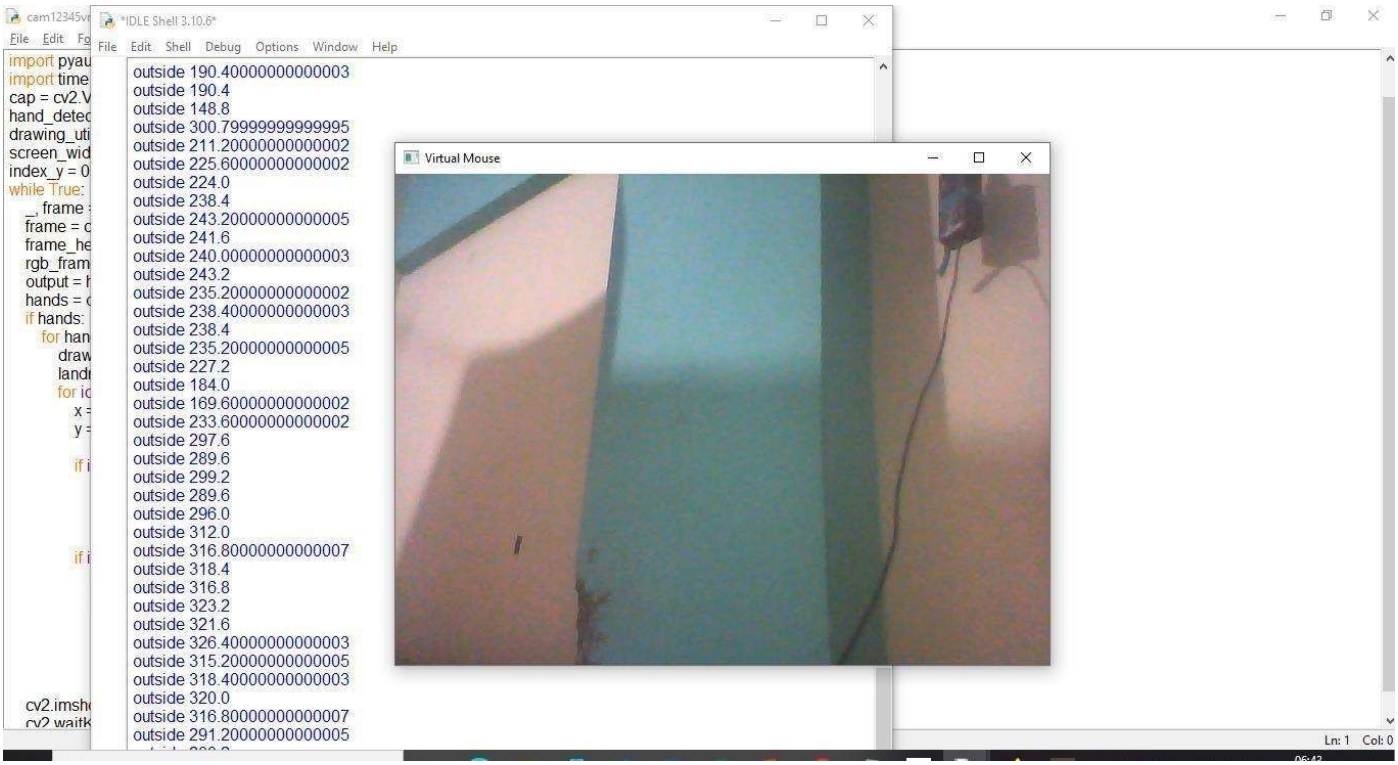
TC004	To check the click function is working.	should be occuras w etake thumb close to our Index finger.	4	Go to the e.g. chrome and take your thumb close to your index finger.	N A		Chrome isopen	**Pass**	**Success**

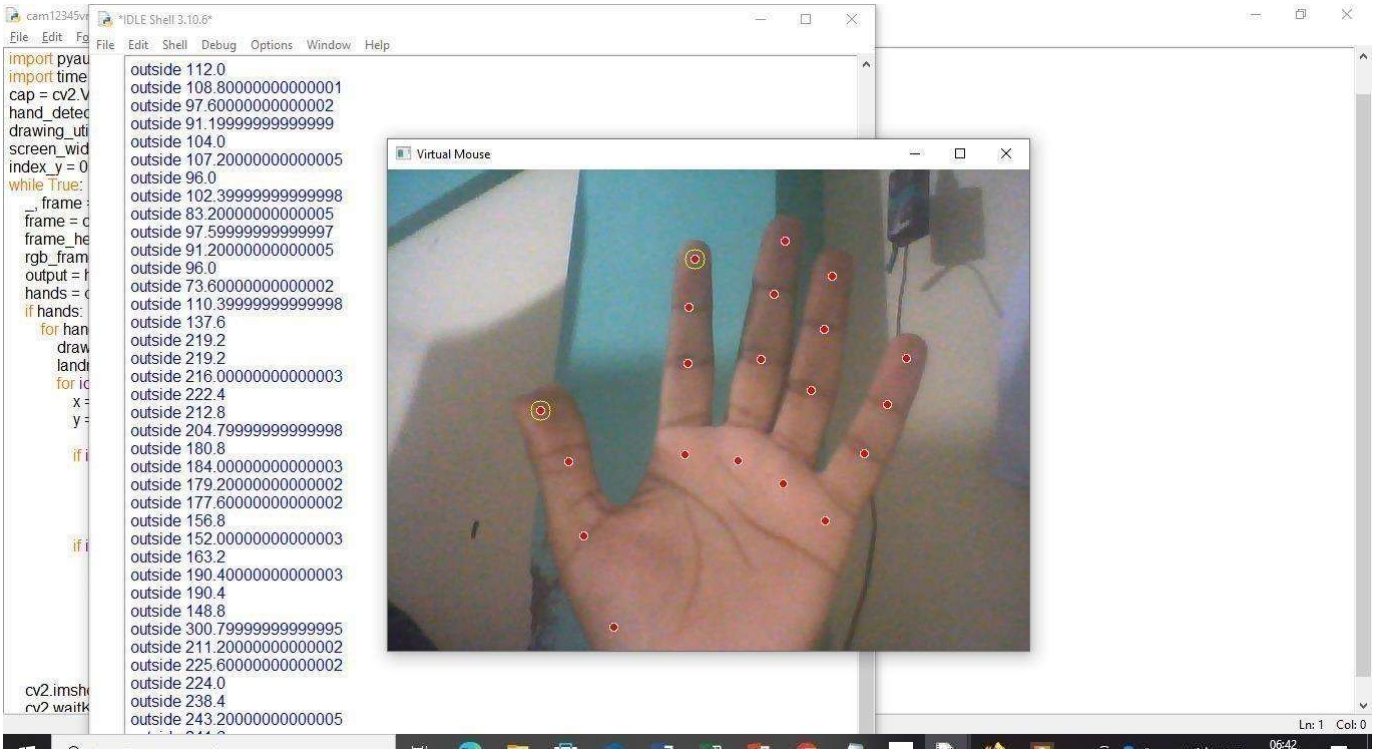
System Coding

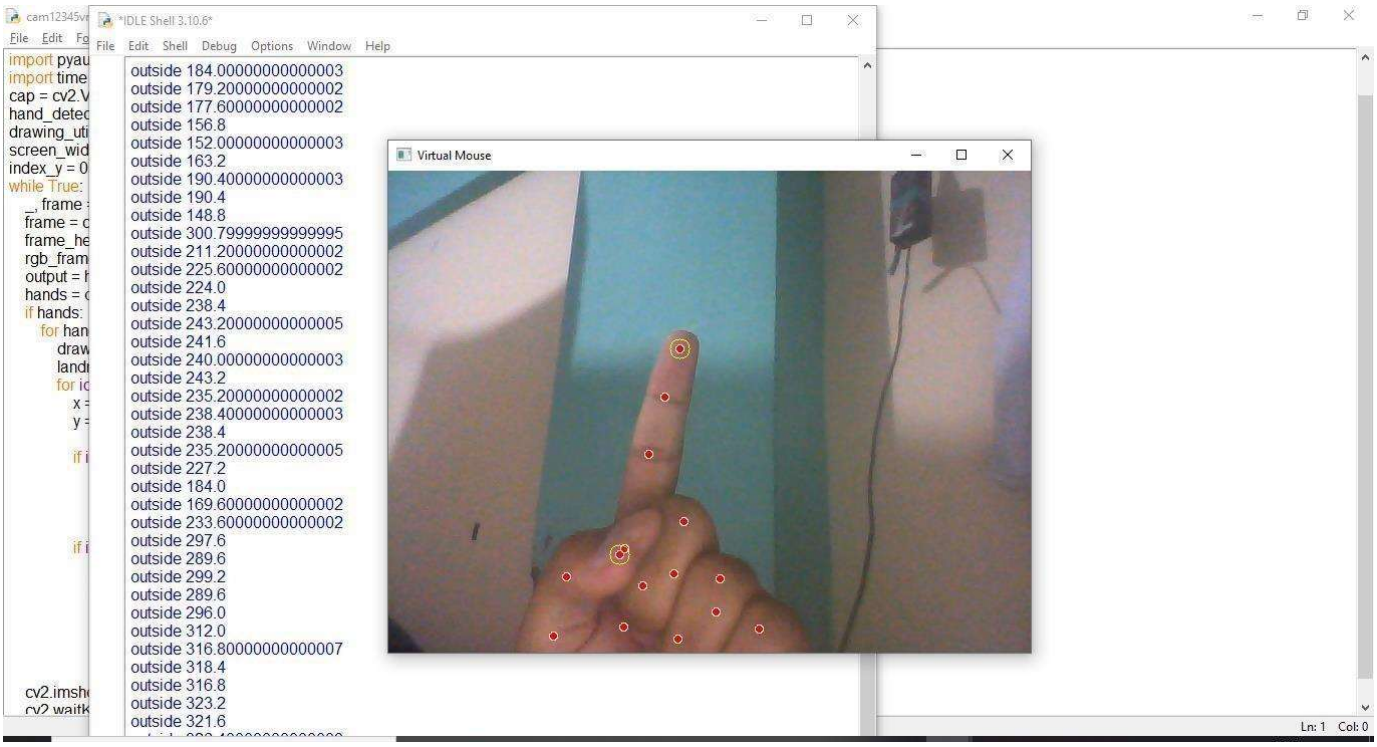
```
import cv2
import mediapipe as mp
import  pyautogui
import time
cap = cv2.VideoCapture(0)
hand_detector = mp.solutions.hands.Hands()
drawing_utils = mp.solutions.drawing_utils
screen_width, screen_height = pyautogui.size()
index_y = 0
while True:
    _, frame = cap.read()
    frame = cv2.flip(frame, 1)
    frame_height, frame_width, _ = frame.shape
    rgb_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    output = hand_detector.process(rgb_frame)
    hands = output.multi_hand_landmarks
    if hands:
        for hand in hands:
            drawing_utils.draw_landmarks(frame, hand)
            landmarks = hand.landmark
            for id, landmark in enumerate(landmarks):
                x = int(landmark.x*frame_width)
                y = int(landmark.y*frame_height)

                if id == 8:
                    cv2.circle(img=frame, center=(x,y), radius=10, color=(0, 255, 255))
                    index_x = screen_width/frame_width*x
                    index_y = screen_height/frame_height*y
                    pyautogui.moveTo(index_x, index_y)
                if id == 4:
                    cv2.circle(img=frame, center=(x,y), radius=10, color=(0, 255, 255))
                    thumb_x = screen_width/frame_width*x
                    thumb_y = screen_height/frame_height*y
                    print('outside', abs(index_y - thumb_y))
                    if abs(index_y - thumb_y) < 20:
                        pyautogui.click()
                        pyautogui.sleep(1)
    cv2.imshow('Virtual Mouse', frame)
    cv2.waitKey(1)
```

Screenshots:






IDLE Shell 3.10.6
File Edit Shell Debug Options Window Help
outside 184.00000000000003
outside 179.20000000000002
outside 177.60000000000002
outside 156.8
outside 152.00000000000003
outside 163.2
outside 190.40000000000003
outside 190.4
outside 148.8
outside 300.79999999999995
outside 211.20000000000002
outside 225.60000000000002
outside 224.0
outside 238.4
outside 243.20000000000005
outside 241.6
outside 240.00000000000003
outside 243.2
outside 235.20000000000002
outside 238.40000000000003
outside 238.4
outside 235.20000000000005
outside 227.2
outside 184.0
outside 169.60000000000002
outside 233.60000000000002
outside 297.6
outside 289.6
outside 299.2
outside 289.6
outside 296.0
outside 312.0
outside 316.80000000000007
outside 318.4
outside 316.8
outside 323.2
outside 321.6
Virtual Mouse
Ln: 1 Col: 0

Future Enhancement

- In future I will add more functionalities of the mouse in AI virtual mouse.
- I will make it more smooth.
- In future other programming language is also used to developing AI virtualmouse, so that this technology become more flexible and easy to use.
- Support to work in more device.
- More libraries are also use in future for developing AI virtual mouse.
- More commands of the hand gesture will add in future.
- More functions in future such as zoom in zoom out, volume control, etc. throughhandgesture command.
- Proper software or platform for AI virtual mouse.

Conclusion

Artificial Intelligence (AI) is a revolutionary field of computer science, which is ready to become the main component of various emerging technologies like big data, robotics, and IoT. It will continue to act as a technological innovator in the coming years. In just afew years, AI has become a reality from fantasy. Machines that help humans with intelligence are not just in sci-fi movies but also in the real world. At this time, we live in a world of Artificial Intelligence that was just a story though for some years.

We are using AI technology in our daily lives either unknowingly or knowingly, and somewhere it has become a part of our life. Ranging from Alexa/Siri to Chatbots, everyone is carrying AI in their daily routine. The development and evolution of this technology are happening at a rapid pace. However, it was not as smooth and easy as it seemed to us. It has taken several years and lots of hard work & contributions of various people to take AI at this stage. Being so revolutionary technology, AI also dealswith many controversies about its future and impact on Human beings. It may be dangerous, but also a great opportunity. AI will be deployed to enhance both defensiveand offensive cyber operations. Additionally, new means of cyber-attack will be invented to take advantage of particular vulnerabilities of AI technology.

AI virtual mouse is the technology based on the Artificial intelligence. AI virtual mouse do the functionalities of the physical mouse without the use of physical mouse. By usingAI virtual mouse its feel like Tony Stark of the Iron man movie. AI virtual mouse do the functionalities like moving cursor, clicking, etc. For making this technology many libraries are used.

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- https://www.computervision.zone/courses/ai-virtual-mouse/
- https://youtu.be/8gPONnGIPgw
- https://www.geeksforgeeks.org/opencv-overview/
- https://learnopencv.com/introduction-to-mediapipe/
- https://youtu.be/vJWzH_2F64g
- https://www.ibm.com/cloud/learn/what-is-artificial-intelligence
- https://www.javatpoint.com/python-pyautogui-library