Design And Implementation of Virtual Mouse With Volume/Brightness Control Using Hand Gestures

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Hand gesture recognition system provides a natural, innovative and modern means of non-verbal communication. It has a wide application area in human-computer interaction and sign language. This paper proposes a way to control the position of the cursor, volume control and brightness control with the bare hands without using any electronic device. While operations such as clicking and dragging objects will be performed with different hand gestures, the proposed system will only require a webcam as an input device. The software required to implement the proposed system is OpenCV and Python. The output of the camera will be displayed on the screen of the system and will be further adjustable by the user. The python dependencies that will be used for implementing this system are NumPy, math, WX.

Keywords: Hand Gestures, GUI, Virtual Mouse, Volume Control, Brightness Control.

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1. Introduction

It has been generations since we have been using hand Gestures for communicating in human society [1]. The most effective and expressive way of human communication is hand gestures, the common language. It is expressive enough to be understood by both the dumb and the deaf. The shaking of hands, thumbs up and thumbs down signs have always been existing in the human communication environment. It is believed that gestures are the easiest way of interaction with anyone. So then why not apply it to the machines that we are using. In this work, we are demonstrating real- gestures.

Aim and objective of research work include-

- For most laptops, touchpad is not the most comfortable and convenient tool.
- Main objective of pre-processing is to represent the data in such a way that it can be easily interpreted and processed by the system.
- Reduce cost of hardware [2].

By this research work, we are aiming to create economical hand recognition software for laptops and PCs with a web-cam support. The project is a hand recognition tool that can be used to perform simple manipulations such as adjusting volume, adjusting brightness and moving the mouse pointer, clicking, and other gesture manipulations such as moving files from computer to computer using fine socket programming. The actions will be simple but exciting and can be handled by hand recognition.

2. Literature Review

Several operations related to mentioned area have been performed by various authors and are discussed below:

Research work was carried out by SK. Abdul Sonia, R.V. Harshita, Y. Veera Reddy, in the International Research Journal Volume 7 Issue VII July 2018. A hand gesture volume control system using programming languages such as Python and C++ languages and using open CV module with a user-controllable high- speed computational GPU explains Cursor, volume and navigation. They implemented hand-controlled mouse cursor movement [3].

The another research paper was presented by Mokhtar M. Hasan, Pramod K. Mishra at International Journal of Image Processing (IJIP), Vol. 4, Issue 5 where they explained about hand gesture brightness control system using HSV color module for segmentation, Edge detection to store the data in the images, Recognition algorithms and Features extraction, Template matching which used raw information. In order to overcome the faults they have maximized the number of samples per gesture which increased the database size and the processing time [4].

The research work done by Vijay kumar sharma, Vimal kumar, Md.Iqbal, Sachin tawara, Vishal jayaswal at GIS Science Journal vol.7, Issue 12, 2020. In this, they explained about hand gesture virtual mouse control system where they proposed a way to control the position of the cursor with just hands without using any electronic device. The proposed system needed a webcam as an input device and the operations are done by clicking and dragging of objects. The camera output is displayed on the system screen [5].

Rafiqul Zaman Khan and Noor Adnan Ibrahim conducted research work describing a hand gesture recognition system in the International Journal of Artificial Intelligence and Applications (IJAIA) Vol. 3, No. 4, July 2012, wherein they applied a multivariate distributed Gaussian to retrieve hand gestures using non-geometric features [6].

Research work was carried out by Munir Oudah, AliAlNaji and Javaan Chahl at J. Imaging 2020, 6, 73. In it, they explained computer vision-based hand gesture recognition. This article covers hand

gesture techniques and identifies the advantages and limitations of the different methods used in openCV. In which they calculate the performance using openCV techniques dealing with similarities and differences, hand segmentation techniques used, algorithms and drawbacks, number and type of gestures, data set, etc [7].

Another research work by Martendra Pratap Singh, Arzoo Poswal, Eshu Yadav in the International Journal of Research Technology and Innovative Science, Volume 7, Issue 5, May 2022, explained volume control using Hand Gesture Recognition as a system that can recognize human hand gestures and use information-like input to control the device and use with real-time gesture recognition. The individual user can control the computer with hand gestures in front of the system's video camera. They developed this project with the help of OpenCV, Python [8].

Other research work done by S. Shriram, B. Nagaraj, J. Jaya, S. Shankar and P. Ajay at Hindawi Journal of Healthcare Engineering Volume 2021, Article ID 8133076 explained an AI virtual mouse system that uses hand gestures and head detection fingers to perform computer mouse functions [9].

Research work done by Nidhishree Arun, Namratha V, Ananya Dutta, Shreenivas B in International Journal of Creative Research Thoughts (IJCRT) demonstrated hand gesture recognition and volume control using python and open-CV. They have developed this system in a simple and more efficient way which can be used to handle sound devices without any physical work. For hand segmentation they have used Haar-cascade classifier in Open-CV module and created a hand gesture without the use of a keyboard or mouse [10].

3. Overview of the System

3.1 Existing System

A computer mouse is an input device that helps you point and interact with what you're pointing at. There are many types of mouse in the current trend. There are mechanical mouse consisting of a single rubber ball that can rotate in any direction and the movement of the pointer is determined by the movement of the rubber ball. Later the mechanical mouse was replaced by the Optical Mouse. Optical Mouse consists of a LED sensor to detect the movement of the pointer. Years later, the laser mouse was introduced to improve the accuracy and to overcome the drawbacks of the Optical Mouse. Later, as the technology advanced greatly, wireless mouse were introduced to make mouse movement hassle-free and improve the accuracy.

No Matter how much the accuracy of the mouse increases but there will always be some limitations of the mouse as the mouse is a hardware input device and there can be some problems like mouse click not functioning properly etc., because mouse is a hardware device and like any other physical object, even mouse will have a finite lifetime and will take significant time to replace the mouse [11].

3.2 Proposed System

The proposed system can be used to fix real-world problems, such as situations where there is no space to use a physical mouse, and also for people who have hand problems and are unable to navigate physical mouse controls. Furthermore, in the midst of a COVID situation, it is not safe to operate devices by touching them as it may lead to a situation where the virus can be spread by touching the device, therefore, the discussed system is recommended. Output can be used to overcome these problems from detecting hand and fingertip gestures used to controlling PC mouse functions using the built-in webcam or camera.

4. Methodology

The proposed system is combination of three subsections which are clubbed together with GUI (graphical user interface). The three subsections are virtual mouse, volume controller and brightness controller.

- GUI**:** Graphical user interface (GUI), a computer program that enables a person to communicate with a computer through the use of symbols, visual metaphors, and pointing devices [12]. A graphical user interface is an application with buttons, windows, and many other widgets that users can use to interact with your application. A good example is a web browser. It has buttons, tabs and a main window where all the content is loaded [13]. Many GUI libraries are available for Python. The most popular are: Tkinter, Kivy, PyQt, WxPython, Libavg, Pyforms, Wax Python GUI, etc. We used Tkinter in our system.

In the Methodology, the technology used in each part of the system is explained separately. These are the following subsections:

4.1 Virtual mouse

The proposed AI virtual mouse system is based on the images that have been captured by the laptop's or PC's webcam. Using the Python OpenCV computer vision library, a video capture object is created and the web camera will start recording the video. The web camera captures and transmits images to the virtual AI system.

The AI virtual mouse system uses an algorithm that transforms and converts the fingertip coordinates of the webcam screen to the full screen of the computer window to control the mouse. When a hand is detected and we find which finger is raised to perform a particular mouse function, a rectangular box will be drawn relative to the computer window in the webcam area where we move over window to use the mouse pointer.

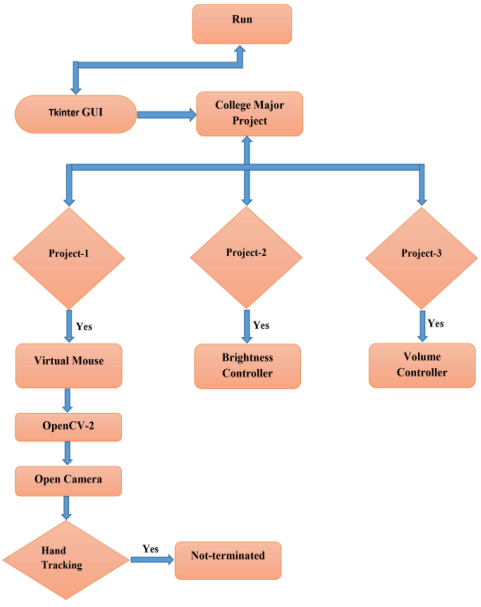

Fig.1 Virtual Mouse Flowchart

5. Volume controller

Building a volume controller with OpenCV can be done in just 3 easy steps:

- Step 1. Detect hand signals
- Step 2. Calculate the distance between the tip of the thumb and the tip of the index finger.
- Step 3. Map the distance between the tip of the thumb and the tip of the index finger with the volume range. In my case, the distance between the tip of the thumb and the tip of the index finger is from 15mm to 220mm and the volume range is -63.5dB to 0.0dB.

Volume controls should not be based on percentages as they assume linearity. Percentages are only valid if, they correspond to dB values. 0% = -63.5dB and 100% = 0dB.

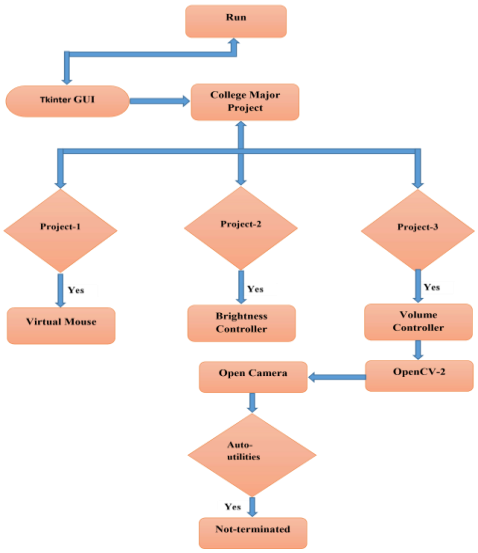

Fig.2 Volume Controller Flowchart

6. Brightness controller

The method is almost the same as the volume control. First detect the landmarks of the hand and calculate the distance between the tip of the thumb and the tip of the index finger, then map the distance between the tip of the thumb and the tip of the index finger with the luminance range. In this case, the distance between the tip of the thumb and the tip of the index finger is 15mm to 220mm, and the minimum distance between the tip of the thumb and the tip of the index finger is 15mm and maximum distance is 220mm. The brightness range is 200-500 nits, 1nit is equal to one candela (one candlepower) per square meter (1cd/m²).

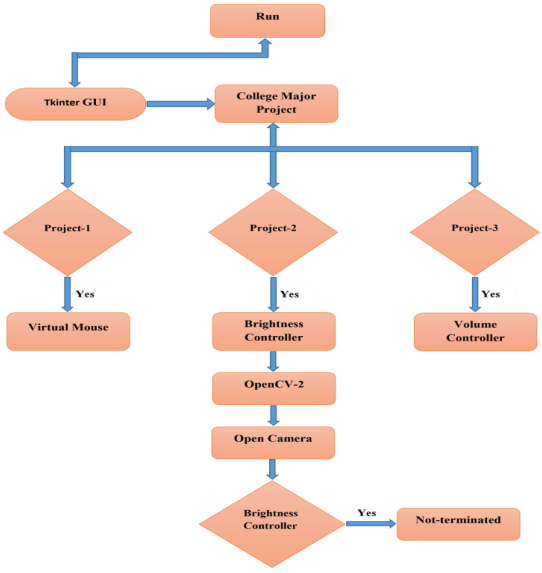

Fig.3 Brightness Controller Flowchart

7. Results

7.1 G.U.I. (Project Starting)

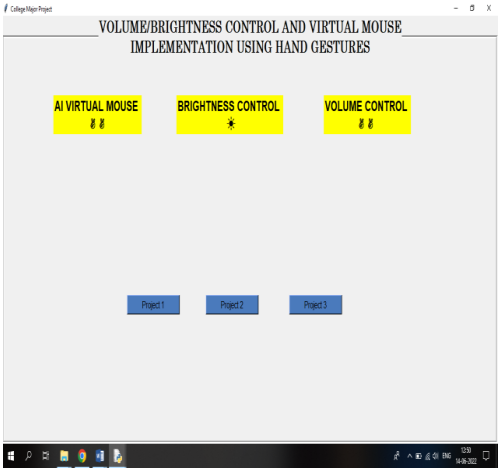

Fig.4 GUI Interfacing

8. AI Virtual Mouse

The proposed system is used to control the mouse pointer by detecting the human hand and moving the pointer in the corresponding human hand direction. System Control simple mouse functions such as left-clicking, dragging and moving the cursor. The process of detecting human skin hands and continuously tracking the cursor movement when the angle between the fingers of the human hand is less than 15 degrees, the process of performing a left click action.

It can be seen that the proposed AI virtual mouse system has achieved about 99% accuracy.

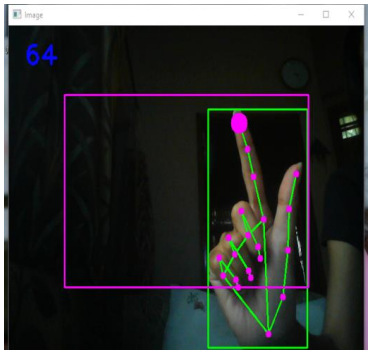

Fig.5 Gesture for cursor movement

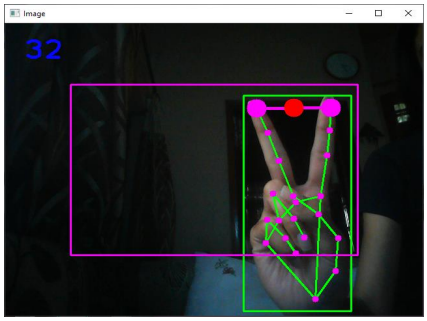

Fig.6 Gesture for left click

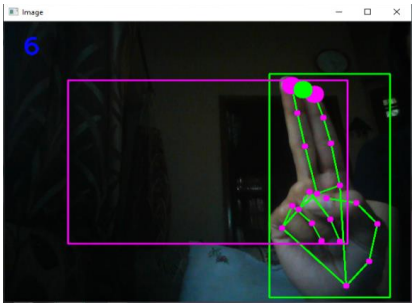

Fig.7 Gesture for right click

9. Brightness Controller

In this system, we mainly focus on hand signal detection and video camera. We can then access the contrast (brightness) functions inside the system and depending on the distance between the thumb and forefinger, the brightness will be modified.

The figure below shows minimal light detection when thumb and index finger are at minimum distance from each other.

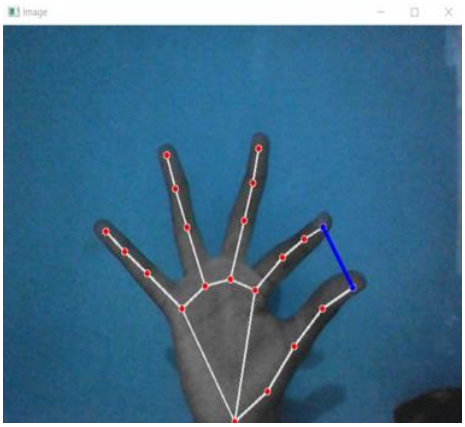

Fig.8 Low Brightness

The figure below shows maximum volume detection when the thumb and index finger are moved apart.

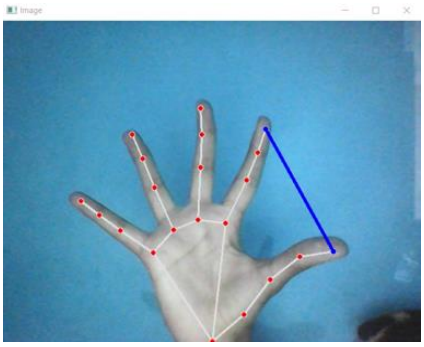

Fig.9 High Brightness

10. Volume Controller

In this proposed system, we mainly focus on detecting hand signs and video cameras. Then we can access the sound functions inside the system and depending on the distance between the thumb and forefinger the volume will be modified.

The figure below shows the minimum volume detection when the thumb and index finger are at a minimum distance from each other.

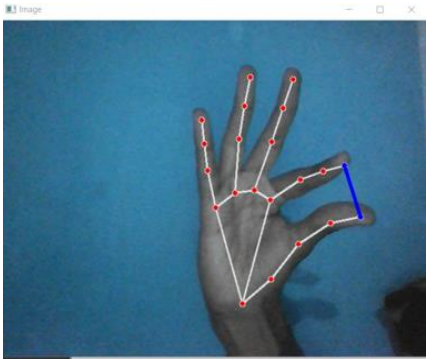

Fig.10 Low Volume

The figure below shows maximum volume detection when thumb and index finger are apart.

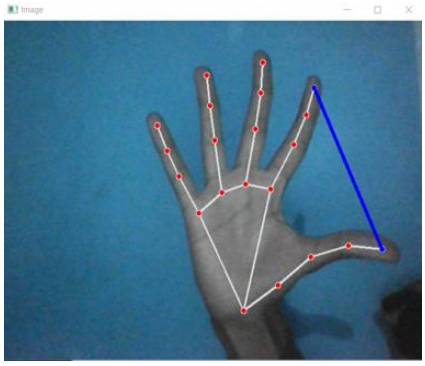

Fig.11 High Volume

➢ Test and Evaluation Results

In the proposed system, the concept of promoting human-computer interaction using computer vision is introduced.

Cross-comparison of AI virtual mouse system tests is difficult because of only a limited number of data sets. Hand gestures and fingertip detection were tested in different lighting conditions and also tested at different distances from the webcam for hand gesture tracking and fingertip detection. An experimental test was performed to aggregate the results shown in Table 1. The test was performed 25 times by 4 people, and this test was performed in different lighting conditions and at different screen distances, and each person tested the AI virtual mouse system 10 times in normal lighting, 5 times in low light, 5 times at a distance short from the webcam and 5 times at a distance from the webcam, and the test results are tabulated in Table 1.

Function Performed	Success	Failure	Accuracy (%)
Mouse movement	100	0	100
Left button click	99	1	99
Right button click	95	5	95
Scroll Up function	100	0	100
Scroll down function	100	0	100
Volume Controlled	100	0	100
Brightness Controlled	100	0	100
No action performed	100	0	100
Proposed System	894	6	99%

Table.1 Experimental Results

From Table 1, it can be seen that the volume/brightness control and virtual mouse implementation using hand gestures system has achieved about 99% accuracy. From this 99% accuracy of the proposed system, we found that the system worked well. As shown in Table 1, the accuracy is low for "right click" because it is the most confusing gesture for the computer. Accuracy of right click is low because the gesture used to perform specific mouse function is more difficult. In addition, the accuracy is very good and high for all other gestures. Compared to previous approaches for virtual mouse, our model performed very well with 99% accuracy.

11. Future Scope

Future work can involve the introduction of an infrared sensor, so that it can detect hands perfectly when the lighting conditions are not conducive. In a progressive implementation, this method can be implemented without using colored tapes. Applications can be extended to games. Gestures can be performed to zoom in and out of the page. This technology has wide applications in the fields of augmented reality, biomedical instrumentation, computer graphics, prosthetics, and computer gaming.

12. Conclusion

This paper presented a completely new system combining AI virtual mouse, volume control and brightness control method using OpenCV, autopy and mediapipe using corresponding fingertip movement. Interaction with the computer in front of the camera without using a physical device is implemented. This method shows high accuracy and very precise gestures that are discarded in real applications. The proposed method overcomes the limitations of existing virtual mouse systems. It has many advantages, for example, it works well in low light as well as changing lighting conditions with complex backgrounds and tracks the fingertips of different finger shapes and sizes with the same

degree of accuracy. Exactly the test results show that the approached system can work very well in real-time applications. We also intend to add new gestures to it for easier system management and interaction with other smart systems. The tracking system can be enriched using a machine learning algorithm like Open Posture. It can also include key points on the body, hands and face for different gestures.

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