Towards controlling mouse through Hand Gestures: A novel and efficient approach

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Abstract

In today's world, we tend to see a lot of development happening in the field of Technology. Today's technology is combined with the technique known as computer science. This paper is additionally supported little a part of AI. This paper presents a Hand gesture-based virtual mouse on our computer's window exploitation camera & handling the complete system by simply moving your fingers. Using finger detection ways for fast camera access and easy computer program makes it additional simply accessible. The system is employed to implement a motion tracking mouse. this technique reduces the employment of any physical mouse which saves time and additionally reduces effort.

1. Introduction

The hand gesture-based virtual mouse is a software program that allows users to provide mouse inputs to a device without using a physical mouse. This research presents a computer creative hand gesture-based virtual mouse device that produces, using hand gestures and hand tip detection, for performing mouse activities on the computer. The major purpose of the suggested device is to perform laptop mouse cursor functions using a webcam or a built-in digital camera within the laptop rather than a conventional mouse device. A computer web camera is used in conjunction with various image processing techniques to create a hand gesture-based digital mouse.

In this research hand movements of a user are used as mouse inputs. A web camera is a set of cameras that indefinitely take photos, and most laptops now include them. Webcams have also been used by security applications that use face recognition to harness the potential of face detection. To fully utilize the power of a system camera, it can be used for Vision-based CC is frequently used, which eliminates the need for such a computer mouse and mouse pad. They can also be used in HCI applications such as motion controllers and sign language databases, which can benefit greatly from using a system camera. A wireless mouse is used to control a system camera. A wireless mouse or a Bluetooth mouse takes several components to work, including a mouse, a dongle, and a battery, but in this project, the client will operate the computer mouse using hand gestures using a built-in camera or a web camera.

The hand gesture-based digital mouse gadget was created using the open Python programming language, as well as OpenCV, a computer vision package that is employed inside the system. As a result, the Media Pipe package is used to track the hands and monitor the end of the thumbs in this edition. The gadget camera gathers and approaches the collected frames in this system, identifying various hand motions and hand tip gestures, and then performing real mouse functionalities.

2. Literature Survey

As trendy technology of human pc interactions become necessary in our everyday lives, sorts of a mouse of quite shapes and sizes were unread, from an inform workplace mouse to a hard-core diversion mouse. However, there are some limitations to this hardware as they're not as environmentally friendly as it

appears. as an example, the physical mouse needs a flat surface to work, to not mention that it needs an explicit space to today to utilize the functions offered. moreover, a number of this hardware are buttery useless once it involves activities with the computer remote because of the cable lengths imitations, rendering it inaccessible.

Sande et al.[1] suggested The present virtual mouse control system comprises generally mouse operations that control the hand gesture-based virtual mouse, left-click, right-click, and scrap-down, among other things, using a hand gesture detection system. Although there are several hand recognition systems, the one they chose was static hand recognition, which is merely a recognition of the shape created by the hand and therefore the definition of action for each shape made, which is confined to a few defined actions and generates a lot of confusion. There are more and additional alternatives to using a mouse as technology progresses.

Agrawal et al.[2] suggested The main goal of this paper is to control any computer vision algorithm-based application running on a computer using two of the most important modes of interaction: head and hand. The video input stream hand is segmented, and the corresponding gesture is recognized based on the shape and pattern of a hand movement. The hidden Markov models are used for the common pre-processing of hand and head gesture virtual mouse. First, take a picture with the camera. A via-jones method is used to detect the second hand and face.

Badi. [3] suggested The basic aim of static hand gesture recognition is to identify given hand gesture data represented by specific attributes into a finite number of gesture classes. The major goal of this work is to explore the usage of two feature extraction approaches, specifically hand contouring and complex moments, to solve the problem of hand gesture detection by identifying the key benefits and drawbacks of each method.

Thakur et al.[4] suggested A hand gesture-based system to handle various mouse actions such as eft and right-clicking, scrolling up and down, and other mouse actions using hand gestures to provide interaction, additional efficiency, and reliability. This paper delineates a hand gesture-based interface for regulating a computer mouse via 2D hand gestures. Coor detection algorithms based on cameras are used to detect hand movements. This technique primarily focuses on the effective usage of a Web Camera to create a virtual device. Each input image's centroid is located. Because hand movement directly moves the centroid, it is the sensing principle for changing the pointer on a computer screen. The left and right-click scroll up down functions of a mouse are implemented by folding the first and middle fingers of the hand respectively, and developing So, comparing the length of fingers images with those in the image gives an idea about the functionality performed by the hand gesture-based virtual mouse.

Pradhan et al.[5] suggested general cursor or trackpad screen, a control system, and the act of a hand gesture control mechanism from the current system. it is not possible to use a hand gesture to access the monitor screen from a distance. The breadth is generally limited in the virtual mouse field, even though it is primarily trying to perform. The code is written in Python and uses the open-source OpenCV image

processing module as was the Python-specific PyAutoGUi library to implement mouse actions. From the webcam's real-time video, just the three colored finger caps are extracted.

3. Problem Statement

To operate a software method to resolve the challenge, keep in mind the issue. The goal here is to devise the most efficient process for humans to can interact with a laptop without having any physical interface with it. Many concepts had been suggested, but they all required hardware motion. Given that hand gesture and hand Tip detection areas sized to are used to handle the laptop mouse functions using a webcam or digital camera, AI digital mouse is frequently used to overcome these challenges. "Hand gesture digital mouse with digital cam" is based on the notion of using Kinect sensors with an HD camera, although the digital camera and Kinect sensor. Using a simple web digital cam, this research aims to reduce costs and improve the robustness of the suggested machine.

4. Objective

The goal of this paper is to create a computer program that uses alternative cursor control mechanisms. This paper intends to create an alternative to the typical virtual mouse system for laptops and computers. The mouse control function may be done by using a web camera and color detection to execute a hand motion virtual mouse hand tip finger. Perform the ai hand gestures of left-clicking, right-clicking, double-clicking, scrolling up and down, and dragging with a virtual mouse.

4.1 The goal of this research is to develop a computer vision-based system for detecting, capturing, and understanding gestures.

4.2 The task is to develop a replacement "low-cost, fast-speed, and coloration image" acquisition device.

5. Methodology

The various functions and conditions used in the system are explained in the flowchart(Fig. 1) of the 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

5.1 The webcam Used in the Hand Gesture Based Virtual Mouse System.

The proposed hand gesture-based virtual mouse system is based on the frames that have been captured by the camera on a laptop or PC. We are using the Python computer vision library OpenCV, the video capture object is created and the webcam will start capturing video. The system camera captures and passes the frames to the system .which is shown in Fig. 2.

5.2 Capturing the Video and Processing.

The hand gesture-based virtual mouse system uses the system cam where each frame will capture till the termination of the program. The video frames are processed from BGR to RGB color space to find the hands in the video frame by frame shown in Fig. 3.

```
def find Hands(self, img, draw = True):

imgRGB = cv2.cvtColor(imgcv2.COLOR_BGR2RGB)

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

5.3 Rectangular Region for moving through the window

The transformational formula is used by the AI virtual mouse system, to transfer the coordinates of the IP from the digital camera screen to the full-screen pc display for dominating the mouse. Once the area unit of the hand is identified, and once we realize that a finger is up for performing arts with the mouse, an oblong box is drawn about the computer window within the digital camera region, wherever we tend to move around at the window using the mouse indicator.

5.4 Detecting the finger is up and performing

The Mouse performs. We tend to detective work that finger is up misusing the tip Id of the several fingers that we tend to found misusing the MediaPipe and thus the several co-ordinates of the fingers that are up, and then the actual mouse perform is performed following that and shown in Fig. 4.

5.5 Mouse function betting on the Hand Gesture and Hand tip Detection mistreatment pc vision for the mouse indicator on the road the pc window

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 window of the computer using the AutoPy module of Python, shown in Fig. 3.

5.6 “For the mouse to perform Left Button Click”

If each the index with tip Id = one and therefore the thumb-finger with tip Id = zero square measure up and therefore the distance between the 2 fingers is lesser than 30px, the computer is created to conduct a left button click using the victimization the input, which is shown in Fig. 7.

5.7 “For the mouse to perform Right Button Click”

If each the middle with tip Id = two(2) and therefore the thumb-finger with tip Id = zero square measure up and therefore the distance between the 2 fingers is lesser than 40px, the computer is created to conduct a right button click using the victimization the input, which is shown in Fig. 8.

5.8 “ For the Mouse to Perform Scroll up and Down”

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 lesser than 30px, the computer is made to perform the scrolling up and down which is shown in Fig. 5.

5.9 “ For the Mouse to Control Brightness”

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 lesser than 30px, the computer is made to perform the brightness less or more which is shown in Fig. 5.

6. Algorithm And Techniques Used

For the aim of detection of hand gestures and hand chase, the MediaPipe framework is employed, and the OpenCV library is employed for pc vision. The rule makes use of the machine learning ideas to trace and recognize hand gestures and hand tips.

6.1 MediaPipe

MediaPipe is a framework that is employed for applying a very machine learning pipeline and associated it's a Google open-source framework. Because the framework is built using statistical knowledge, the MediaPipe framework will help for cross-platform programming. The MediaPipe framework is multimodal, which means it can handle a wide range of audio and video formats. The MediaPipe framework is employed by the developers to create and analyze systems using graphs, as well as to create systems for application development. The steps involved in a MediaPipe-based system are specified area unit methods out in the pipeline configuration. The pipeline will be able to run on a variety of platforms, allowing for quantifiability on mobile and desktop devices. The MediaPipe framework is made up of three main components: performance analysis, a framework for collecting device knowledge, and a collection of items known as calculators that are reusable. A pipeline may be a graph that consists of made up of elements known as calculators, with each calculator connected by streams through which knowledge packets pass. Developers are prepared to replace or outline custom calculators at any point in the graph when developing their software. A data-flow diagram is created by combining the calculators and streams; the graph is created with MediaPipe, and each node can be a calculator. As a result, streams connect the area unit of the node. For real-time detection and recognition of a hand or palm, the single-shot detector model is used. The MediaPipe employs the single-shot detector concept. First, it's the first training for a palm detection model within the hand detection module because palms are easier to teach. Furthermore, non-most suppression is much more effective on little items like palms or fists, Locating joint or knuckle coordinates inside the hand region is a model of hand landmarks.

6.2 OpenCV

Maybe a pc vision library with object identification picture processing methods. OpenCV may be a library of python artificial language, and it is frequently used to create period pc vision applications are developed by the victimization of the pc vision library The OpenCV library is used in image and video. The construct of improving the human-computer interface victimization pc vision is offered inside the planned hand gesture-based virtual mouse system.

7. Performance Analysis

In the planned AI virtual mouse system, the concept of advancing the human-computer interaction mistreatment laptop vision is given.

Cross comparison of the testing of the AI virtual mouse system is troublesome as a result of solely restricted numbers of datasets area unit accessible. The hand gestures and fingertip detection are tested in numerous illumination conditions and have additionally been tested with completely different distances from the digital camera for the chase of the hand gesture and hand tip detection. An associate degree experimental take a look at has been conducted to summarize the results shown in Table 1.

Table 1
Performance Analysis

Hand Gesture	Fingertip Capture	Success	Failure	Accuracy (%)
Mouse Movement	1	100	0	100
Left-Click	2	96	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
		587	12	97.8

The take a look at was performed twenty-five times by four persons leading to 587 gestures with manual labeling, and this take a look at has been created {in completely different in several in numerous} lightweight conditions and at different distances from the screen, and every person tested the AI virtual mouse system ten times in traditional lightweight conditions, five times in faint lightweight conditions, five times in shut distance from the digital camera, and five times in long distance from the digital camera, and therefore the experimental results area unit tabulated in Table 1.

From Table 1, it is often seen that the planned AI virtual mouse system had achieved associate accuracy of regarding 97.8%. From this 97.8 accuracy of the planned AI virtual mouse system, we tend to return to understand that the system has performed well. As seen in Table, the accuracy is low for “Scroll function” as this can be the toughest gesture for the pc to know. The accuracy for scroll performance is low as a result of the gesture used for acting the actual mouse performance is more durable. Also, the accuracy is extremely smart and high for all the opposite gestures. Compared to previous approaches for a virtual mouse, our model worked fine with 97.8 accuracies.

Table 2
Test Cases

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 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 in detecting hand gestures.
4	Used at a near distance (15cm) from the webcam.	> 80%	At this distance, this software should perform perfectly.	It works fine and all features work properly.
5	Used at a far distance (35cm) from the webcam.	> 96%	At this distance, this software should work fine.	At this distance, it is working properly.
6	Used at a 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.

8. Conclusions And Future Scope

Due to accuracy(as in table 2) playing a very important role in creating the program as helpful as an actual physical mouse, many techniques had to be enforced. when implanting such a variety of applications there's a huge replacement of the physical mouse i.e., there's no want of any physical mouse. every& each movement of the physical mouse is finished with this motion following the mouse (virtual mouse).

There area unit many options and enhancements required for the program to be a lot of user-friendly, accurate, and versatile in numerous environments. the subsequent describes the enhancements and

therefore the options required:

a) good Movement: because of the present recognition method area unit is restricted to a 25cm radius, Associate in Nursing adaptive zoom in/out functions area unit needed to enhance the lined distance, wherever it will mechanically regulate the main focus rate supported the space between the users and therefore the digital camera.

b) higher Accuracy & Performance: The latent period area unit heavily counts on the hardware of the machine, this includes the processing speed of the processor, the dimensions of the accessible RAM, and therefore the accessible options of the digital camera. Therefore, the program might have higher performance once it's running on an honest machine with a digital camera that performs higher in several styles of lighting.

c) Mobile Application: In the future, this net application is conjointly able to use on automaton devices, wherever touch screen idea is replaced by hand gestures.

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Figures

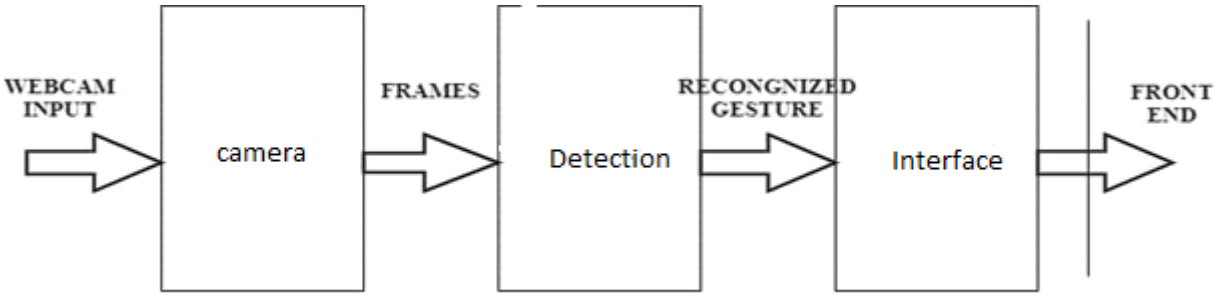

Figure 1

Block diagram of hand gesture-based virtual mouse.

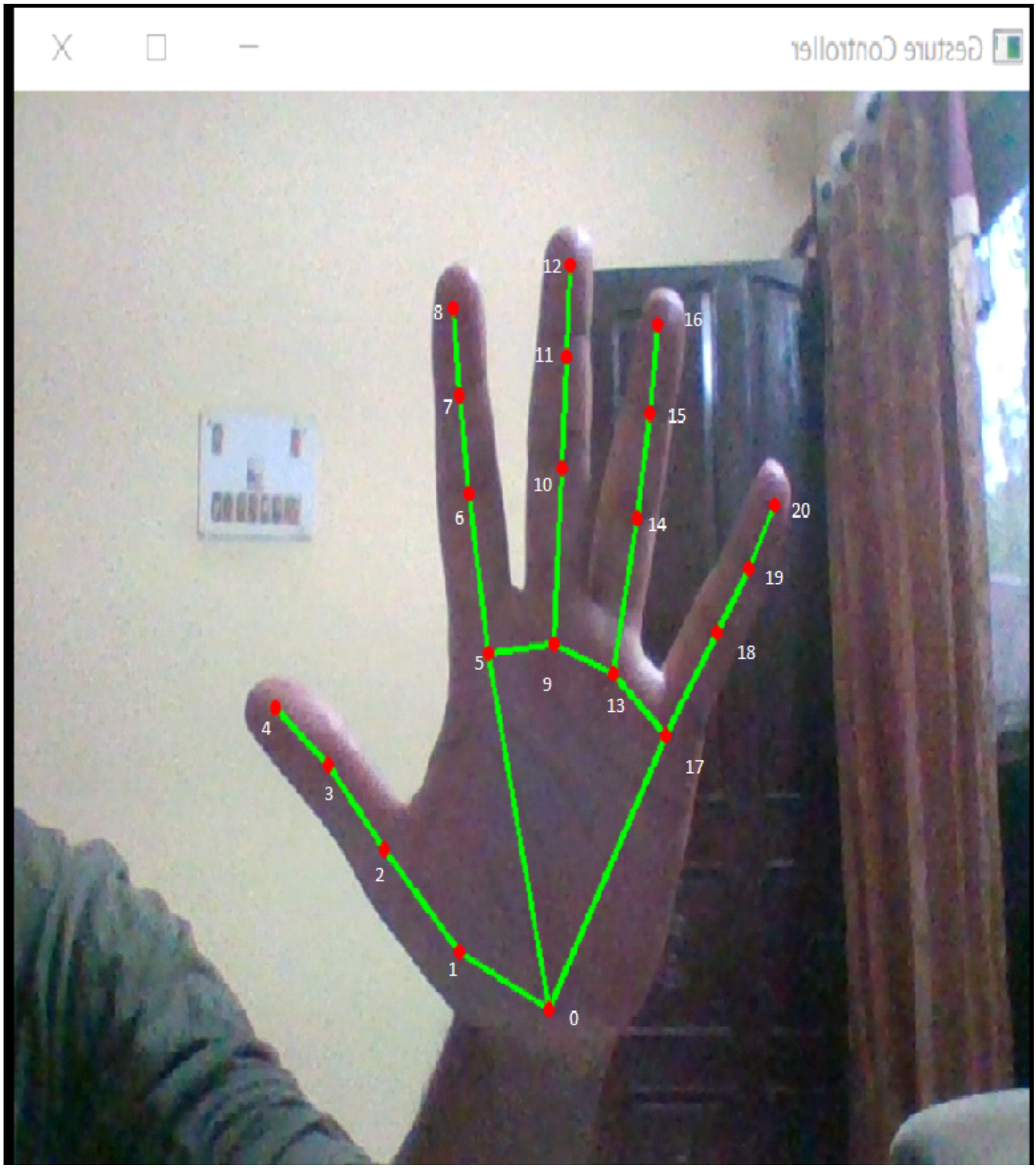

Figure 2

Co-ordinates or land marks in the hand

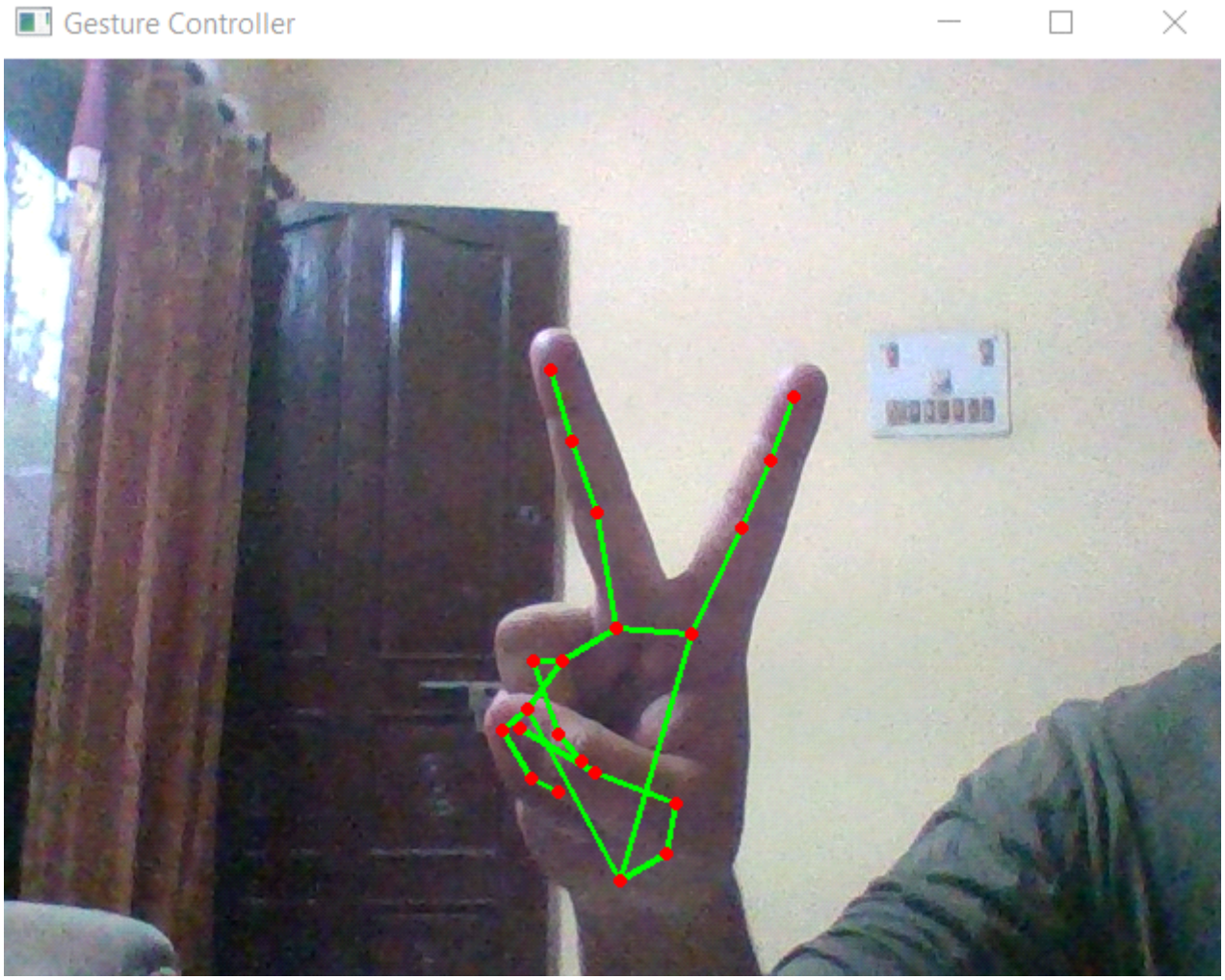

Figure 3

For moving the cursor we will use two fingers.

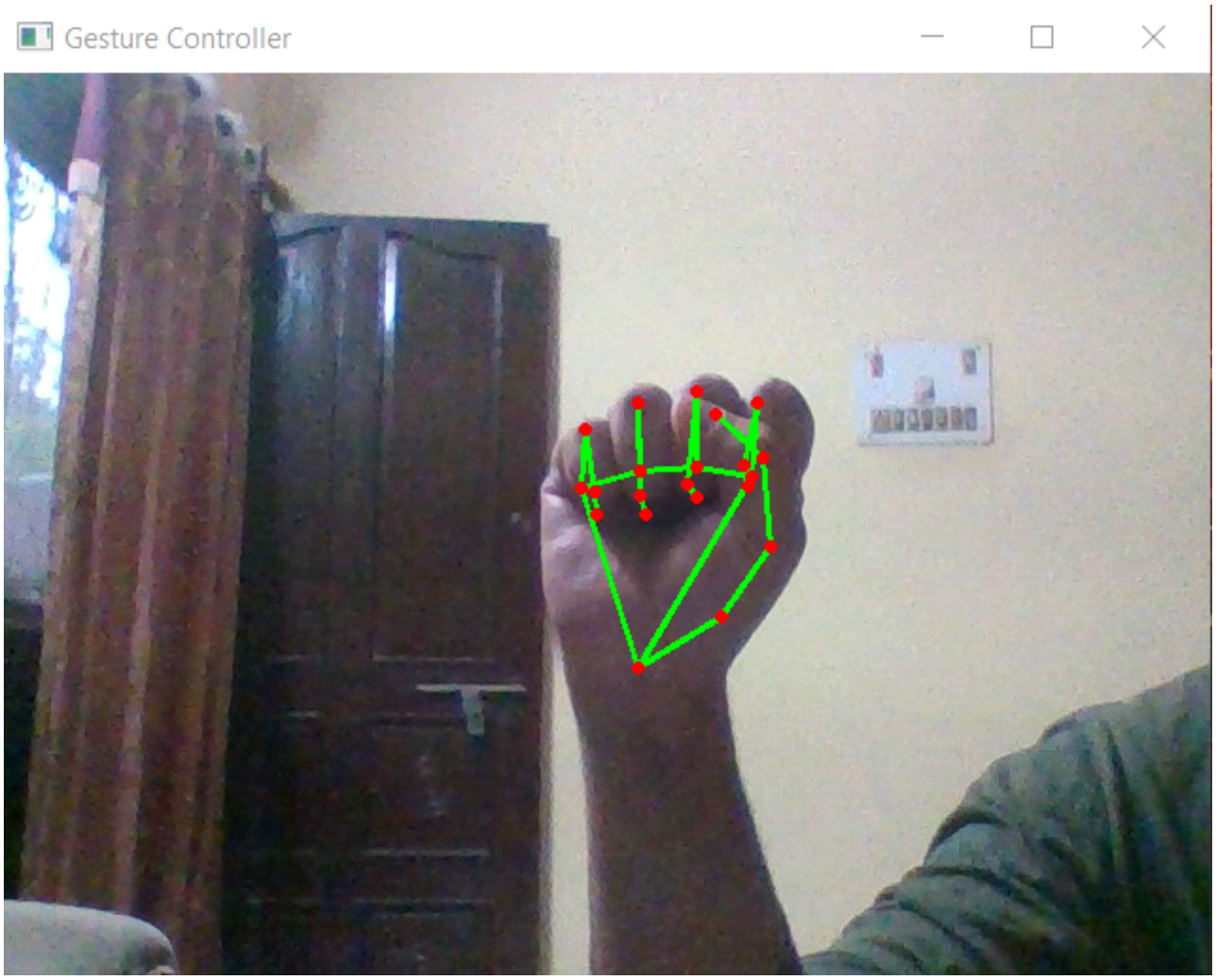

Figure 4

To drag the file we will use all the fingers

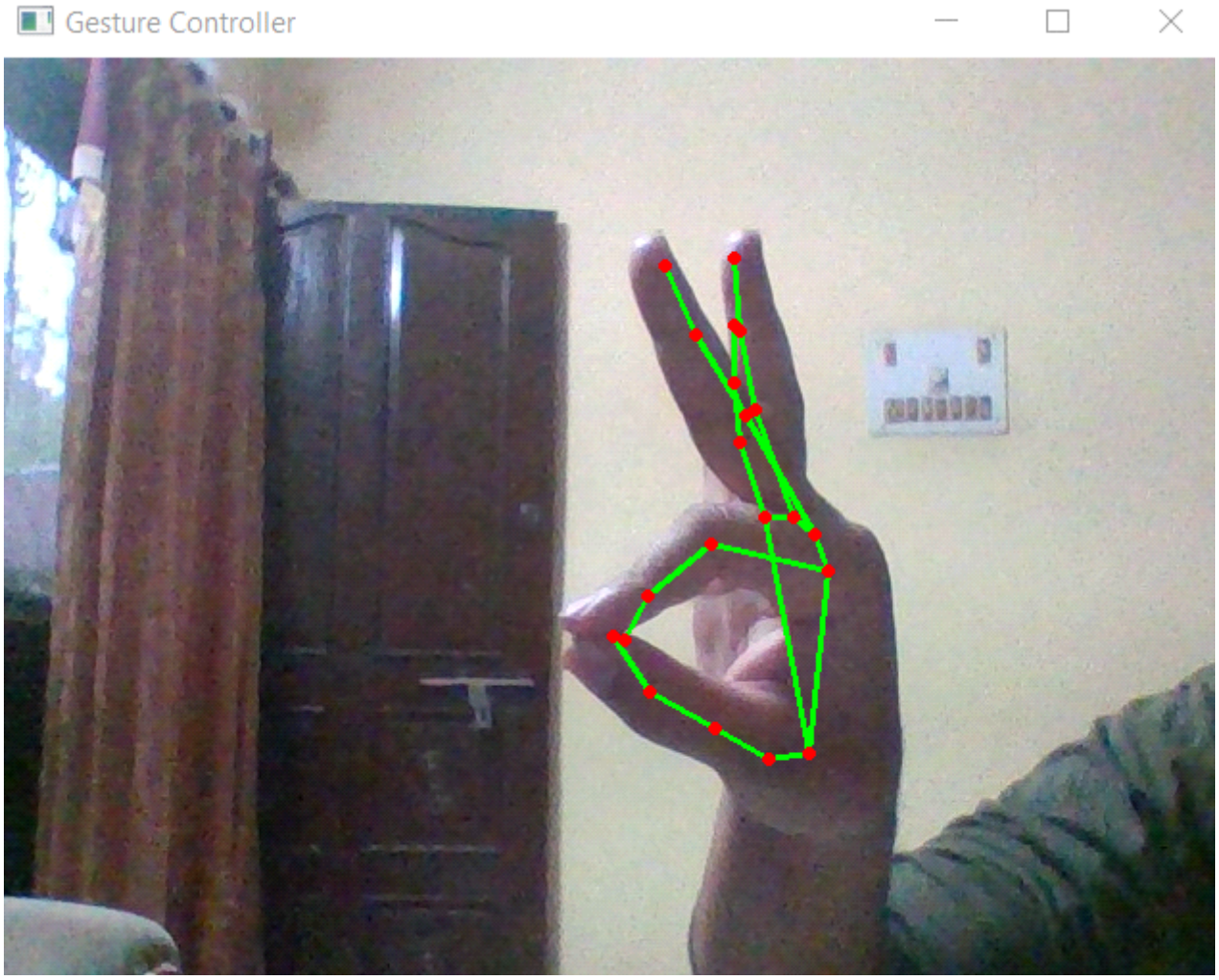

Figure 5

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

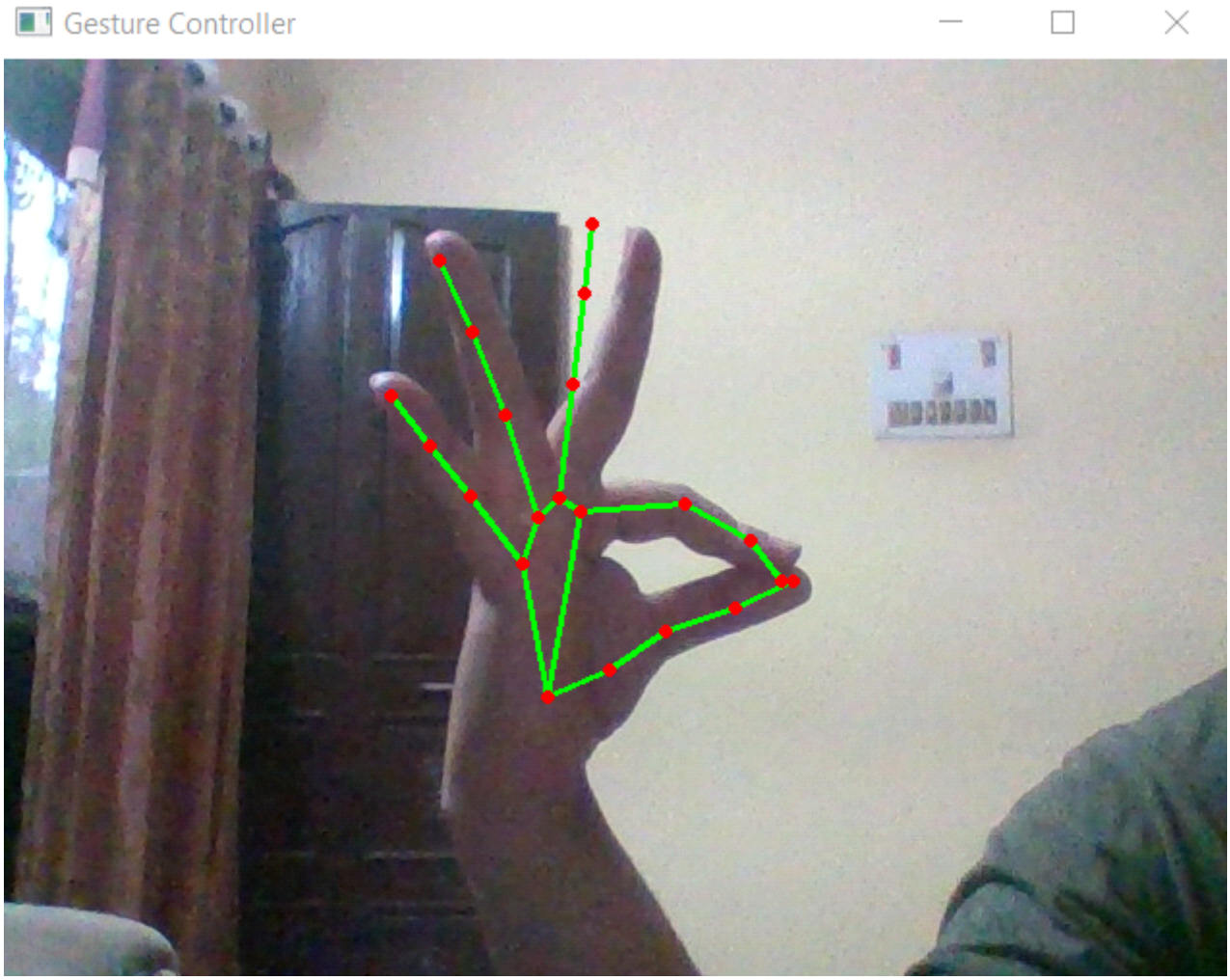

Figure 6

For brightness up and down we will use one finger and the thumb.

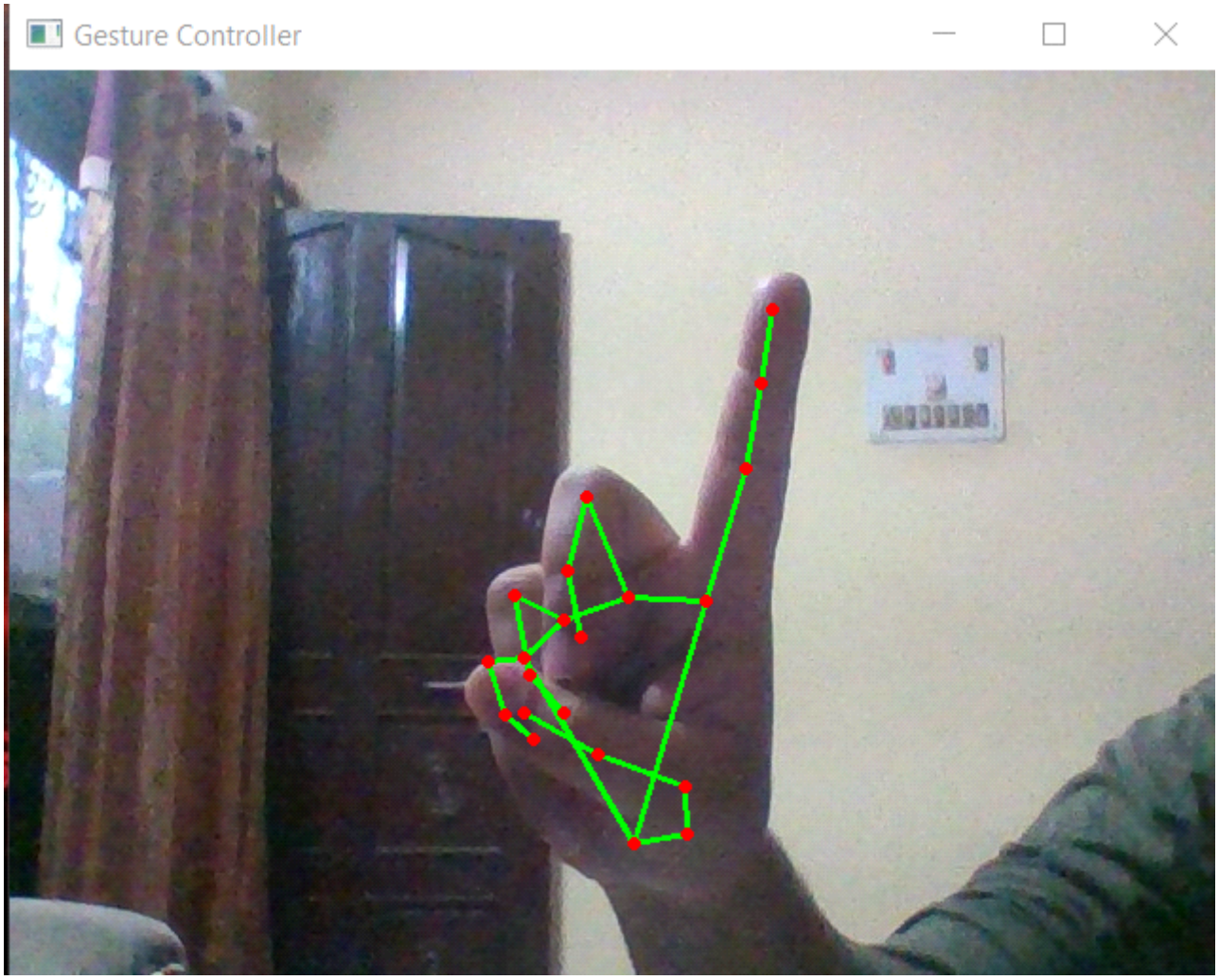

Figure 7

For the left click, we will use one finger.

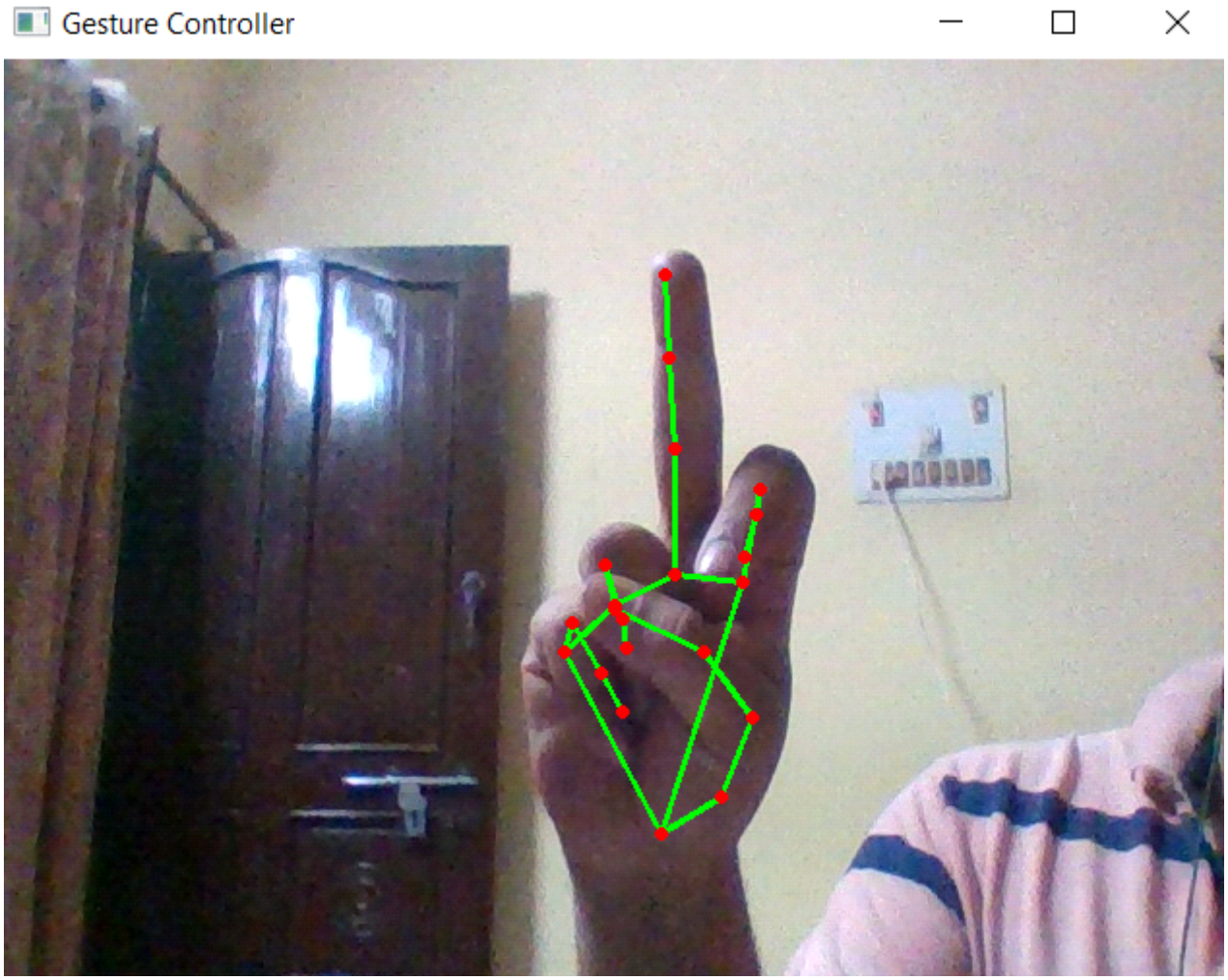

Figure 8

For the right click we will use one finger.