

A thick dark blue vertical bar is positioned on the left side of the page. A blue arrow-shaped banner points to the right, containing the date. Below the banner, several thin, curved lines in dark blue and light grey sweep upwards from the bottom left corner.

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# Artificial Intelligence

## Final Project Report

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## ABSTRACT

The mouse is one of the wonderful inventions of Human-Computer Interaction (HCI) technology. Currently, wireless mouse or a Bluetooth mouse still uses devices and is not free of devices completely since it uses a battery for power and a dongle to connect it to the PC. In the proposed AI virtual mouse system, this limitation can be overcome by employing webcam or a built-in camera for capturing of hand gestures and hand tip detection using computer vision. The algorithm used in the system makes use of the machine learning algorithm. Based on the hand gestures, the computer can be controlled virtually and can perform left click, right click, scrolling functions, and computer cursor function without the use of the physical mouse. The algorithm is based on deep learning for detecting the hands. Hence, the proposed system will avoid COVID-19 spread by eliminating the human intervention and dependency of devices to control the computer.

## INTRODUCTION:

With the development technologies in the areas of augmented reality and devices that we use in our daily life, these devices are becoming compact in the form of Bluetooth or wireless technologies. This paper 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. The main objective of the proposed system is to perform computer mouse cursor functions and scroll function using a web camera or a built-in camera in the computer instead of using a traditional mouse device. Hand gesture and hand tip detection by using computer vision is used as a HCI with the computer. With the use of the AI virtual mouse system, we can track the fingertips of the hand gesture by using a built-in camera or web camera and perform the mouse cursor operations and scrolling functions and also move the cursor with it.

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 and 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.

Python programming language is used for developing the AI virtual mouse system and also 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 Media Pipe package for the tracking of the hands and for tracking of the tip of the hands and also Pynput, Autopy, and PyAutoGUI packages were used for moving around the window screen of the computer for performing functions such as left click, right click, and scrolling functions. The results of the proposed model showed very high accuracy level and the proposed model can work very well in real-world application with the use of a CPU without the use of a GPU.

## **1.1. Problem Description and Overview:**

The proposed AI virtual mouse system can be used to overcome problems in the real world such as situations where there is no space to use a physical mouse and also 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 possible situation of spread of the virus by touching the devices, so the proposed AI virtual mouse can be used to overcome these problems since hand gesture and hand Tip detection is used to control the PC mouse functions by using a webcam or a built-in camera.

## **1.2. Objective:**

The main objective of the proposed AI virtual mouse system is to develop an alternative to 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 functions such as left click, right click, and cursor movement.

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## **2. Algorithm Used for Hand Tracking**

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 gestures and hand tip.

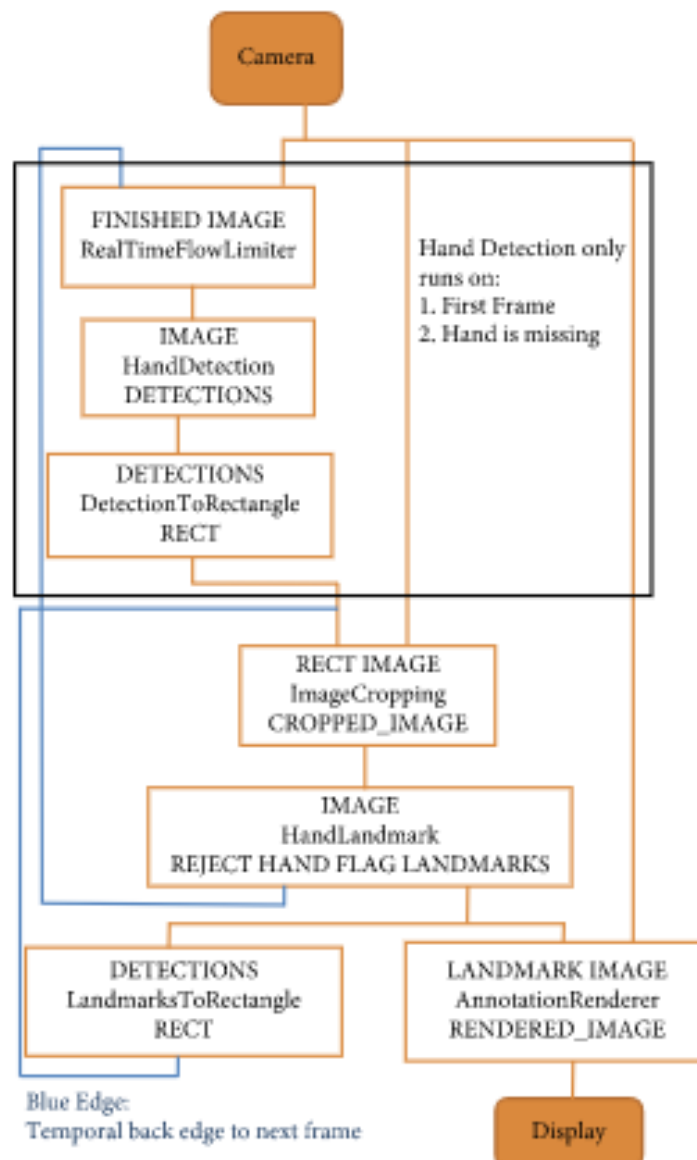
### **2.1. MediaPipe:**

MediaPipe is a framework which is used for applying in a machine learning pipeline, and it is an opensource framework of Google. The MediaPipe framework is useful for cross platform development since the framework is built using the time series data. The MediaPipe framework is multimodal, where this framework can be applied to various audios and videos. The MediaPipe framework is used by the developer for building and analyzing the systems through graphs, and it has also been used for developing the systems for the application purpose. The steps involved in

## VIRTUAL MOUSE CONTROL USING HAND GESTURES

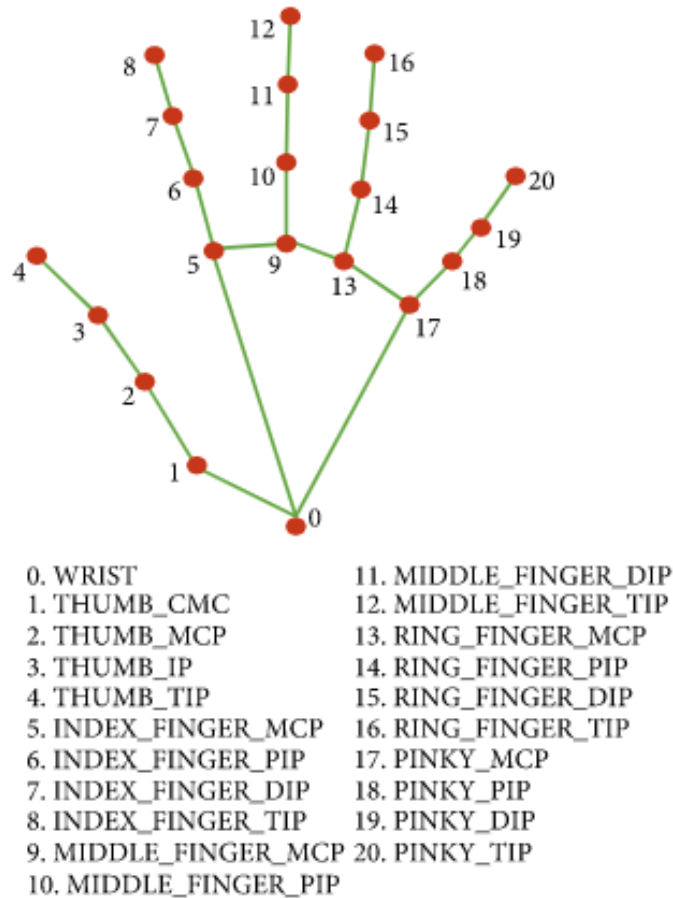
the system that uses MediaPipe are carried out in the pipeline configuration. The pipeline created can run in various platforms allowing scalability in mobile and desktops. The MediaPipe framework is based on three fundamental parts; they are performance evaluation, framework for retrieving sensor data, and a collection of components which are called calculators and they are reusable. A pipeline is a graph which consists of components called calculators.

Each calculator is connected by streams in which the packets of data flow through. Developers are able to replace or define custom calculators anywhere in the graph creating their own application. The calculators and streams combined create a data-flow diagram; the graph (Figure 1) is created with MediaPipe where each node is a calculator and the nodes are connected by streams.



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Single-shot detector model is used for detecting and recognizing a hand or palm in real time. The single-shot detector model is used by the MediaPipe. First, in the hand detection module, it is first trained for a palm detection model because it is easier to train palms. Furthermore, the nonmaximum suppression works significantly better on small objects such as palms or fists. A model of hand landmark consists of locating 21 joint or knuckle co-ordinates in the hand region, as shown in Figure 2.



## 2.2. OpenCV

OpenCV is a computer vision library which contains 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

## **3. METHODOLOGY:**

### **3.1. 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. The web camera captures and passes the frames to the AI virtual system.

### **3.2. Capturing the Video and Processing**

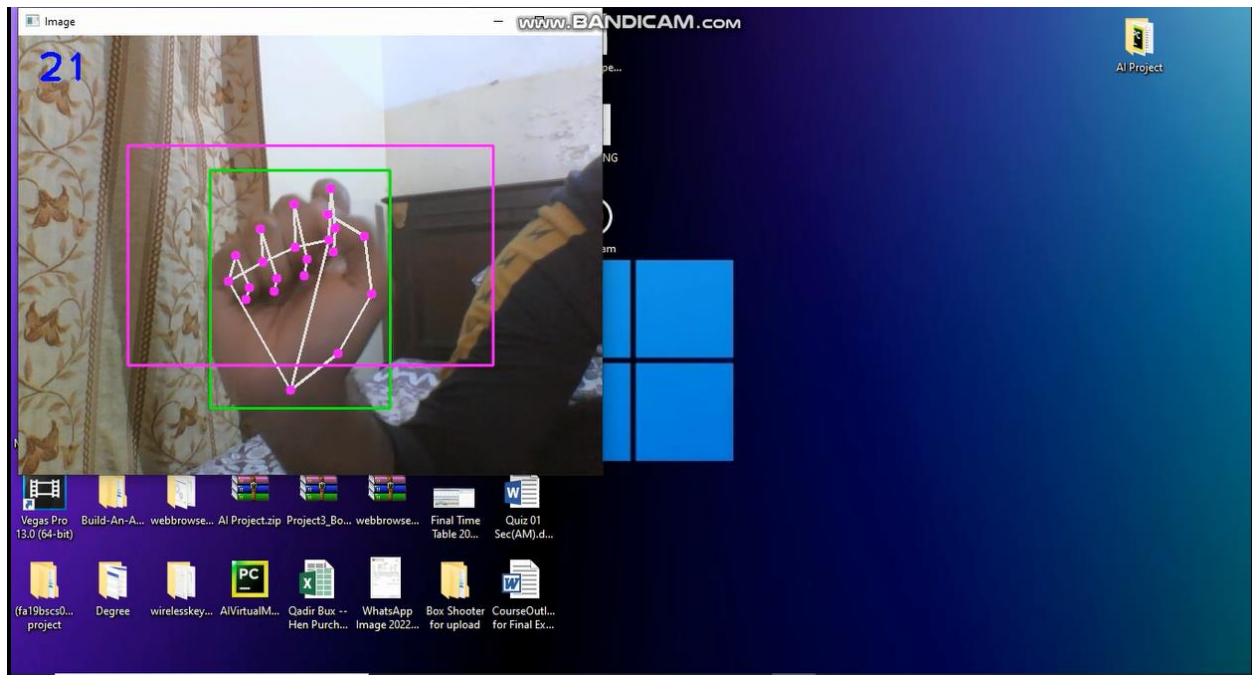
The AI virtual mouse system uses the webcam where each frame is captured till the termination of the program. The video frames are processed from BGR to RGB color space to find the hands in the video frame by frame

### **3.3. (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 fingertips 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

## 4.1. 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.



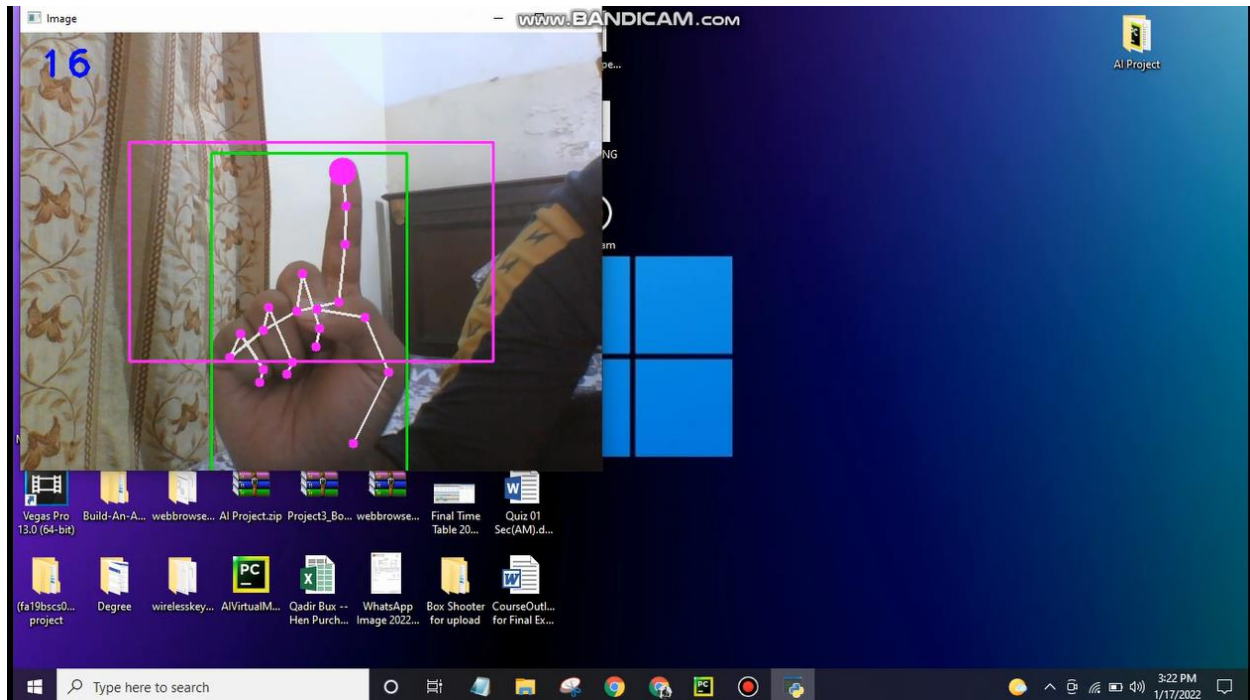
## Mouse Functions Depending on the Hand Gestures and Hand Tip Detection Using Computer Vision

### 4.2. 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 = 0 are down, the mouse cursor is made to move around the window of the computer using the AutoPy package of Python.

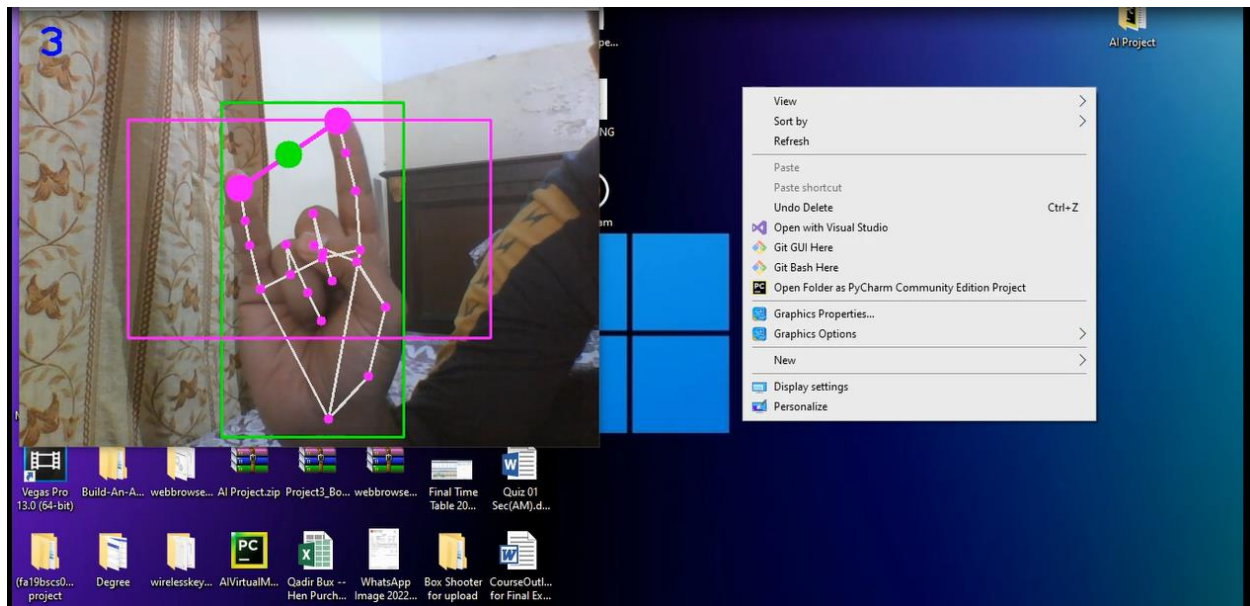


# VIRTUAL MOUSE CONTROL USING HAND GESTURES



## 4.3. For the Mouse to Perform Right 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 40 px, the computer is made to perform the right mouse button click using the pynput Python package





## **5. Future Scope:**

The proposed AI virtual mouse has some limitations such as small decrease in accuracy of the right click mouse function and also the model has some difficulties in executing clicking and dragging to select the text. These are some of the limitations of the proposed AI virtual mouse system, and these limitations will be overcome in our future work.

Furthermore, the proposed method can be developed to handle the keyboard functionalities along with the mouse functionalities virtually which is another future scope of Human-Computer Interaction (HCI).

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## **6. Applications:**

The AI virtual mouse system is useful for many applications; it can be used to reduce the space for using the physical mouse, and 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.

Major applications:(i)The proposed model has a greater accuracy of 99% which is far greater than the that of other proposed models for virtual mouse, and it has many applications(ii)Amidst the COVID-19 situation, it is not safe to use the devices by touching them because it may result in a possible situation of spread of the virus by touching the devices, so the proposed AI virtual mouse can be used to control the PC mouse functions without using the physical mouse(iii)The system can be used to control robots and automation systems without the usage of devices(iv)2D and 3D images can be drawn using the AI virtual system using the hand gestures(v)AI virtual mouse can be used to play virtual reality- and augmented reality-based games without the wireless or wired mouse devices(vi)Persons with problems in their hands can use this system to control the mouse functions in the computer(vii)In the field of robotics, the proposed system like HCI can be used for controlling robots(viii)In designing and architecture, the proposed system can be used for designing virtually for prototyping

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## **7. Work Distribution:**

Report was prepared by Rauhaan Arif, while Hamza & Moiz worked on Coding part

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## **8. Conclusions:**

The main objective of the AI virtual mouse system is to control the mouse cursor functions by using the hand gestures instead of using a physical mouse. The proposed system can be achieved by using a webcam or a built-in camera which detects the hand gestures and hand tip and processes these frames to perform the particular mouse functions.

## VIRTUAL MOUSE CONTROL USING HAND GESTURES

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From the results of the model, we can come to a conclusion that the proposed AI virtual mouse system has performed very well and has a greater accuracy compared to the existing models and also the model overcomes most of the limitations of the existing systems. Since the proposed model has greater accuracy, the AI virtual mouse can be used for real-world applications, and also, it can be used to reduce the spread of COVID-19, since the proposed mouse system can be used virtually using hand gestures without using the traditional physical mouse.

The model has some limitations such as small decrease in accuracy in right click mouse function and some difficulties in clicking and dragging to select the text. Hence, we will work next to overcome these limitations by improving the fingertip detection algorithm to produce more accurate results.