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Smart Mouse

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***Abstract*— The mouse is one of the great inventions of HCI (Human Computer Interaction) technology. Nowadays there are Bluetooth devices (Wireless Mouse) that are used for controlling the PC. Wireless or Bluetooth mouse technology is Present, but it's not device-free. Bluetooth mouse requires the use of batteries and the included dongle. The presence of additional electronics in the mouse makes it difficult to use. In the proposed virtual mouse system, employing a webcam or a built-in camera for capturing hand gestures and hand tip detection using computer vision can be used to overcome these limitations. Based on the users' hand gestures, the PC can be controlled virtually and can perform left-click, right-click, double-click, and computer cursor function just as a physical mouse, without using the physical mouse. Hence, the proposed system is very practical in this post-COVID-19 world by eliminating human intervention and dependency on devices to control the computer, As a result, the transmission of devices through physical contact by multiple users is reduced. This project promotes an approach to Human Computer Interaction (HCI) where cursor movement can be controlled using a real-time camera; it is an alternative to the current methods including manual input of buttons or changing the positions of a physical computer mouse. Instead, it utilizes a camera and computer vision technology to control various mouse events and is capable of performing every task that the physical computer mouse can.**

***Index Terms*— HCI (Human-Computer Interaction), Hand Gesture, Gesture Recognition.**

I. Introduction

As technology advances daily, devices are becoming more and more compact. Some devices are now wireless, while others are latent. So, in this paper, we develop a system that could make some devices go latent in the future, which is the future of HCI (Human Computer Interaction). That is to create a virtual mouse using hand gesture recognition. Hand gesture technology is used in many areas of today's automation world, including medical applications, industrial applications, IT hubs, the banking sector, and many more. The goal is to control the mouse pointer functionality with just a simple camera instead of a traditional or regular mouse. A virtual mouse acts as a medium between the user and the machine through only one camera. This helps the user interact with the machine without a mechanical or physical device. Usually, we use the mouse, keyboard, or other interacting devices that are compact with our machine. But the wireless device also requires power and connectivity technology, but for this paper, the user's bare hands are the only input option on her webcam. It is a very interactive way to control the mouse pointer. This system is implemented using the Python programming language, OpenCV, and Mediapipe. This technology has the potential to replace the typical mouse or machine remote control.

II. Literature Survey

Hand Gesture Cursor Control Applications are used in many ways, but most of them require wearing a Data Glove.

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This reduces power efficiency between the user and the system. System complexity is an issue for this process.
There are two possible Gesture Recognizers in HCI. One is Hardware-based and the other is Computer Vision based. One of his early hardware-based systems was proposed by Quam (1990). This system required the user to wear his bulky DataGlove to use the system [1]. Although this method provides very precise control, it is very difficult to use as some gestures are not for everyone and are very inconvenient for mass users in the everyday world. There are also two types of visual hand gesture recognition: Marker-based and Non-marker-based. But the Marker-based recognition is more accurate than Non-marker-based recognition. Also, the major advantage of Marker-based recognition is that the accuracy is more than the other methods. However, this method is simple and has almost nothing compared to DataGlove on Hardware based systems. As most Marker-based recognition makes use of at least two color markers to track the operations and because multiple colors are detected, the system slows down and the system lags during the performance.
In 2010, Li Wensheng, Deng Chunjian, and Lv Yi published a paper on “Implementation of Virtual Mouse based on machine vision” [2] in which the fingertip is detected and tracked based on color, and the user is required to wear the finger knots of a given color. This natural motion of the mouse pointer is achieved by smoothing the path of the fingertip location using a physical model of the mouse pointer. But the main disadvantage is that the user has to use the finger knots because it detects the color to perform the mouse operations.
In 2013, Ashwini M. Patil, Sneha U. Dudhane, and Monika B. Gandhi worked on “Cursor Control System Using Hand Gesture Recognition” [3] in which they used simple computer vision and multimedia techniques to develop a machine-user interface that implements hand gesture recognition. But the major disadvantage of this system is that skin pixel detection and hand segmentation should be performed from a saved frame before using the gesture comparison algorithm.
In 2014, Abhik Banerjee and Abhirup Ghosh worked on “Mouse Control using a Web Camera based on Color Detection” [4]. In this, the mouse operations are performed by a hand gesture which is captured using the camera based on the color detection technique. But the disadvantage of this method is that it requires a light background and it will not function properly if there will be any noise in the background. Also, it requires computers of high configuration to give good results.
In 2014, Ashish Mhetar, B K Sriroop, Kavya AGS, Ramanath Nayak, Ravikumar Javali and Suma K V worked on ”Virtual Mouse” [5]. The technology they used was an IR camera, IR pen, and Teensy which cost a lot. Their aim was to improve the methods of teaching by making use of technology. Since they are using more output devices, it is costly.
In 2018, Abhilash SS, Lisho Thomas, Naveen Wilson, and Chaithanya C worked on “Virtual Mouse Using Hand Gesture” [6] in which the system works on color detection and the number of colors detected. But the disadvantage of this system is that it only works by detecting the colors and performs only a few operations of the mouse. Also, another main cause of this system is that it requires a static background.
In 2019, Shibly Kabid, Dey Samrat, Md. Aminul Islam and Showrav Shahriar worked on the ”Design and Development of a Hand Gesture Based Virtual Mouse” [7]. In this research paper, the technology used was Python programming language and OpenCV. We found some drawbacks in it like it needs a well-lit environment, and it’s not suitable in poor lit conditions.
In June 2020, Udit Kumar, Sanjana Kintali, Ashraf Ali, and Kola Sai Latha worked on the ”Hand Gesture Controlled Laptop Using Arduino” [8]. They used the Arduino Uno and simple inexpensive ultrasonic sensors used to find the ranges and recognize hand gestures. Again since it is using many hardware devices it requires a complex setup and costs more.
In July 2020, Prof. Monali Shetty, Christina A. Daniel, Manthan K.Bhatkar, and Ofrin P. Lopes worked on ”Virtual Mouse using object tracking” [9]. The technology used was Python, OpenCV, HSV technology, and Image processing. In this, they used the HSV color detection technique for detecting the object and performing the mouse operations. Here they use any color object and place it on their fingertips so the tips can be detected and the mouse operations can be performed. But using the external object to track the tips increases the dependency on others. The biggest disadvantage of this is that we require a plain background. Without a plain background, it will be difficult for it to detect the object.
In 2020, Vantukala VishnuTeja Reddy, Thumma Dhyanchand, Galla Vamsi, and Satish Maheshwaram worked on ”Virtual Mouse using colored fingertips and Hand gesture recognition” [10]. They have used image processing, Neural Networks algorithm, OpenCV, and Python. Here they used the colored fingertips method to detect and perform the mouse operations. The disadvantage of this method is that plain background is required and can be only done by using colored fingertips.
In 2021, Mr. Devanshu Singh, Mr. Ayush Singh, Mr. Aniket Kumar Singh, Mr. Shailesh Chaudhary, and Asst. Prof. JayvirSingh Kher worked on a ”Virtual mouse using OpenCV” [11]. The technology they used is OpenCV,

Matlab, Anaconda, Numpy, and Image Processing. Here they used an Image processing idea to detect the position of the cursor. And used python for hand gesture recognition. Here they used the color finger technique which is a bit complex.

III. METHODOLOGY

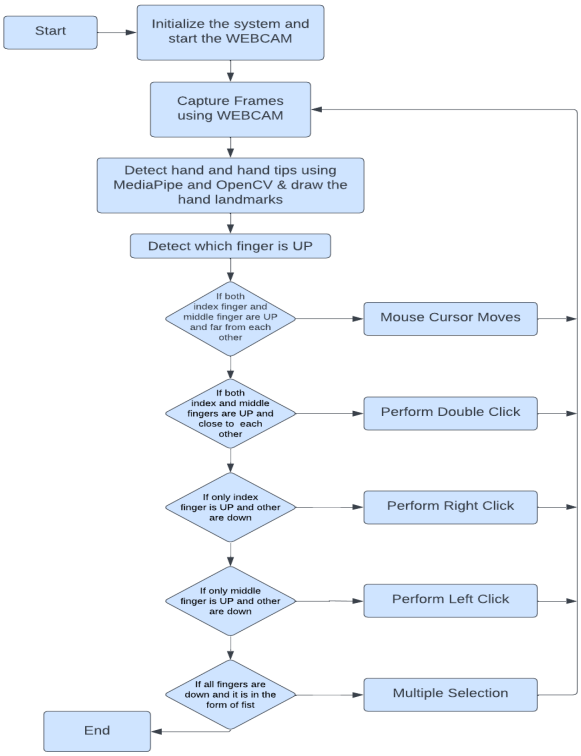

Figure 1. Block Diagram of our Model

The system works with frames captured by a computer's webcam or a laptop's built-in camera. The system uses the webcam to capture video in real-time by creating a video capture object. Since we have a single camera on our laptop, we use 0, and if having more than 1 camera use 1,2,3,. . . . Then the camera will capture frame by frame and will pass it to the system. Using an infinite loop, the webcam captures all images until the program exits. Then next human hand positions are then stored in the system using the usual "coordinate system". At the start, we classify the hands as left and right by using the classification of hands obtained by the media pipe. Once we detect the hands then we will draw the landmarks on the hands. A hand landmark consists of 21 joint or knuckle coordinates in the hand region, as shown in Figure 2.

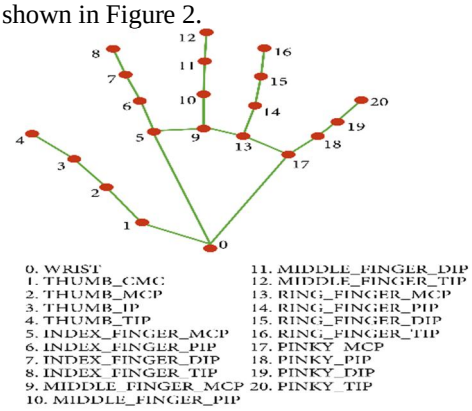

Figure 2. Co-ordinates or landmarks in the hand

These Mediapipe hand landmarks were then converted to recognizable Gestures. After which we will construct all the necessary attributes for hand-recognition objects. Finding gesture encoding using the current finger state. Once the hand is detected we will find the Euclidean Distance between two points. This distance is used to know about the fingertips of hands. Now assign 1 if the finger is open else 0. Next set the fingers by computing the ratio of the distance between the fingertip, middle knuckle, and base knuckle. As we did with the finger detection, handle the fluctuations due to noise. Now execute the commands according to the detected gestures. Locate the hand to get the cursor position using pyautogui and return the coordinates of the current hand position. Save the current and the previous coordinates of the hand and then stabilize the cursor by dampening the motion of the hand. Now we can see the movements of the cursor when we move our hand. These movements performed by the user are recognized using OpenCV. Following this, we assign hand movements to already defined coordinates. This mapping is then analyzed for corresponding cursor movements. These movements are useful for gesture recognition and analysis. Additionally, proper action mappings to gestures performed by the user have been implemented. PC is controlled by the movement and gestures of his hands. The algorithm keeps looking for the gesturing hand at the last known position till the machine loses focus.

IV. Result and Evaluation

In this work, we used Human-Computer Interaction and Computer Vision which will be a valuable contribution to future interaction between humans and machines. The proposed research paper is on controlling mouse functions with the help of hand gestures. The main function is mouse movements, left-click, right-click, double-click, drag-n-drop, and multiple file selection. To find the accuracy of our model we first need to find the accuracy of individual gestures. We asked 25 people to test our model which will give a total of 150 outcomes since each user will use 6 different gestures (25x6=150). The results are in Table 1 and the graph of accuracy is shown in Figure 3. (100 + 96 + 88 + 100 + 100 + 92) / 6 = 96% So, the overall accuracy of the Smart Mouse would be 96%.

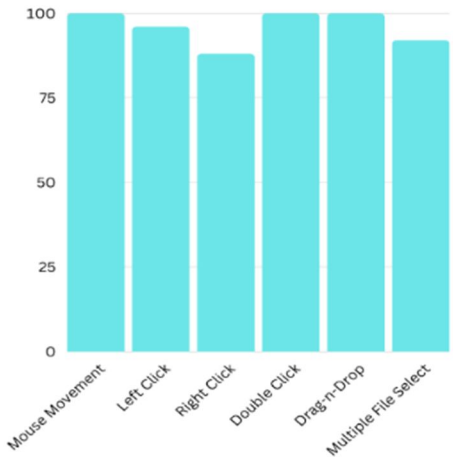

Figure 3. Graph of Accuracy

Table I. Experimental Results

Mouse Function Performed	Success	Failure	Accuracy(%)
Mouse Movement	25	0	100
Left Click	24	1	96
Right Click	22	3	88
Double Click	25	0	100
Drag – n - Drop	25	0	100
Multiple File Select	23	2	92

Figure 4. Left Click

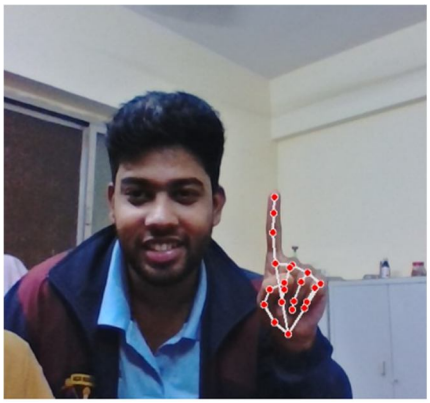

Figure 5. Right Click

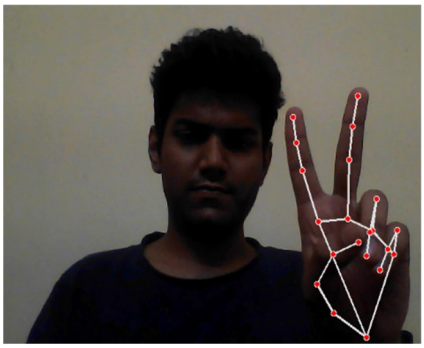

Figure 6. Mouse Movement

Figure 7. Double Click

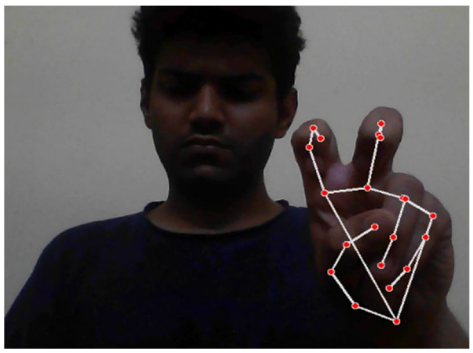

Figure 8. Drag-n-Drop

Figure 9. Multiple File Select

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