



# Hand Gesture Recognition For Human Computer Interaction

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## Abstract:

A hand gesture recognition system provides a natural, innovative and modern way of nonverbal communication. In this project, we have created an AI-based Mouse Controller. It will first detect the hand landmarks, then track and then perform functions. The virtual mouse will be operated without touching any device or screen. This project represents a concept of controlling our video display with the assistance of hand gestures, which relies on one in each of the studies of Human Computer Interaction. This project shows that we are able to control our screen by moving our fingers which will work as cursor. To make this happen, all we need a working webcam and three main algorithms that are, mediapipe, OpenCV and autopy. Mediapipe is employed for hand tracking, OpenCV for image processing and drawing and at last autopy for controlling the mouse movement and its functioning. Our proposed project is on hand gesturebased system that allows users to control desktop mouse movements using hand gesture. To detect hand gesture movements, our system makes use of a desktop webcam. The goal is to control mouse cursor functions with a simple camera or webcam rather than a traditional or standard devices. Using only a camera, the Virtual Mouse provides an infrastructure between the user and the machine. It enables the user to interact with a machine without the need for any mechanical or physical devices, and even allows to control mouse functions.

**Keywords:**= MediaPipe, OpenCV, AutoPy, Hand Tracking, Gesture-Based Control, Webcam-Based Interaction, Cursor Control, Touchless Interfacne, Real-Time Object Detection , Machine Learning, Finger Tracking, User Interface Automation, Smart Interaction System, Image Processing, Contactless Computing.

## I. INTRODUCTION

Hand gestures are an easy and natural way to communicate in day-to-day life. However, a human-computer interaction system based on gestures has various application scenarios. For example, play games that intend to provide a mouse and keyboard-free experience or control robots in some environments. A small box will appear in the center of the screen while the computer's webcam records video of the person using it while they are seated in front of it. The objects displayed there will be processed by the code and compared with it. If they match, the particular mouse function will be performed. If the gesture doesn't match the box will appear as it is, the known gesture will perform the function.

A mouse is a pointing device that facilitates human-computer interaction. There has been much development in the types of mouse. Starting from a wired mouse to a bluetooth mouse, then a touchpad and touch screen. The interaction between humans and computers has increased widely, while the domain is witnessing continuous development with new methods and techniques being discovered. Hand gesture recognition is one of the most advanced domains in which computer vision and artificial intelligence have helped to improve communication with people and also supported gesture-based signal systems.

The recent advancement of hand gesture recognition in various industries has also caught the interest of business for human-robot interaction in the production and operation of autonomous vehicles. Hand gesture recognition has a huge variety of uses in general. 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.

### OBJECTIVES

- To develop a virtual mouse using python programming language which works using hand gestures.
- To create a system which won't require any hardware to operate mouse which will reduce the hardware cost.
- To find an alternative way to use at public places to reduce spread of virus through touch and will help people to return to normal routine after pandemic.
- To help those people who are physically challenged and unable to use their hands on physical mouse so we try to give them an easy method to go their task easily and effortlessly.

## II. PROBLEM STATEMENT

Even today, many of us still find interacting with computers and hardware to be an unpleasant experience, despite the event of input devices over decades. Computers and hardware should be tailored to our natural modes of communication: visual communication and speech. In our purposed project, we've designed a system that has the power to regulate our display screen with the assistance of our hand gestures, which allows a pleasing interaction, and which is free and easy to use. Our purposed Virtual Mouse 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 persons who have problems with their hands and are not able to control a physical mouse. And talked about current world scenario the COVID-19 situation, it is not safe to use the device by touching them because it may result in a possible situation of the spread of the fungus or viruses by touching the devices. It depends on the environment, like noise in the environment or light in the environment.

### III. PROPOSED SYSTEM

The proposed system is an AI-based Virtual Mouse Controller that enables users to control computer mouse operations through hand gestures captured by a webcam. The system eliminates the need for traditional input devices by providing a touchless and intuitive method of human-computer interaction.

The webcam continuously captures live video frames, which are processed using OpenCV for image acquisition and preprocessing. MediaPipe is employed to detect and track hand landmarks in real time, providing accurate information about finger positions and movements. Based on the detected hand landmarks, specific gestures are recognized and mapped to corresponding mouse actions such as cursor movement, left-click, right-click, double-click, drag-and-drop, and scrolling.

AutoPy is integrated into the system to convert the recognized hand gestures into mouse control commands. The movement of the index finger is used to control the cursor position on the screen, while different combinations of finger gestures are used to perform various mouse functions. The system operates in real time, ensuring smooth and responsive interaction between the user and the computer.

The proposed Virtual Mouse Controller offers a cost-effective, user-friendly, and contactless solution for computer interaction. It has potential applications in smart environments, interactive systems, accessibility technologies, gaming, presentations, and touch-free computing applications.

### IV. LITERATURE SURVEY

Tran, DS., et al. [1] proposed a virtual mouse method using RGB-D images and fingertip detection [2020]. The hand region of interest and the centre of the palm are first extracted using in-depth skeleton-joint information images from a Microsoft Kinect Sensor version-2 and then converted into a binary image. Then, the contours of the hands are extracted and described by a border-tracing algorithm. The k-cosine algorithm is used to detect the fingertip location based on the hand contour coordinates. Finally, the fingertip location is mapped to RGB images to control the mouse cursor based on a virtual screen. This study still suffers from several limitations that are mainly inherited from Microsoft Kinect. Tsung-Han Tsai et al. [2] Design of a hand gesture recognition system for human-computer interaction [2019] proposed skin and motion detection is used for capturing the region of interest from the background regions. A connected component labelling algorithm is proposed to identify the centroid of an object. To identify the exact area of the hand gesture, the arm area is removed with the aid of a convex hull algorithm. Moreover, a real-time demonstration system is developed, based on a single-camera mechanism which allows for the use of variable devices. Simulation results show that the recognition rate is still high, although some interference is encountered in the simulated environments. Vantukala Vishnu Teja Reddy et al. [3] Virtual mouse control using coloured finger tips and hand gesture recognition [2020] developed models 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 the other is by hand gesture detection. This includes three main steps: finger detection using colour identification, hand gesture tracking, and implementation of an on-screen cursor. In this study, hand gesture tracking is generated through the detection of the contour and the 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.

S. Varun et al. [4] virtual mouse implementation using open CV. [2019] developed models which are based on color detection and mouse movement based on highlighted color which is given from the user for the movement of the mouse. A two-figure input can be seen where it is forming two rectangles and forming an average point from both figures. That point will act like a mouse pointer. Once the point moves, the mouse pointer in the runtime also moves along. So, using this, the movement of the mouse can be implemented. The updating of the mouse pointers depends on the position of the prespecified coloured caps in the mask that is created for understanding the system. The created mask is converted from an RGB background to a black and white that will be used for the detection of the prespecified coloured objects that will help with the movement of the mouse. If the prespecified coloured caps camouflage with the background, they will not be detected, and thus no movement of the mouse is possible. M. S. Shajideen and V. H. Preetha [5]: hand gestures and the virtual mouse for humancomputer interaction [2018] proposed model, which has hand pointing gestures incorporated with other hand gestures in 3D space. Two USB cameras are used, which are placed orthogonal to each other to obtain a top and side view of different hand gestures. MATLAB software is used for it. For separate two views, the two detectors are trained and choosing various image samples for various directions at the top & side view. At the training stage, binary patterns are applied for image conversation and feature generation for each sample. Then two cascade detectors were built, which depend on AdaBoost feature selection. At the testing stage, after the transformation of the input image into the working image, each and every detector monitors and scans the working image in each view separately. Aashni Haria et al. [6]: hand gesture recognition for human-computer interaction [2017]. developed model, they designed a robust marker-less hand gesture recognition system that can efficiently track both static and dynamic hand gestures. Our system translates the detected gesture into actions such as opening websites and launching applications like VLC Player and PowerPoint. The dynamic gesture is used to shuffle through the slides in a presentation. Our results show that an intuitive HCI can be achieved with minimum hardware requirements. Monika B. Gandhi and Ashwini M. Patil.[10] proposed a study in cursor control system using hand gesture recognition. in [2013] . In this work, a vision-based system to control various mouse activities, such as left and right clicking, using hand gestures to make the interaction more efficient and reliable is proposed. This paper delineates a vision-based interface for

regulating a computer mouse via 2D hand gestures. Hand gestures rely on camera-based colour detection techniques. This method mainly focuses on the use of a web camera to develop a virtual HCI device in a cost-effective manner. The centroid of each input image is found. Hand movement also moves the centroid, thus making it the principle of sensing for the alteration of the cursor on the computer screen. The hand image is treated here as the parent image. The left and right click functions of a mouse are implemented by folding the first and middle fingers of the hand, respectively, and developing a baby image. So, by comparing the length of fingers in baby images with those in mother images, they have got an idea of the functionality performed by the hand gesture. The limitation is that stored frames are needed to be processed for hand segmentation and skin pixel detection. S.Veluchamy et al.[7] vision based gesturally controllable human computer interaction system.[2015] proposed hand contours and complex moments to resolve the hand gesture recognition issue by identifying the main advantages and disadvantages of each method. An artificial neural network is built for the purpose of classification by using the back propagation learning algorithm. The hand gesture image is passed through three stages: pre-processing, feature extraction, and classification. In the state of pre-processing, some operations are practised to extract the hand gesture from its background and prepare the hand gesture image for the feature extraction stage. In the very initial method, the hand contour is used as a factor that treats the scaling and translation issues. The complex moment's algorithm is, however, used to outline the hand gesture and treat the rotation problem in addition to the scaling and translation problems. Banerjee, A. et al. [9] Mouse control using a web camera based on colour detection [2014] vision-based gesturally controllable human-computer interaction system. The gesture recognition system

consists of five major steps. They are input image acquisition, preprocessing, feature extraction, classification of gestures, and generation of suitable commands for the system. Vision-based hand gesture recognition can be used for applications like industrial robot control, sign language translation, and rehabilitation devices for people with upper extremity physical impairments. Vision based gestural controllable human computer interaction system, to obtain robust and more accurate result, adopted various methods in the pre-processing stage and feature extraction stage. In the pre-processing stage, the skin colour threshold method is used in background modelling for more accurate hand region segmentation. After this, in the feature extraction stages, the SIFT and MBC algorithms are used Ram Pratap Sharma et al. [8] describe human-computer interaction using hand gestures. [2015] proposed to recognise the static hand gesture images (i.e., frames) based on shapes and orientations of hands, which are extracted from the input video stream recorded in stable lighting and simple background conditions. We can use these vision-based recognised gestures to control multimedia applications (like Windows Media Player, Windows Picture Manager, VLC Player, etc.) running on computers using different gestural commands.

### V. IMPLEMENTATION

#### AI BASED VIRTUAL MOUSE CONTROLLER BLOCK DIAGRAM

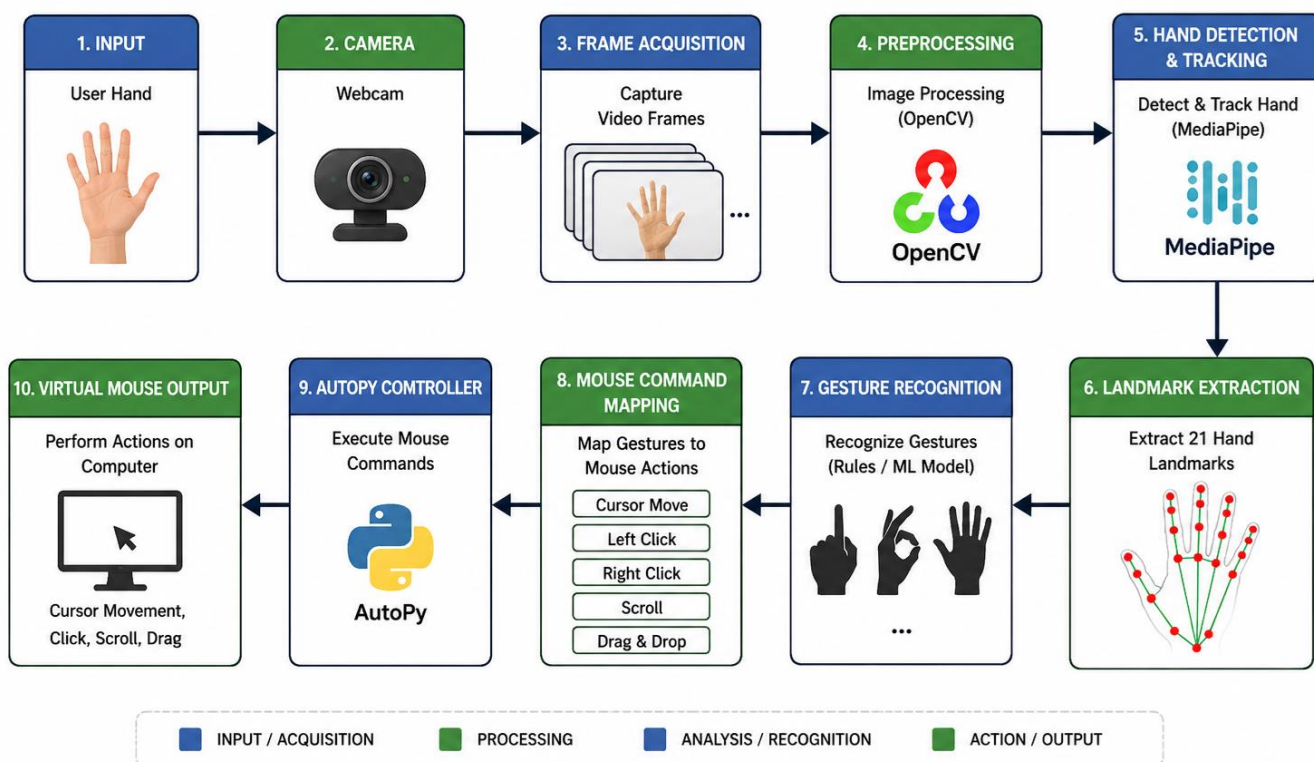


Fig1.1 hand gesture recognition for human computer interaction

1. Gesture Tracking For the characteristic of area of hand signals and hand development, the Media Pipe system is utilized, and Open-CV library is utilized for PC machine vision the standard purposes the AI contemplations to keep and see the hand developments and fingertip. Input Camera Interface Hand Counter Extraction (media pipe) Accessing Mouse Virtually Detect Module Background Subtraction HAND GESTURE RECOGNITION FOR HUMAN COMPUTER INTERACTION VTU PG Studies Mysuru Dept. of CSE 15

2. Open-CV Module PC vision is an interaction by which we can comprehend the pictures and recordings how they are put away and how we can control and recover information from them. PC Vision is the base or generally utilized for Artificial Intelligence. The primary Open-CV form was 1.0. Open-CV is delivered under a BSD permit and thus it's free for both scholar and business use. It has C++, C, Python and Java connection points and supports Windows, Linux, Mac OS, iOS and Android. At the point when Open-CV was planned the fundamental center was continuous applications for computational productivity.

3. MediaPipe Use the MediaPipe Hand Tracking module to track the user's hand movements, identify the landmarks, and extract the hand features such as the position, orientation, and gestures. By using Mediapipe, you can create a highly accurate and responsive virtual mouse system that can be used in various applications such as gaming, accessibility, and virtual reality. Finder framework is utilized by the Media Pipe, in the Hand discovery module of python, its style for a finger and hand recognition model because of it's easy to mentor hand. The planed model of hand reason mark comprises of 21 joint reason and co-ordinates inside the hand, as displayed in

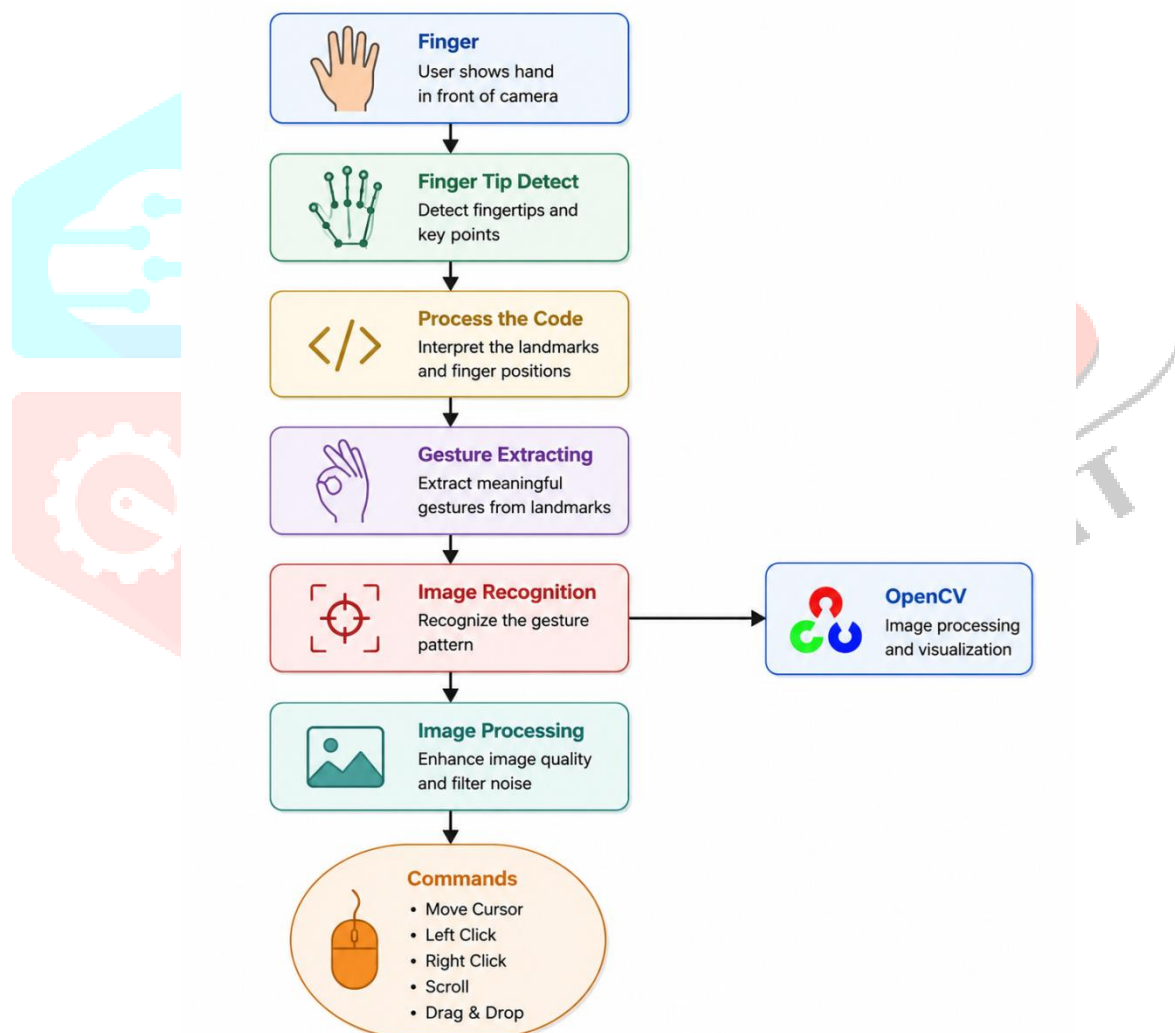


Fig1.2 Flow Chart

- The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.
- The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process,

an external entity that interacts with the system and the information flows in the system. The figure in the Fig 1.2 represents the DFD of Wine Prediction.

## VI. RESULTS AND DISCUSSION

The developed AI-Based Virtual Mouse Controller was successfully implemented and tested using a standard webcam, MediaPipe, OpenCV, and AutoPy. The system was capable of detecting and tracking hand landmarks in real time and converting specific hand gestures into corresponding mouse actions. The experimental results demonstrated that the system could accurately recognize finger movements and gestures under normal lighting conditions. Cursor movement was achieved by tracking the index finger position, while different finger combinations were used to perform mouse operations such as left-click, right-click, scrolling, and drag-and-drop. The response time of the system was found to be sufficiently fast for real-time interaction, providing a smooth user experience.

MediaPipe effectively detected the 21 hand landmarks, enabling precise gesture recognition. OpenCV successfully processed video frames and enhanced image quality for accurate hand detection. AutoPy translated the recognized gestures into mouse commands, allowing seamless control of the computer without any physical mouse device.

The system achieved high accuracy when the hand was clearly visible to the webcam. However, performance was affected by poor lighting conditions, background clutter, and hand occlusions. Despite these limitations, the proposed system proved to be a reliable and cost-effective solution for touchless human-computer interaction. The project demonstrates the practical application of artificial intelligence and computer vision technologies in developing gesture-based control systems. The Virtual Mouse Controller can be applied in smart environments, interactive presentations, accessibility solutions, gaming applications, and contactless computing systems. Future improvements may include support for multiple hand gestures, custom gesture training, enhanced robustness under varying environmental conditions, and integration with advanced machine learning models for increased accuracy and functionality.

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