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Towards Controlling Mouse through Hand Gestures: A Novel and Efficient Approach

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Abstract

We tend to notice a lot of development in the computing world in today's modern world. Computer science is a technique that combines today's technologies. This paper is also backed by a small portion of AI. This paper shows how to use our computer's window exploitation camera to create a hand gesture-based virtual mouse that allows you to control the entire system by merely moving your fingertips. Finger detecting methods for quick camera access and simple computer software make it even more accessible. A motion tracking mouse is implemented using the system. This technology eliminates the need for a physical mouse, saving time and effort.

Keywords: Image processing, hand gesture, mediapipe, virtual mouse control, finger detection

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1. Introduction

The hand gesture-based virtual mouse is a piece of software that allows users to control a device without using a traditional mouse. This study proposes a computer-based creative hand gesture-based virtual mouse device that generates mouse operations on the computer utilizing hand gestures and hand tip recognition. The main goal of the recommended gadget is to replace a traditional mouse with a webcam or a built-in digital camera within the laptop to perform laptop mouse cursor tasks. A hand gesture-based digital mouse is created using a computer web camera and numerous image processing algorithms.

In this study, a user's hand movements are employed as mouse inputs. A web camera is a series of cameras that can shoot images endlessly, and they are currently included in most laptops. Security apps that use face recognition to leverage the potential of face detection have also utilized webcams. To make the most of a system camera's capabilities, it can be used for Vision-based CC, which eliminates the requirement for a computer mouse and mouse pad. They can also be utilized in HCI applications like motion controllers and sign language databases, where the utilization of a system camera can be very beneficial. A system camera is controlled by a wireless mouse. A Bluetooth mouse or a wireless mouse the customer will operate the computer mouse using hand gestures using a built-in camera or a web camera in this project, which requires numerous components such as a mouse, a dongle, and a battery.

The open Python programming language, as well as OpenCV is a computer vision software used within the system, were used to construct the hand gesture-based digital mouse. As a result, in this edition, the Media Pipe package is utilized to watch the hands and keep track of the end of the thumbs. In this system, the gadget camera collects and approaches the captured frames, distinguishing various hand motions and hand tip gestures, and then performs true mouse functions.

2. Literature Survey

As modern technology of human-computer interactions became more prevalent in our daily lives, mice of various shapes and sizes, ranging from an inform business mouse to a hard-core diversion mouse, became ubiquitous. However, this hardware has certain limits, as it is not as ecologically friendly as it appears. The actual mouse, for example, requires a flat surface to function, not to mention an explicit place to employ the features available today. Furthermore, due of the cable lengths imitations, some of this hardware is absolutely useless when it comes to activities with the computer remote, rendering it unreachable.

According to Sande [1], The current virtual mouse control system consists of mouse operations that control the mouse in general. Using a hand gesture detection system the hand gesture-based virtual mouse, left-click, right-click, and scrap-down, among other things. Despite the fact that there are various hand recognition systems, they picked static hand recognition, which is simply a recognition of the form created by the hand and thus the definition of action for each shape made, which is limited to a few defined actions and causes a lot of confusion. As technology advances, there are more and more alternatives to utilizing a mouse.

Agrawal et al. [2], The major purpose of this study is to use two of the most important ways of interaction: head and hand, to operate any computer vision algorithm-based application running on a computer. The video input stream is held in one hand. The shape and pattern of a hand movement are used to recognize a similar gesture. For the common pre-processing of hand and head gesture virtual mouse, hidden Markov models are used. Take a photo with the camera first. The second hand and face are detected using the via-jones approach.

Badi. [3] proposed the main goal of static hand gesture recognition is to categorize given hand motion data into a finite number of gesture classes using particular features. The main purpose of this research is to investigate how two feature extraction approaches, namely hand contouring and complex moments, might be used to tackle the problem of hand gesture identification by identifying the essential advantages and disadvantages of each method.

Thakur et al. [4], Hand gestures are used to manage various mouse motions such as left- and right-clicking, scrolling up and down, and other mouse actions, providing interaction, increased efficiency, and reliability. This study describes a two-dimensional hand gesture-based interface for controlling a computer mouse. To identify hand movements, color detection methods based on cameras are utilized. This method focuses on how to effectively use a Web Camera to create a virtual gadget. The centroid of each input image is determined. The sensing principle for altering the pointer on a computer screen is that hand movement directly moves the centroid. Folding the first and middle fingers of the hand, respectively, and developing the left and right-click scroll up and down functions of a mouse as a result, comparing the lengths of the fingers in the image with those in the image provides insight into the functionality of the hand gesture-based virtual mouse.

Pradhan et al. [5], suggested a generic cursor or trackpad screen, a control system, and the act of a hand gesture control mechanism. A hand motion cannot be used to reach the monitor screen from a distance. Even though it is primarily striving to accomplish, the virtual mouse field's breadth is often limited. The code is written in Python and makes use of the open-source OpenCV image processing package, as well as the Python-specific PyAutoGUI library for mouse actions. Only the three colored finger caps are retrieved from the webcam's real-time video.

3. Problem Statement

The problem in mind when using a software solution to fix the problem. The idea is to come up with the most effective way for humans to interact with a laptop without having to touch it. Many ideas have been proposed, but they all necessitated the movement of hardware. Given that a webcam or digital camera is employed to handle the laptop mouse tasks, an AI digital mouse is typically used to address these issues. "Hand gesture digital mouse with digital cam" is based on the idea of using Kinect sensors with an HD camera, despite the fact that the digital camera and Kinect sensor are separate. The goal of this study is to save costs and improve the machine's robustness.

4. Objective

The purpose of this work is to develop computer software that employs other cursor control mechanisms. This study aims to develop a virtual mouse system for laptops and PCs as an alternative to the common virtual mouse system. A web camera and color detection can be used to execute a hand motion virtual mouse hand tip finger for the mouse control function. Left-clicking, right-clicking, double-clicking, scrolling up and down, and dragging with a virtual mouse are all examples of AI hand motions.

• The goal of this study is to create a computer vision-based system that can recognize, capture, and understand gestures.

• The goal is to create a "low-cost, quick-speed, and reliable" substitute.

5. Methodology

The hand gesture-based virtual mouse explained in the flowchart (figure 1) showing many functions and conditions used in the system.

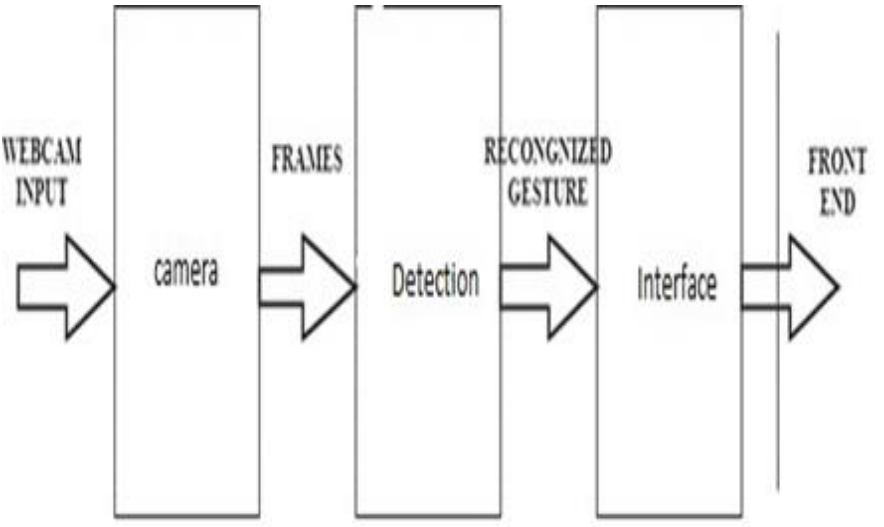
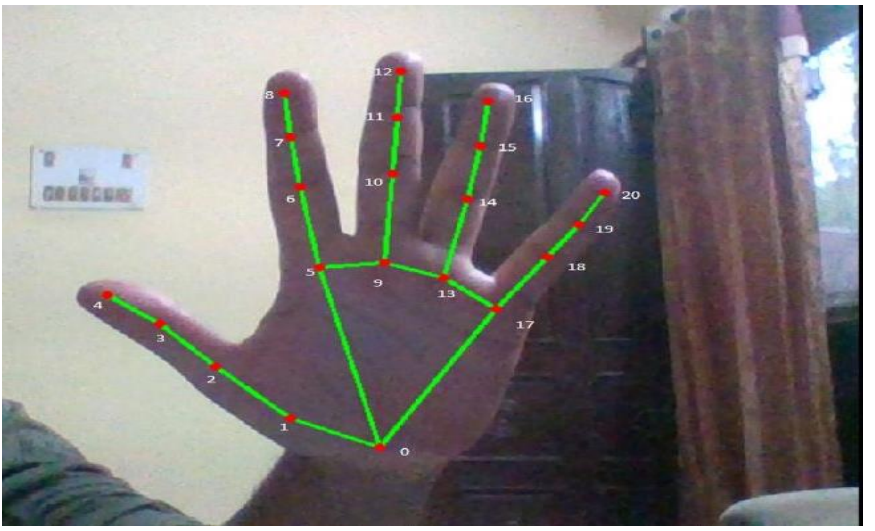


Figure 1: Block diagram of hand gesture-based virtual mouse



WRIST

THUMB_CMC

THUMB_MCP

THUMB_IP

THUMB_TIP

INDEX_FINGER_MCP

INDEX FINGER_PIP

INDEX FINGER_DIP

INDEX FINGER_TIP

MIDDLE_FINGER_MCP

MIDDLE FINGER_PIP

MIDDLE FINGER_DIP

MIDDLE FINGER_TIP

RING FINGER_MCP

RING FINGER_PIP

RING FINGER_DIP

RING FINGER_TIP

PINKY_MCP

PINKY_PIP

PINKY_DIP

PINKY_TIP

Figure 2: Co-ordinates or landmarks in the hand

The webcam The Hand Gesture Based Virtual Mouse System makes use of all the.

The suggested hand gesture-based virtual mouse technology is based on frames acquired by a laptop or PC's camera. The video capture object is constructed using the Python computer vision package OpenCV, and the webcam will begin capturing video. The system camera captures an image and passes the frames to the system. Which is shown in figure 2.

6. Video Capture and Post-Processing

The system camera is used by the hand gesture-based virtual mouse system, which captures each frame until the application ends. To find the hands in the video frame by frame, the video frames are converted from BGR to RGB color space. In figure 3. def find Hands (self, img, draw = True):

ImgRGB=cv2.cvtColor (imgcv2.COLOR_BGR2RGB)

Self. Results = self.hands.process (imgRGB)

6.1. Moving Through the Window Rectangular Region

The AI virtual mouse technology uses the transformational formula to move the IP coordinates from the digital camera screen to the full-screen computer display for mouse dominance. An oblong box is drawn around the computer window within the digital camera region, where we tend to move around at the window using the mouse indicator after the area unit of the hand is identified and we recognize that a finger is up for performing arts using the mouse. The hand gesture-based virtual mouse explains many of the system's capabilities and conditions.

6.2. Detecting that the finger is up and performing the action

The Mouse puts up a show. We tend to detective work that finger is up misusing the tip Id of the several fingers that we tend to find abusing the MediaPipe, and thus the several co-ordinates of the fingers that are up, and then the actual mouse perform is performed after that, as shown in figure 4.

Mouse function based on Hand Gesture and Hand Tip Detection misusing computer vision for the mouse indicator on the route to the computer window.

The mouse indication is created to a makeover from around the computer window using the AutoPy module of Python, as shown in figure 3. F. If the finger is up with tip Id = one (1) or each the finger with tip Id = one (1) and therefore the finger with tip Id = two (2) area unit up, the mouse indication is created to a makeover from around the computer window using the AutoPy module of Python, as shown in figure 3.

"For the mouse to do Left Button Click"

If each of the index fingers with tip Id = one and the thumb-finger with tip Id = zero are up and the distance between the two fingers is less than 30px, the computer is programmed to make a left button click utilizing the input, as shown in Figure 7.

"For the mouse to perform Right Button Click"

If each of the middle fingers has a tip Id of two (2) and the thumb-finger has a tip Id of zero, and the distance between the two fingers is less than 40px, the computer is programmed to perform a right button click using the input, as shown in figure 8.

"To perform the Mouse to Scroll Up and Down"

The computer is made to do the scrolling up and down shown in figure 5 if both the index finger with tip Id = 1 and the thumb finger with tip Id = 0 is up and the space between the two fingers is less than 30px.

"To Control Brightness with the Mouse"

The computer is created to execute the brightness less or more if both the index finger with tip Id = 1 and the thumb finger with tip

Id= 0 is up and the distance between the two fingers is less than 30px, as shown in figure 5.

7. Techniques & Algorithms Applied

The MediaPipe framework is used to identify hand gestures and hand chases, and the OpenCV library is used for computer vision. To trace recognizes hand motions and hand tips, the rule use machine learning concepts.

7.1. Media Pipe

MediaPipe is a Google open-source framework that is used to implement a machine learning pipeline. The MediaPipe framework will aid cross-platform programming because it is created utilizing statistical information. The MediaPipe framework is multimodal, meaning it can deal with a variety of audio and video formats. Developers use the MediaPipe framework to design and evaluate graph-based systems, as well as to create systems for application development. In a MediaPipe-based system, the stages are described as area unit methods in the pipeline design. The pipeline will be able to run on a range of platforms, including mobile and desktop computers, providing for quantifiability. The three major components of the MediaPipe framework are performance analysis, a framework for collecting device knowledge, and a collection of reusable calculators. A pipeline is a graph made up of elements known as calculators, each of which is connected to the next by streams through which knowledge packets move. When designing software, developers are prepared to replace or outline custom calculators at any point in the graph. By merging the calculators and streams, a data-flow diagram is built; the graph is created with MediaPipe, and each node can be a calculator. As a result, streams connect the node's area unit. The single-shot detector variant is used for real-time detection and recognition of a hand or palm. The MediaPipe makes use of a single-shot detector. Because palms are easier to teach, it's the first training for a palm detection model within the hand detection module. Furthermore, non-most suppression is significantly more effective on little items like palms or fists. A model of hand landmarks involves locating joint or knuckle coordinates within the hand region.

7.2. Open CV

Then maybe a computer vision library containing object detection and image processing methods. OpenCV is a python artificial language library that is commonly used to develop period computer vision applications. In image and video processing, the OpenCV library is employed. The intended hand gesture-based virtual mouse system includes a framework for strengthening the human-computer interface by using computer vision.

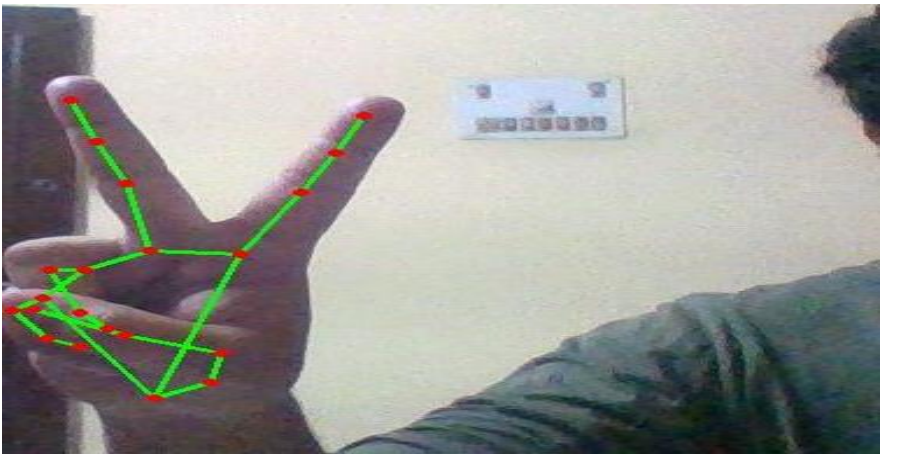


Figure-3 For moving the cursor we will use two fingers.

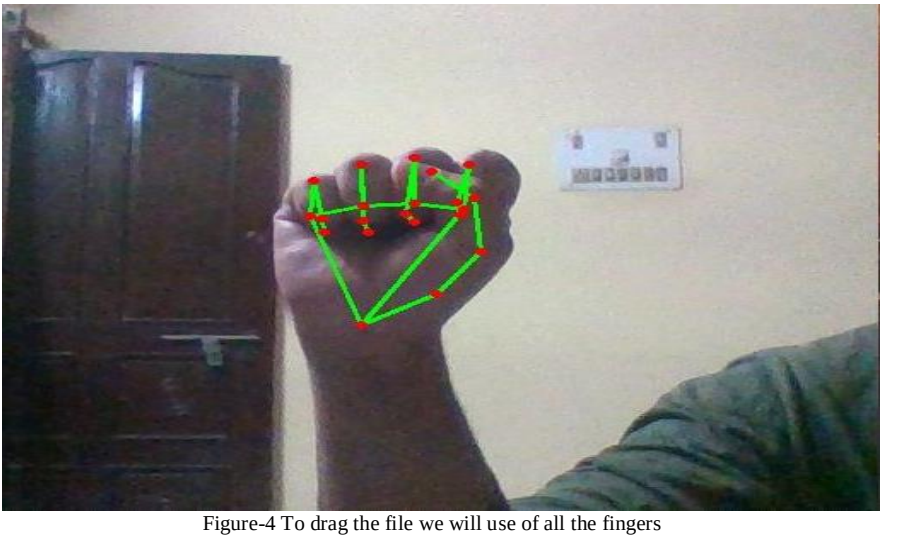


Figure-4 To drag the file we will use of all the fingers

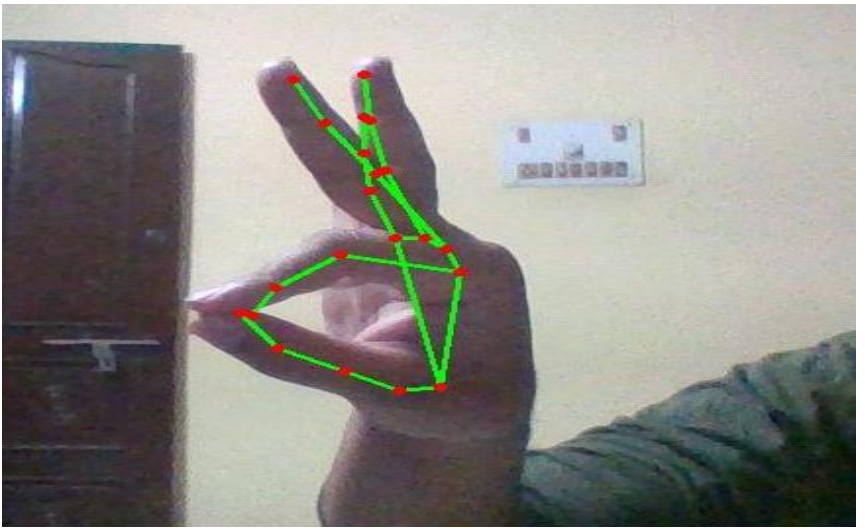


Figure-5 For volume up and down (scroll up and down) we will use one finger and one thumb.

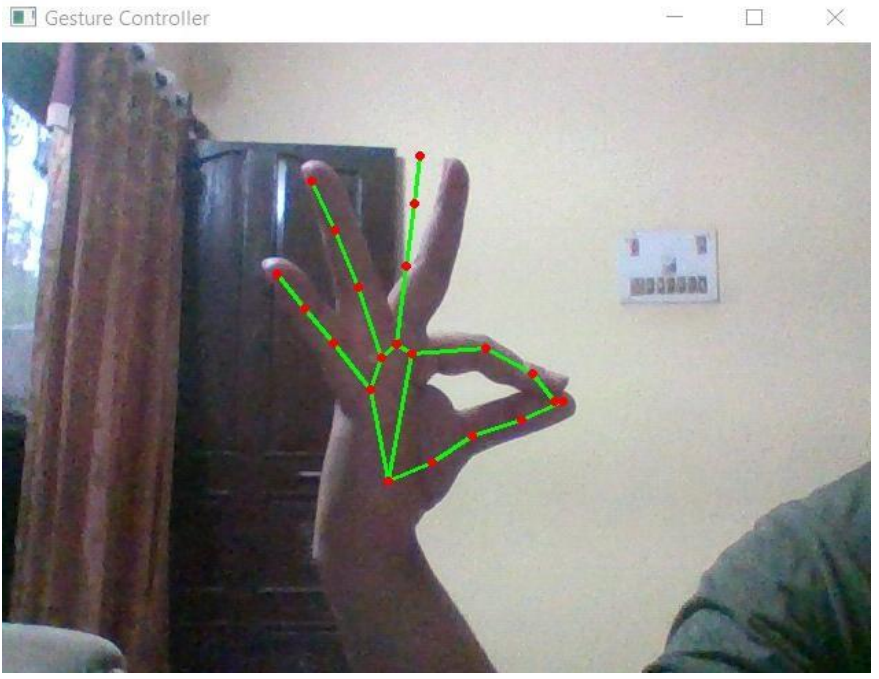


Figure- 6 For brightness up and down we will use of one finger and the thumb.

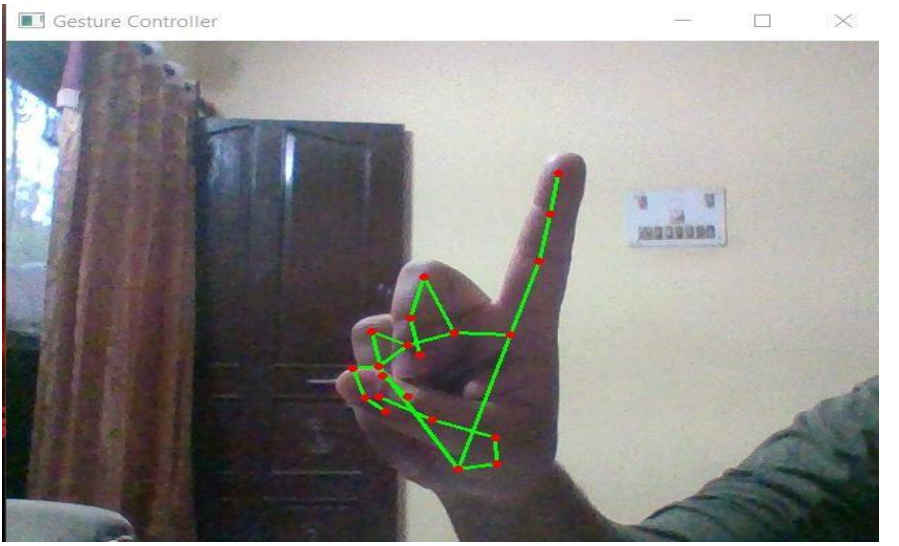


Figure-7 For the left click, we will use of one finger.

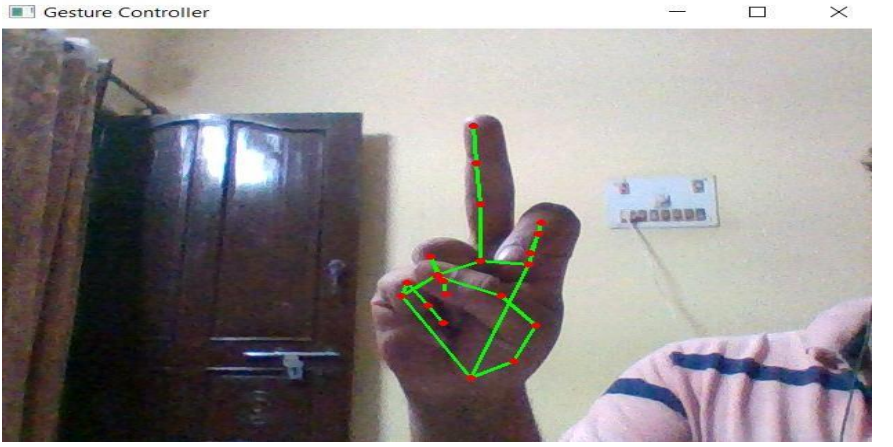


Figure-8 For the right click we will use of one finger.

8. Analysis of Performance

The concept of improving the human-computer interface mistreatment laptop vision is offered in the projected AI virtual mouse system. Because there are only a limited number of datasets available, cross-comparing the testing of the AI virtual mouse system is difficult. Hand gestures and fingertip detection have been tested in a variety of lighting situations, as well as at various distances from the digital camera for the chase of the hand gesture

and hand tip recognition. To summarise the outcomes in Table 1, an associate degree experimental examination was carried out. The study was performed twenty-five times by four people, obtaining 587 gestures with manual labelling, and it was carried out in various lightweight conditions and at various distances from the screen, with each person testing the AI virtual mouse system ten times in traditional lightweight conditions, five times in faint lightweight conditions, five times in close distance from the digital camera, and five times in open distance from the digital camera. Therefore the experimental results area unit is tabulated in Table 1.

Result

Hand Gesture	Fingertip Capture	Success	Failure	Accuracy (%)
Mouse Movement	1	100	0	100
Left-Click	2	95	4	96
Right-Click	3	97	2	97
Double-click	4	96	4	96
Scroll up down	5	98	2	98
No action	6	100	0	100
		586	12	97.6

Table 1 shows that the proposed AI virtual mouse system obtained a 97.6 percent association accuracy. We prefer to come to comprehend that the anticipated AI virtual mouse system performed effectively because of its 97.8% accuracy. The accuracy for the "Scroll function" is low, as shown in Table, because this is the most difficult motion for the computer to recognize. Because of the gesture employed for acting, the accuracy of scroll performance is inferior, but actual mouse performance is more durable. In addition, all of the opposite gestures have exceptionally good accuracy. Our model performed well with 97.6% accuracy when compared to other approaches for a virtual mouse.

Test Cases (Table 2)

Test case id	Scenario	Boundary Value	Expected Result	Actual Result
1	Used in a normal environment.	>90%	In a normal environment, hand gestures can be recognized easily.	Hand gestures got easily recognized and work properly.
2	Used in a bright environment.	>60%	In a brighter environment, software should work fine as it easily detects the hand movements but in brighter conditions, it may not detect the hand gestures as expected.	In bright is the conditions, the software works very well.
3	Used in dark environment	<30%	In a dark environment, it should work properly.	In a dark environment, the software didn't work properly of detecting hand gestures.
4	Used at is near distance (15cm) from the webcam.	>80%	At this distance, in this software should perform perfectly.	It is works fine and all features work properly.
5	Used at isa far distance (35cm) from the webcam.	>96%	At this distance, in this software should work fine.	At this distance, it is working properly.
6	Used at a is farther distance (60cm) from the webcam.	>60%	At this distance, there will be some problems in detecting hand gestures but it should work fine.	At this distance, The functions of this software work properly.

9. Conclusions & Future Scope

Many techniques have to be used due to the need of accuracy (as shown in table 2) in creating the application as useful as a physical mouse. There is a significant replacement of the actual mouse when implementing such a wide range of applications, i.e., there is no need for a physical mouse. Every physical mouse movement is completed by this motion that follows the mouse (virtual mouse).

There are several alternatives and enhancements that must be made in order for the application to be more user-friendly, accurate, and versatile in a variety of settings. The following summarises the enhancements and, as a result, the options that are required:

Good Movement: Because the current recognition method is limited to a 25cm radius, adaptive zoom in/out functions are required to increase the lined distance, where it will mechanically limit the primary focus rate based on the distance between the users therefore the digital camera.

Accuracy & Performance: The latent period area unit is strongly reliant on the machine's hardware, which includes the processor's processing speed, the dimensions of the available RAM, and therefore the available RAM.

The digital camera's options as a result, when the software is executed on a reliable machine with a digital camera that performs well in a variety of lighting conditions, the program may function better.

Mobile Application: This web application will be able to run on robot devices in the future when the touch screen concept will be replaced by hand movements.

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