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Artificial Intelligence Virtual Mouse using Hand Gesture

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***Abstract*: This study recommends a machine learning-based AI virtual mouse to increase user productivity and accessibility. This paper presents the AI virtual mouse's algorithm, scope, aims, applications and benefits. Human-computer interactions heavily rely on hand gesture recognition. There are many new technological developments taking place, i.e., modern methods of human-computer interaction and hand gesture recognition. Many other techniques i.e., biometrics and hand gesture recognition routinely seen on smartphones, where control can be done on the system by showing the hand in front of a webcam, can be used for any type of help to people.**

***Keywords*: AI virtual mouse, hand gesture, artificial intelligence, python.**

1. Introduction

Artificial intelligence (AI) has made great strides recently, and a wide range of sectors are increasingly using this technique. The development of a virtual mouse that can be controlled by AI algorithms, is among the most intriguing uses of AI. Virtual mouses are computer-generated models of actual mouses, that may be instructed to carry out a variety of actions. This paper represents an overview of the state of the art for AI virtual mouses in this paper, including its design, implementation, and applications.

With the widespread use of computers in our daily lives, human-computer interaction is becoming more and more convenient. People with disabilities have a lot of difficulties using these areas appropriately. This work offers a gesture-based artificial intelligence (AI) virtual mouse system, that mimics mouse activities in a computer using hand motions and hand tip detection. The aim of the suggested system is to swap out the conventional mouse for a web camera or a built-in camera on a computer to perform mouse pointer and scroll tasks. Computer vision is used in human-computer interaction (HCI), to recognize hand movements and identify tips [1]. An AI virtual mouse, based on hand motions may be used to move the pointer using a built-in camera or a web camera, as well as to execute mouse cursor functions i.e., scrolling.

The gesture-based AI virtual mouse framework makes use of both the Python programming language and the OpenCV computer vision library. The MediaPipe bundle is used by the proposed gesture-based AI virtual mouse framework to track hands and hand tips, while the AutoPy bundle is used to navigate the PC window screen and carry out actions i.e., left- and right-clicking and looking capabilities. The suggested model can perform better in real-world operations while employing a CPU rather than a GPU, and the results show an incredibly high position of fineness. In routine life, vision and gestures are important approaches for communication among mortal beings, and the same part is played by the mouse in Graphical User Interface (GUI) grounded computers. A better interactive system for human-computer interaction can therefore be created using a combined methodology. When used with a touch screen and a webcam, computer vision techniques can create a virtual human-computer commerce device that is indispensable. In this design, a cutlet shadowing-grounded virtual mouse operation will be designed and enforced using a regular webcam. It uses Python's OpenCV module and the artificial intelligence (AI) concept of object tracking to put this into practice.

2. System Architecture

The AI virtual mouse system comprises two main components: hardware and software. The hardware component includes a camera, which is used to track hand movements as well as gestures, and a microphone, which is used to capture natural language commands. The software component includes an AI model that interprets the camera and microphone input and performs mouse functions based on the user's commands and hand movements.

Computer vision techniques are applied to the camera input to recognize and track hand motions as well as movements. The system uses machine learning algorithms to learn the user's hand movements and gestures and enables it to adapt to individual preferences and behavior over time. The microphone input is processed using natural language processing algorithms, which convert spoken commands into text and map them to mouse functions such as clicking, scrolling, and dragging.

A. Limitations of Existing System

The AI virtual mouse has a few drawbacks also. The technology relies on facial recognition, which may not work accurately in all lighting conditions or for individuals with

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certain facial features. Additionally, it requires a camera, to be installed on the computer, which may be a privacy concern for users. Since the mouse is a hardware input device, it will always have limitations, and issues like mouse click malfunctions may arise. Mouse is an equipment gadget like some other actual item even the mouse has some sturdiness memories inside which is useful and after its solidness time, it requires the replacement of the mouse.

B. Edges of Existing System

The advantages of AI virtual mouse are numerous. It allows individuals with physical disabilities to access and interact with technology more easily, improving their quality of life. This technology also has the potential to increase productivity and reduce the risk of repetitive strain injuries in industrial and commercial settings. Furthermore, it is a non-invasive and affordable solution that can be easily implemented. For gesture recognition, computer vision techniques are utilized. Video capture is a package in OpenCV, that is used to capture data from live video. We must first determine the applications for which the model has been developed, as well as the development of mouse movement without the system mouse. Users can use hand gestures to control the virtual mouse with hand gesture recognition. The system's webcam is used to monitor hand movements [2].

3. Process Proposed System Methodology

A. Design of AI Virtual Mouse

A thorough understanding of mouse biology, movement, and behavior is necessary for the design of an AI virtual mouse, which is a challenging process. The creation of a 3D model, a digital representation of the mouse, is the first step in creating an AI virtual mouse. For accurate movement and behavior simulation, this model must be extremely accurate and should include the mouse's shape, fur, and other characteristics.

The 3D model needs to be programmed to move and behave in a way that is consistent with how a real mouse would move and behave. This can be achieved by either using machine learning techniques to train the model to recognize and react to particular stimulants, or by programming the model with algorithms that mimic the movements and behaviour of real mouse.

To determine the coordinates of the frame, the system will convert the webcam's real-time video input into an array. These coordinates will assist the program in accurately locating the fingers and identifying, which fingers are raised. The system can determine, which finger is up and will then carry out any assigned actions, such as clicking or moving, as a result.

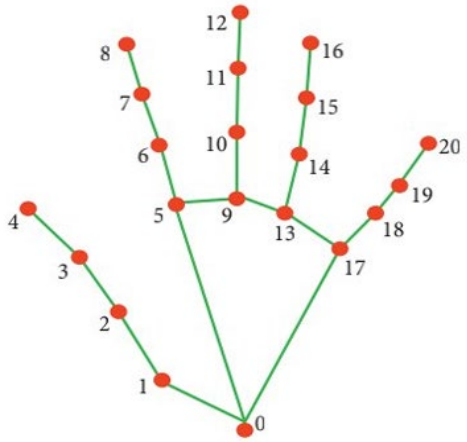
B. Implementation of AI Virtual Mouse

The implementation of AI virtual mouses involves many different technologies and programming languages, including computer graphics, physics engines, and machine learning algorithms. The most common approach to implementing AI virtual mouse is to use game engines, such as Unity or Unreal Engine, which provides a comprehensive suite of tools for creating and simulating 3D environments and movements.

One of the key challenges in implementing AI virtual mouses is ensuring that their movements and behaviors are as realistic as possible [3]. This requires a deep understanding of mouse anatomy and physiology, as well as the movements and behaviors that are typical of a real mouse. To achieve this, researchers often use machine learning algorithms to train the virtual mouse to recognize and respond to specific stimuli, such as changes in their environment.

C. Methodology

- *Capturing video:* The use of the OpenCV module is to capture realtime video using a webcam which acts as an input for further processing.
- *Find hand landmarks:* Using Python libraries like CV2 and MediaPipe coding has been done to locate the hand landmarks. It will locate 21 points, as shown in fig.1 after recognizing the hand.



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

Fig. 1.

- *Capture the points of the index and middle finger:* The various functions in a library named “Hand Tracking Module” has been included for simplicity. This module can detect hands, find fingers, count the number of fingers that are up, measure the space between fingers, etc.
- *Verify which fingers are up:* The program determines which fingers are up.
  - Fingers on the index side: If only the index finger is up, the mouse is in moving mode. The cursor may be moved by dragging a finger over the screen.
  - Index finger and Middle finger: If both are up, the

mouse is in clicking mode. When the distance between these two fingers is short, the clicking function will be performed.

- *Convert the coordinates to get the correct positioning:* Accurate location tracking of the cursor on the screen is important for the exact working of the mouse.
- *Carry out the functions:* By locating the coordinates and tracking the fingers, the mouse functions has been can be performed virtually i.e. without any physical contact with the device.
- *Frame rate:* Frame rate helps to check if the movements of the cursor are smooth or not.
- *Smoothen the values so the mouse is not jittery:* By observing the change in frame rate and movement of the cursor, some smoothing technique has been applied to the mouse so that it is easy to use for the user.
- *Display:* The display has also been due to track by webcam to show the implementation properly.

4. Algorithm

The AI virtual mouse uses a complex algorithm, to track the user's head movements and translate them into cursor movements. The algorithm relies on facial recognition technology, to identify the user's face and track their head movements [4]. The algorithm also takes into account the distance between the user's face and the computer screen to calculate the cursor's movements accurately.

A. MediaPipe

Google's open-source MediaPipe framework is used for applications in a machine learning pipeline. As the framework was created utilizing time series data, it may be used for cross-platform programming. It is multimodal because different audio and video formats may use this framework. It is used by the developer to create and analyze systems using graphs, as well as to create systems for application purposes. The pipeline setup is where the stages that make up the Media Pipe using the system are carried out. Scalability in mobile and desktop environments is made possible by the pipeline's flexibility to function on a variety of platforms.

B. OpenCV

The image-processing techniques for object detection are part of the OpenCV computer vision library. Real-time computer vision applications may be created by utilizing the Python programming language's computer vision library [5]. Processing of images and videos as well as analyzes like face and object identification requires the OpenCV library.

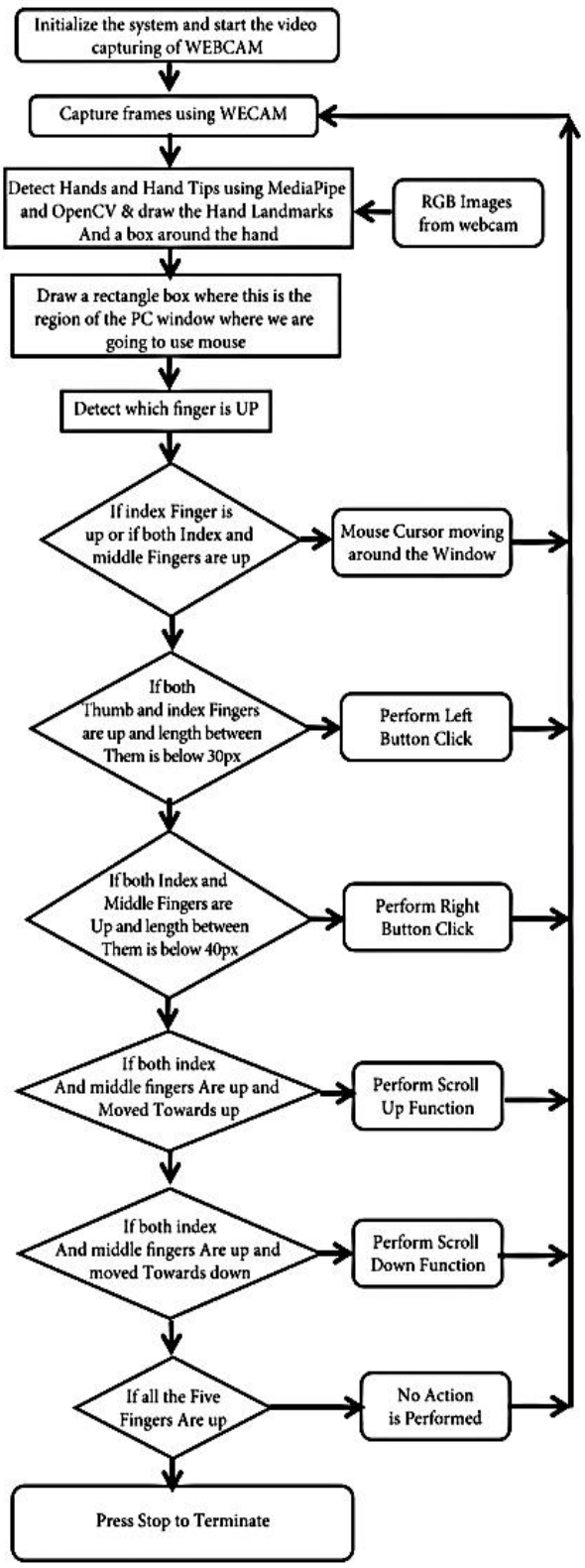


Fig. 2. Flowchart of AI virtual mouse

5. Applications

A variety of uses for the gesture-based AI virtual mouse system includes reducing the amount of space needed for a genuine mouse and in circumstances when it is impossible to use one. The use of gadgets is decreased, which also enhances

human-computer interaction.

Major applications:

- Robots and automation systems can be controlled via the system.
- It is able to draw 2D and 3D images by moving its hands.
- AI virtual mouses may be utilized to perform virtual reality as well as augmented reality games without the requirement for wireless or cable mouse equipment.
- The suggested AI virtual mouse may be used to operate PC mouse operations without using the real mouse during the COVID-19 epidemic since it is risky to use the equipment by touching it because doing so, could cause the virus to spread.
- People who have trouble using the mouse functions on a computer can use this technology.
- In the robotics industry, the proposed system, which makes use of HCI [6], can be used to manage robots.
- The design and architecture method that has been suggested should be used to develop the virtual prototype.

6. Future Scope and Goals

The potential for the AI virtual mouse is enormous. With continued advancements in artificial intelligence and machine learning, this technology has the potential to become even more sophisticated and accurate. Additionally, this technology could be integrated with other assistive technologies to create a comprehensive suite of tools for individuals with physical disabilities. There are certain drawbacks to the suggested gesture-based AI virtual mouse, including the model's inability to select text by clicking and dragging and a modest loss of precision when utilizing the right-click mouse function [7]. Several of these issues are present in the proposed gesture-based AI virtual mouse system, and they will be addressed in further study.

Another potential application for human-computer interaction is the handling of virtual keyboard and mouse functionality, which can be added to the proposed system (HCI). Making a virtual mouse that can be used to navigate a screen or device without touching it. A touchless mouse controller will be helpful in today's world, dealing as it reduces the risk of infection spreading through touch on public service devices. Many people touch the same screen, similar to a self-ticketing machine at a train station, which raises the risk of virus infection. Without touching the screen, the virtual mouse can be operated. The scope of human-computer interaction technology can be expanded through these studies.

7. Experimental Results

The artificial intelligence (AI) virtual mouse model serves as an illustration of computer vision and machine learning concepts. Hand tracking, finger-tip detection, and gesture identification have all been carried out in a variety of lighting conditions and at varied distances from the camera.

Instead of utilizing a physical mouse, there are a number of AI-based methods that employ Python and Open CV with a real-time camera that recognizes hand landmarks and tracks gesture patterns. Machine learning methods are employed in the algorithm used in these systems. Without using a real mouse, the computer may be virtually controlled using hand gestures to accomplish left-click, right-click, scrolling, and computer cursor tasks. The primary goal of the virtual mouse system is to eliminate the need for a real mouse in favor of hand gestures for cursor control. Since it prevents direct touch, the virtual mouse is useful for everyday use and will be valuable in situations like COVID epidemics.

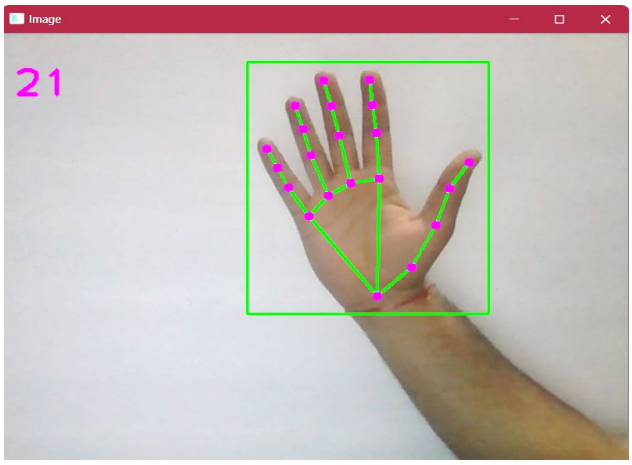


Fig. 3. Capture the hand detection using webcam

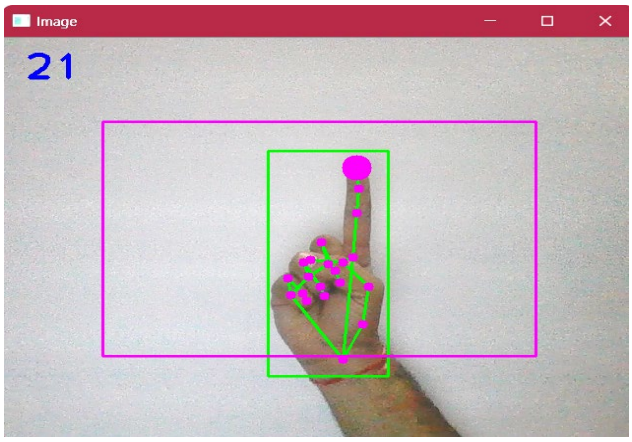


Fig. 4. Identify of which finger is up

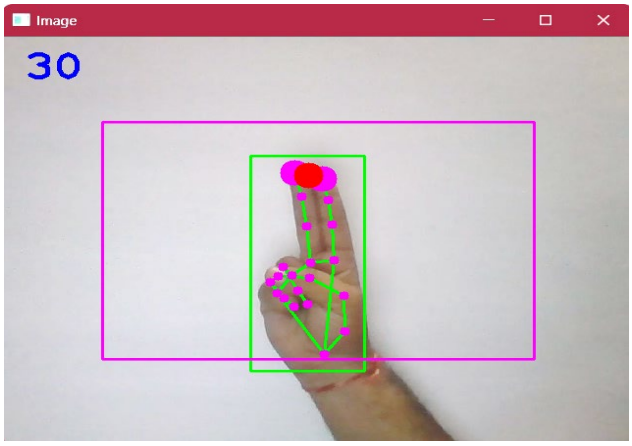


Fig. 5. Hand gesture to perform the right click

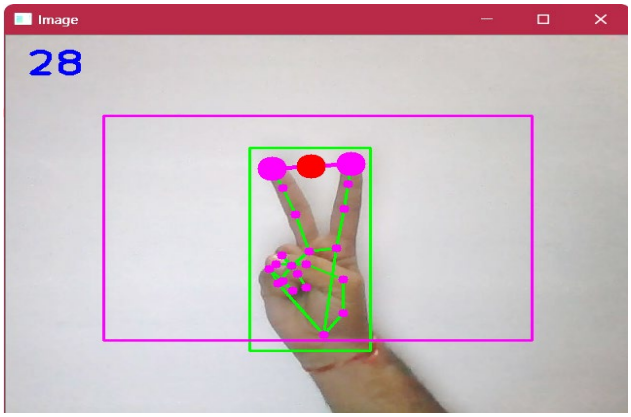


Fig. 6. Hand gesture to scroll up/down click

8. Conclusion

The gesture-based AI virtual mouse system's primary aim is to control the mouse cursor's functions with hand gestures rather than a hardware mouse. By using a webcam or a built-in camera to detect and interpret hand motions and hand tips, the proposed system can be used to perform specific mouse actions. It is possible to use the proposed mouse system for real-world applications and to stop the spread of COVID-19 because it can be used virtually using hand gestures rather than the standard physical mouse. The developed Python-based AI virtual mouse system can control mouse functions with hand gestures rather than a physical mouse. It also processes the frames and it receives from either a built-in or a webcam in order to carry out the specific mouse functions.

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