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AI-Powered Virtual Mouse Controlled by Hand Gestures

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Abstract— The present paper proposes a novel way of cursor control using hand movements that a standard webcam can easily capture instead of the traditional mouse. It offers a hands-free experience with ease by eliminating the need for a hardware device. The technology utilizes the ability of the webcam to record hands perfectly. The hand gestures are not just imitated, however. Some hand gestures will be developed to serve various operations, such as dragging and right and left click. This permits users to take advantage of the cursor and the functionalities of it in a smooth and intuitive fashion. For one to implement this system as aforementioned, Python and OpenCV come in handy. These models imitating the undulating movement of human hand movements have the capabilities to significantly increase the usability of such computer vision applications. The technological world today is constantly evolving because of the plenty of technologies. One of such fascinating concepts is the human-machine interface. The concept fundamental this is known as signal acknowledgment, which is a method for duplicating mouse functions on a screen without any need for equipment.

Keywords—Gesture Control Virtual Mouse, Virtual Mouse,Hand Gestures, OpenCV

I. INTRODUCTION

There are plenty of technology-based aspects in our daily lives.We have so many technologies, the computer technologies of the world are growing at the same time. They are used to perform various tasks that humans cannot do. In fact, they dominate human life because they have the potential to perform tasks that humans cannot. Human-computer interaction can be done with a printing device such as a mouse. A mouse is an input device that is used to communicate with a graphical user interface, such as pointing, scrolling and scrolling, etc. Hardware mouse on computers and touchpad on laptop takes a lot of time to execute complex operations when the hardware mouse is in action. let's go, it would be ruined at some time. With complex algorithms and neural networks, computers have gained the capacity to detect not only the hand movements but also the nuances of facial expressions and body language, enhancing the communication channel between users and machines. Additionally, the unstoppable drive towards miniaturization in the world of electronics is transforming our understanding of computing devices. From phones that neatly fit into our hands to wearable devices that blend perfectly into our clothing, the physical forms of technology are becoming more and more inconspicuous. This move towards invisibility is not

just superficial but also indicative of a fundamental change towards a less obtrusive incorporation of technology in our lives. One of the more prominent innovations that illustrate this pattern is the virtual mouse system, a wonder of contemporary engineering that combines computer vision libraries such as OpenCV with the flexibility of Python programming. Through the leveraging of packages like Pynput, Autopy, and PyAutoGUI, users are able to have extremely fine control over on-screen actions with nothing more than a series of wrist flicks. But it is the integration of MediaPipe that actually takes this system to the next level, providing unprecedented accuracy when tracking hand motion and finger positions. This all-encompassing system enables users to overcome the limitations of conventional input devices, enabling them to interact with their computers in an intuitive and immersive way.Along with Navigating Through virtual worlds or working with intricate data sets, the lines between human and machine dissolve, creating a symbiotic relationship where each enhances the strengths of the other.

II.EXISTING SYSTEM

Under the existing system, cursor control is provided by the use of a mouse, which can either be wired or wireless according to the choice of the user. An optional strategy that can be explored by clients is through the use of hand signals to collaborate with the system. This new method is implemented through a virtual mouse control system utilizing the webcam feed to identify colored tips, such as red, green, and blue, located on the fingers. These color tips are, in effect, identifiable objects which the webcam is able to detect and understand without difficulty. Through the use of this technology, users are able to fluidly perform normal mouse functions such as dragging windows, minimizing programs, scrolling up and down, and left and right clicking completely

through hand movement. In order to enhance client experience even more, it is planned that the skin type ID system, within which colored fingers play a central role, will be enhanced to eliminate the necessity of these colored finger markers.The goal of this upgrade is to enhance the flexibility and responsiveness of the system so that skin color can be identified accurately on its own in order to propel the cursor control functionality. As it stands, the system greatly depends on static hand recognition methods, which include processes such as finger counting, fingertip identification, and hand shape analysis. Although successful in maximizing the system's accuracy in interpreting user input, the complexity added by these methods might possibly pose challenges in terms of ease of use and understandability.

Thus, in future iterations, the focus will be on streamlining these processes to maintain efficiency without compromising user accessibility and usability

III. LITERATURE SURVEY

Prior work has investigated the application of glove and coloured marker-based hand gesture recognition for virtual mouse control. These approaches had limitations. Gloves are restrictive, hard to wear for extended periods, and can irritate the skin. Coloured markers may not always be suitable for nuanced control. Future methods, such as those based on Google's MediaPipe framework, provide a more viable approach. This technology enables the virtual mouse to be controlled using gestures, and different actions such as clicks, dragging, and adjustments are facilitated with better precision. The challenges of various backgrounds and lighting conditions in hand gesture detection for HCI are overcome by this research. The authors propose a technique that integrates a motion history image-based approach to classify dynamic hand gestures with an adaptive skin colour model (based on face identification) to segment the hand region. The system employs four classes of learned Haar-like features to classify hand motions, such as the up, down, left, right, fist, and waving hand. The majority of home appliances can be operated using this combination. Five individuals tested the framework by sending 250 signals at different distances; the framework demonstrated its reasonability with an average precision of 94.1% and a handling season of 3.81 milliseconds per outline.

This paper suggests a PC vision and AI based constant hand signal location system for human-PC interaction. The authors improve S. Shriram's technique for cursor contactless control, presumably through hand gestures. The technology utilizes convolutional neural network models that MediaPipe created under an OpenCV and Python environment. An individual camera serves as the information device, and the framework's output is presented to client alteration.

This article explores PC vision and hand movement recognition in the context of Coronavirus and their potential uses to VR and HCI, particularly as a means to minimize reliance on real devices. The system under consideration can potentially carry out gesture-based control, like dragging and clicking items, by making use of computer vision techniques. Though not directly cited as a reference, hand tracking and motion tracking imply these approaches. It uses a webcam as input device and is coded using Python and OpenCV. Among its dependencies are NumPy, math, and mouse (possibly for mimicking mouse clicks). Output from the camera is provided to calibrate for the user. This work creates the possibility of gesture recognition being increasingly critical for future HCI and VR interfaces.

To further enhance openness for human-PC correspondence (HCI), this investigation suggests a hand signal operated virtual mouse system that employs PC vision and artificial intelligence (ML)methods. The innovation, which is meant for individuals with physical constraints, captures hand movements with a camera. On the virtual display, recognised gestures are then translated to corresponding mouse motions. Scalability and flexibility in devices and situations are the primary objectives of the system. It provides complete virtual control without needing extra equipment by integrating voice instructions with static and dynamic hand signs

This article suggests a new Human-Computer Interaction (HCI) approach that uses computer vision and deep learning models to mimic human hand gestures and manipulate cursor functionality. The system takes advantage of the OpenCV and MediaPipe libraries in a Python environment, possibly supplemented by the PyAutoGUI package for automation purposes. Finger movements are identified and converted into cursor movements using this method, eliminating the need for actual hardware.

It suggests a virtual mouse technology based on hand gesturesdriven by smart machines (AI). PC vision and diversity discovery are used to identify explicit hand locations that are colored or occlude similar to manage mouse activities. The system employs Python and state-of-the-art PC vision computations to achieve this ability. It is designed to function flawlessly without the need for additional hardware and allows distant PC control through hand gestures for left-and right-clicking and cursor Development.

Using the help of computer vision, this project creates avirtual keyboard and mouse that can be operated using hand gestures. The device uses a webcam to record hand movements, and computer vision algorithms analyse the pictures to identify particular gestures (perhaps employing convex hull defect calculations). Following recognition, appropriate mouse and keyboard commands are assigned to these motions. The framework is being created on the Boa constrictor stage with

Python fully intent on offering a virtual connection point that is sans equipment and remote .

In this research, a hand gesture-controlled contactless cursor-control system is proposed. A webcam is the sole input device for the system, and Python and OpenCV are employed in its implementation. The authors likely employ computer vision algorithms not mentioned specifically to recognize various hand gestures that relate to cursor movement. Some advancements can also be used to regulate the clicking and hauling functions. NumPy, math and mouse (perhaps to simulate mouse clicks) are some of the Python requirements used by the framework, which also displays the webcam yield for client modification

IV. ARCHITECTURE

Figure 1 shows a functional block diagram of the suggested system, how it works. We must extend our hands and touch the webcam. The webcam boots up and begins to capture frames for the video. The given image was subjected to preprocessing. The main job of the image pre-primary processor is standardising the image. Scaling and pre-processing an image to get equal heights and widths is referred to as standardisation

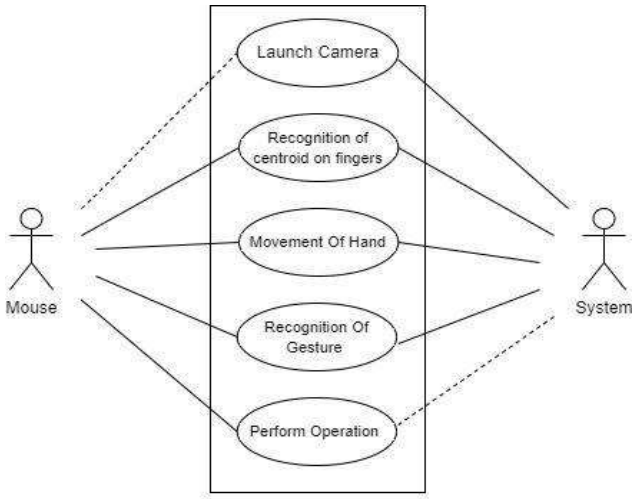

Fig-1. Use case Diagram

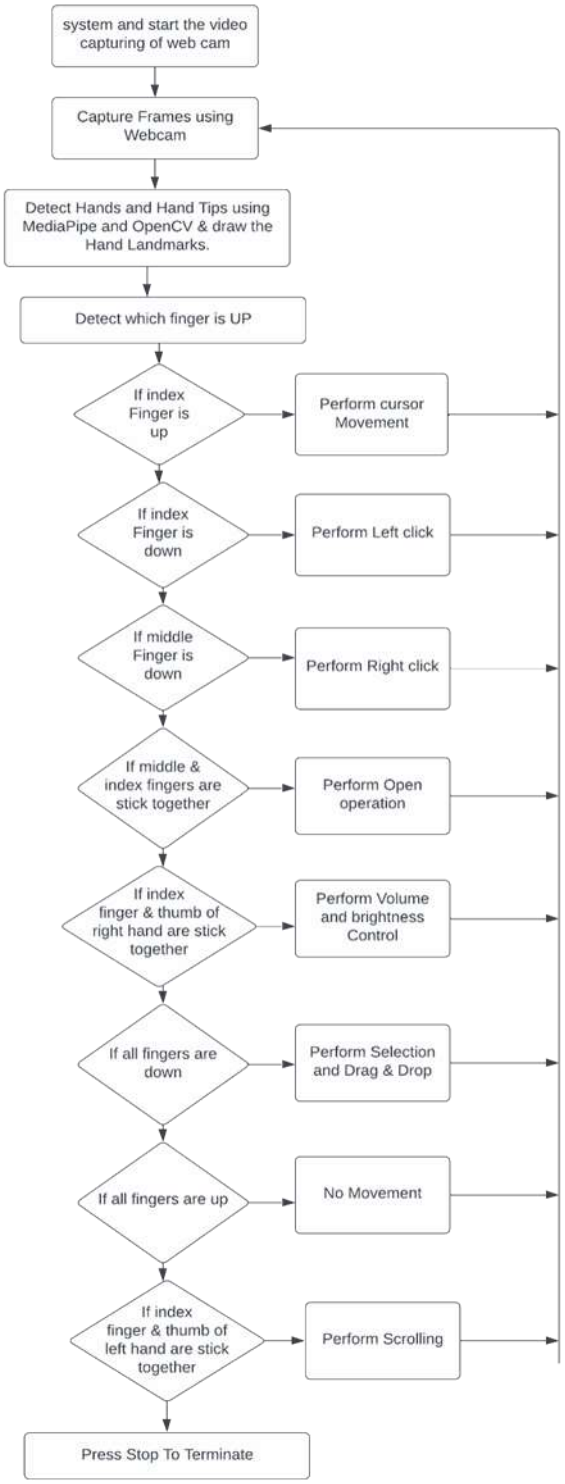

Fig-2. Flowchart

These days, an image processing technique is used to improvethe quality of the average image. Following image processing, MediaPipe and OpenCV are used to identify the

finger tips when the camera moves. After determining the hand and fingertip placements, it starts to outline. There are hand tourist spots and a crate enclosing the hand on the screen. On the Windows PC, draw a rectangle box big enough for the mouse. The fingers that are up and down on you will be recognized by it. In view of the finger discoveries, the mouse activity is performed. Then, the program gets back to the edges to play out the following activity. This is the overall system operation

V. TOOLS USED

I utilized the open-source Mediapipe library to enable effective hand and finger recognition. Developed by Google and built on cross-platform capabilities, this framework incorporates OpenCV for a range of computer vision tasks. The Mediapipe system applies machine learning principles to recognize and track hand gestures accurately

Mediapipe

Google created the open-source MediaPipe framework to make it easier for developers to create real-time, crossplatform computer vision applications. Object detection, posture estimation, hand tracking, facial recognition, and a number of additional features are included in these technologies. Developers may quickly create complex pipelines that combine several algorithms and processes by using MediaPipe. Real-time execution of these pipelines is possible on a variety of hardware platforms, including as CPUs, GPUs, and specialised accelerators such as Google's Edge TPU. Moreover, the framework offers interfaces for smooth communication with other well-known machine learning libraries, such PyTorch and TensorFlow

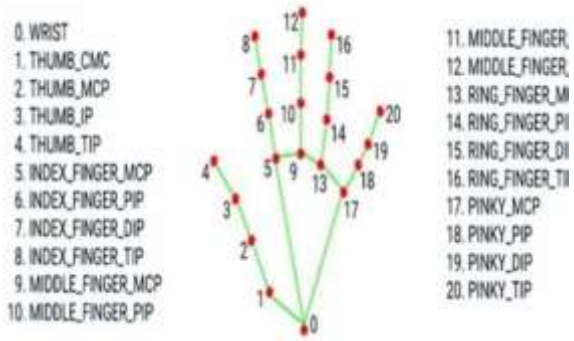

Fig -3: Hand Coordinates or Landmarks

OpenCV

An exhaustive programming library for PC vision and AI, OpenCV can be downloaded for nothing determined to assist developers with making PC vision applications. Filtering, feature identification, object detection, and tracking for both photos and movies are just a few of its many features. OpenCV can be used with other programming languages, such as Python, Java, and MATLAB, through its bindings. Numerous fields, such as robots, self-driving cars, augmented reality, medical image analysis, and more, use the C++ library. It is an effective tool for developers, offering a wide range of instruments and methods that simplify the creation ofintricate computer vision applications acrossseveral fields.

Scope of the Project

The two most popular techniques for recognizing hand gestures are vision-based, which uses images processing methods that rely on camera input and hardware-based methods that need the user to wear a device. It is clear that the proposed system is vision-based, utilizing camera inputs and image processing techniques. Our goal is to provide more gestures so that in the future users may finish more jobs faster. This concept describes a system in which gestures are made exclusively with the appropriate hand. Consequently, advancements made to the current approach will make it possible to use both hands for specific movements in the future. This recommended method will save time and effort for the user, and it will make using computers easier for those who are blind or impaired.

VII. RESULT ANALYSIS

Fig- 1: Brightness and volume control

With help of this gesture, we can control brightness level and volume level by moving hand towards upward,downward, towards left and right.

Fig-2: Cursor Movement

With help of this gesture, we can control cursor by moving hand in given window

Fig – 3: Left Click

With help of this gesture, we can perform left click Operation.

Fig-4: Double click

With help of this gesture, we can perform double click operation.

Fig-5: Right click

With help of this gesture, we can perform left click operation.

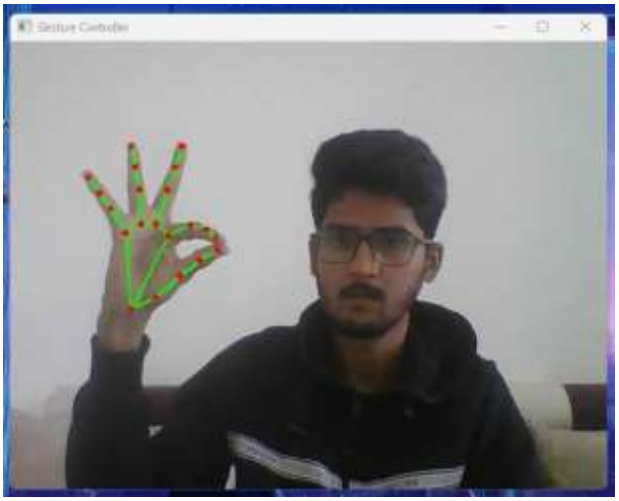

Fig-6: Scrolling

With help of this gesture, we can perform scrolling operation

Fig-7: Selection, drag & drop

With help of this gesture we can perform selection, drag,drop operation.

Future Scope

There's a lot of potential for the future with hand gestures and control of the virtual mouse. More advanced interactions are to be seen in future innovation in gesture recognition, which should allow users to easily make multiple-fingered gestures, zoom, and scroll. This normal point of interaction will be further enhanced through combined voice ordering, providing a highly natural way to interact with PCs. Multimodal interaction will make possible collaborative workspaces in which users can readily combine hand gestures with touch screens or keyboards, maximizing efficiency, over individual requirements. Adaptive interfaces for users with impairments

will provide for the updating of accessibility features and for a more accessible computer environment. Outside of traditional computers, 3D handtracking provides even more opportunities by allowing natural interaction within virtual and augmented reality environments. Thinkinteracting with objects within a virtual the world or just a simple hand gesture to operate smart home appliances. You can make an exceptional and strong virtual mouse framework utilizing hand motions that impacts the bearing of human-PC communication by focusing on continuous execution to ensure liquid cursor development, UI plan that offers clear direction on upheld signals, areas of strength for and security measures to defend client information.

Applications

Virtual mouse control with hand gestures moves beyond the familiar desktop experience to a wide variety of engaging uses. It helps users with disabilities by allowing control of the cursor via head tracking or eye gaze, promoting greater autonomy. For creative professionals, think of working with objects in 3D design software with intuitive hand actions or zooming easily through pictures with a sweep. Virtual and augmented reality becomes a living, breathing environment with natural hand interaction, where users can explore virtual spaces or engage with augmented objects naturally. Gaming can be transformed with gesture-controlled activities, introducing a strategic and immersive element to gaming. Even homes and offices can be smartened up. Think of dimming lights, adjusting thermostats, or controlling media players with just hand gestures. Presentations can be scrolled through easily, and whiteboards can be used in collaboration using hand gestures, creating a more interactive environment. Through exploring these varied uses, your virtual mouse project based on hand movements has the potential to revolutionize human PC collaboration in various fields.

Advantages

Hand motion based virtual mouse control has many advantages over ordinary procedures. First of all, it encourages accessibility by giving users with limited hand mobility a another means of input. For individuals who experience difficulty with customary mouse, envision having the option to control the cursor by simply gazing at the ideal spot or by utilizing head following, which would foster more prominent freedom. Second, utilizing hand motions to communicate with PCs is a more instinctive and regular way to deal with use innovation. Imagine using a simple wave of your hand to manipulate items in 3D design software or a flick of your fingers to easily browse through photographs. For designers and artists, this simple contact can improve workflow and creativity. Thirdly, with augmented and virtual reality, hand motions can open up new possibilities. Consider connecting with augmented reality or exploring virtual worlds. normal hand signals to control things, bringing about an amazingly enamoring and vivid experience. All things considered, hand gesture-based virtual mouse control makes a computer more accessible, improves user experience, and creates opportunities for creative interaction across a range of industries.

VIII. CONCLUSION

The primary aim of the AI virtual mouse system is to seamlessly replace the conventional physical mouse with a more intuitive interface based on hand gestures. By harnessing the capabilities of webcams or integrated cameras to recognize and interpret hand movements and gestures, this system eliminates the need for a physical mouse altogether. Through real-time processing of frames captured by the camera, the system translates hand gestures into corresponding mouse functions, offering users a novel and efficient way to interact with their computers. One of the key advantages of this AI virtual mouse system lies in its superior accuracy and performance compared to previous models. By leveraging advanced algorithms and machine learning techniques, the system can accurately track hand movements and gestures with remarkable precision. This elevated degree of exactness improves the general client experience as well as addresses normal difficulties related with customary mouse input strategies, like cursor nervousness or slack. Furthermore, the transition to an electronic interface controlled by hand gestures offers a myriad of practical benefits. Past the comfort of killing the requirement for actual equipment, the computer based intelligence virtual mouse opens up additional opportunities for clients with portability disabilities or ergonomic worries. By allowing users to control mouse functions through natural hand movements, the system promotes accessibility and inclusivity in computing environments.

REFERENCES

1. G. D. Prasad, "Virtual mouse implementation using OpenCV", JETIR, vol. 7, no. 6, pp. 5, 2020
2. G N Srinivas, S Sanjay Pratap, V S Subrahmanyam , K G Nagapriya, A Venkata Srinivasa Rao, “Virtual Mouse Control Using Hand Gesture Recognition“, IRJET ,Feb 2023, e-ISSN: 2395-0056 p-ISSN: 2395-0072.
3. Bharath Kumar Reddy Sandra, Katakam Harsha Vardhan, Ch. Uday, V Sai Surya, Bala Raju, Dr. Vipin Kumar,“GESTURE-CONTROL-VIRTUAL-MOUSE”,IRJETS, April-2022, e-ISSN: 2582-5208.
4. 4.V.V. Reddy and T. Vantukala, "Virtual Mouse Using Coloured Fingertips and Hand Gesture Recognition", In Proceedings of the IEEE-HYDCON, 2020
5. M. Christina, A. Daniel, M. K. Bhatkar and O. P. Lopes, "Virtual Mouse Using Object Tracing", In Proceedings of ICCES-2020, 2020

6. Nagaraj M. Lutimath, Niharika K, K Bhuvanesh, Mohan M and Muhammad Zidan K M," The Design of Hand Gesture Controlled Virtual Mouse Using Convolutional Neural Network Technique", May 2023, IJIRT, ISSN: 2349-6002.
7. Piyush Pilare, Coral Mahato, Chanchal Khergade, Shubham Agrawal, Prasheel Thakre," IMPLEMENTATION OF HAND GESTURECONTROLLED MOUSE USING ARTIFICIAL INTELLIGENCE ", August - December 2022, ISSN: 2254-4143.
8. Ajay Sarwade, Gautami Sirsul, Shruti Salaskar,Vrushali Chennur, " GESTURE RECOGNITION BASED VIRTUAL MOUSE AND KEYBOARD", IJCRT, 2023, ISSN: 2320- 2882.
9. Vijay Kumar Sharma, Vimal Kumar, Md. Iqbal, Sachin Tawara and Vishal Jayaswal "Virtual Mouse Control Using Hand Class Gesture" ,· December 2020, ISSN NO : 1869- 9391.
10. Nishi Jain and Sanjay Jadhav, AI Virtual mouse using OpenCV python. JETIR, vol. 9, no. 7, pp. 5, 2022.
11. Hritik Joshi, Nithin waybhase, L Ratnesh and M Dharmendra, "Design of virtual mouse using gesture recognition and machine learning", Research square 2022, 2022.
12. Tharsanee, R.M., Soundariya, R.s., Kumar, A.S., Karthiga, M., & Sountharrajan, S. (2021). Deep Convolutional neural network-based image classification for COVID-19 diagnosis. In Data Science for COVID-19 (pp. 117-145). Academic Press.
13. J. Lu, H. Li and Y. Chen, "An Intelligent Virtual Mouse System Based on Face Recognition and Eye Tracking", IEEE International Conference on Artificial Intelligence and Computer Applications (ICAICA), pp. 164-168, 2020.
14. Tharani, G., Gopikasri, R., Hemapriya R., & Karthiga,M. (2022). Gym Posture Recognition and Feedback Generation Using Mediapipe and OpenCV. In International Journal of Advance Research and Innovative Ideas in Education (pp. 2053-2057).