

Virtual Mouse using OpenCV and VNC

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Abstract

Virtual Network Computing (VNC) plays a significant role in advanced remote access by allowing users to remotely control another computer or virtual machine over a network connection, and applies to real-world entities. Virtual remote control is the ability to use software with a graphical user interface to remotely operate a computer or virtual machine. One of the key advantages of controlling a virtual remote is that it allows users to interact with the remote system as if they were physically present at the remote location. This research proposes a design of virtual mouse that relies on Hand Gesture Recognition using OpenCV and VNC. It tracks hand movements and recognizes the gestures to perform the mouse tasks. Hand gesture recognition technology uses computer vision algorithms and machine learning techniques to analyse and interpret human hand movements.

Keywords: VNC, web camera, Mediapipe, Hand-gestures, OpenCV, Object Tracking.

1. Introduction

A computer mouse is an input-pointing device that is used to control the cursor on a computer screen. It typically has two or more buttons and a scroll wheel which is used to navigate and interact with Graphical User Interfaces (GUIs) and other applications. The regular trackpad gradually becomes occupied by the virtual mouse. Since it is hardware, it also has a limited lifespan during which it can be used; once that period has passed, a new mouse needs to be purchased. As technology advances, everything is possible including voice detection becoming virtualized. Thus, in the future, speech recognition and eye tracking used to operate the mouse pointer, could substitute the mouse of the computers.

2. Related Works

2.1. AI Virtual Mouse

During pandemic, it is not possible to use the public computer centre due to the spread of disease or infection when it is used. To avoid this condition, the touchless mouse or virtual mouse is preferred. The research [2] proposed a virtually controlled mouse. The first step of the process is to locate the hand pose and then to perform the required process or function. Python is the main language in the concept and Computer Vision is the base for the work.

2.2. Virtual Mouse using Hand Gesture

Mouse is the finest invention and best invention in Human-Computer Interaction (HCI). In the busy world, Bluetooth technology and wireless technology are in high demand; however, there are some lacks in this field like the need for cost-effective and powerful technology. The study [15] covers modern technology which approaches the world to help HCI in a good manner and with available elements like web cameras. Electronic devices are not required more on the implementation. The performance is like clicking and dragging. The execution of the work works under Python and Open CV.

3. Goal of the Research

The goal of a virtual mouse project is to create a software application or program that allows users to control their computer mouse without the need for a physical mouse. This could be accomplished through various methods [14], such as using hand gestures, eye tracking, or

keyboard shortcuts. The aim is to provide an accurate rate of gesture movement for future enhancement using a virtualized mouse, to have better accessibility in upcoming events, and to enhance its performance in the future usage.

4. Methodology

The virtual mouse is developed using Python and OpenCV libraries. The system uses a webcam to capture the user's hand sign and track the movement of the cursor [5]. The cursor movement is determined by the user's hand movement and left and right clicks are controlled using convex hull detection. The virtual mouse is tested on a group of participants and their performance is evaluated using various metrics such as accuracy, speed, and usability [2].

5. Overview of the System

5.1. Existing System

In the existing system [1], a computer mouse is an input tool that facilitates pointing and interaction with the object being directed at. Many different styles of operations are currently popular, including the mechanical mouse, which is made of a single rubber ball that can spin in any direction and control the movements of the cursor. Eventually, the optical mouse takes the area of the mechanical mouse.

5.2. Proposed System

The proposed system provides a significant improvement in accuracy and usability, compared to existing virtual mouse systems. Participants reported a high level of satisfaction with the system and found it easy to use [2]. The system also allowed the participants to perform various tasks, such as clicking and control the mouse without touching it. The participants were able to successfully control the cursor using their hand signals and have a good level of accuracy and minimal error rates [3].

5.3 System Requirements

Table 1. Hardware and Software Requirements

Hardware requirements	Software requirements
1)PC/Laptop	1)Window OS
2)Webcam	2)Open CV
	3)Anaconda (Python 3.9)

6. System Architecture

There are three major components for the structural part of the system such as, image processing, cursor control, and feature extraction [8]. The movement of the user can be detected in the video format input with the help of a camera in the concept based on the processing image features [9]. The hand motion pose of the users can be located by implementing some algorithms in the language Python in-built libraries [13] to observe and execute the desired output which is expected by the clients.

7. Modules of the Research

- Transformational Algorithm
- Image Processing Module
- Feature Extraction Module
- Cursor Control Evaluation

Module Description

7.1 Transformational Algorithm

The algorithm used in the virtual mouse using OpenCV and VNC is called Transformational Algorithm. The Transformational Algorithm [12] is used to convert the hand gestures of the given input hand, from the webcam screen to computer window, to track the cursor movement or control the mouse without touching it.

Algorithm steps:

Step1: Start.

Step2: Initialize the system and activate the webcam.

Step 3: Input the hand gestures.

Step 4: Record or capture the image or frame, by the webcam.

Step 5: By using transformational algorithm, process the images.

Step 6: Recognize the hand gestures by Convex Hull-Detection method.

Step 7: Identify which fingers are raised.

Step 8: Perform based on the verified hand gestures.

7.1.2 Image Processing Module

The camera plays a mighty role because it observes or captures or records input of the video to work on the module of image processing, with some algorithms of open CV to get the outcomes to match the user's expectation [4]. The method undergoes some filters like finding perfect algorithms and adjusting some camera settings to achieve it [5]. The performance of this system is easily achieved due to the easily available essential requirements like libraries of the open CV and module of image that play a marvel role in discovering the user's motion.

7.1.3 Feature Extraction Module

The features extraction module uses the common algorithms to decode the video format obtained as the feed to get that output [7]. This module has a few techniques such as, identify hand gestures movement with basic algorithms, and train labeled information to make unique output for the system.

7.1.4 Cursor Control Evaluation

The designing of this system can be achieved by an important module which is called cursor control module. It assists to command the mouse cursor [8][10]. The movements of the cursor like quick responses, right-pop, and left-pop, are more cursor-related limiting factors by getting signals from extracted features that come out as the output for a particular

feed. The PyAutoGUI libraries used the wide scale input function to control the mouse indicator [9].

8. System Development

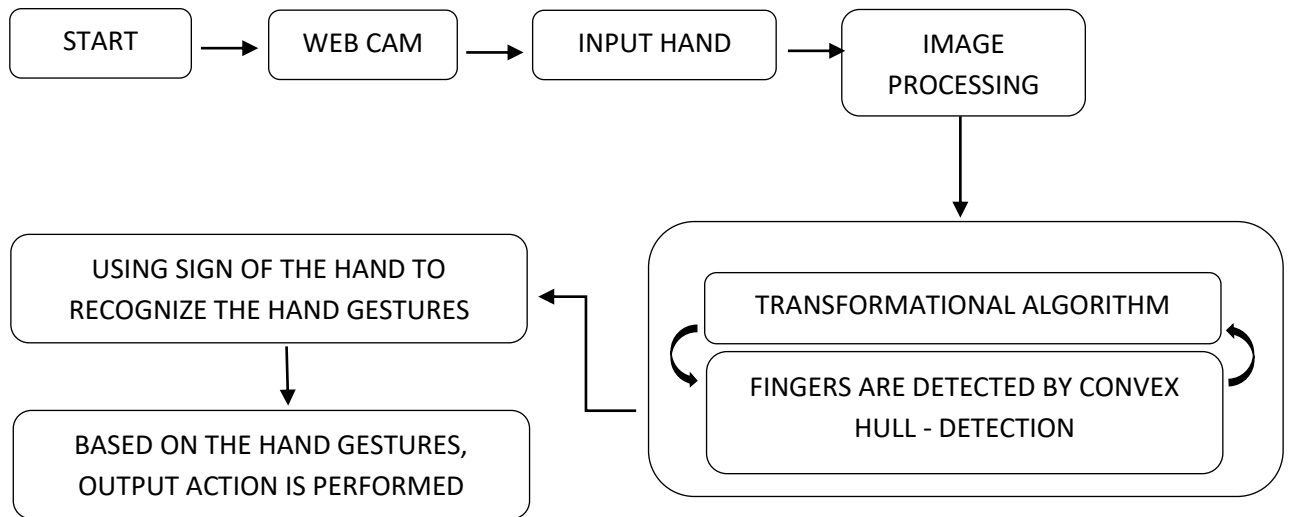


Figure 1. Flowchart of the Proposed System

The above flowchart shows the working state of the virtual mouse [11] and its operations. The steps of the operations are:

Step1: Start.

Step2: Webcam is used.

Step 3: Hand sign by the user is taken as input.

Step 4: By using the transformational algorithm, the images are pre-processed.

Step 5: The fingers are detected by Convex Hull-Detection method.

Step 6: Based on the hand signs, the actions are performed.

The screenshots of the virtual mouse operations have been depicted below.

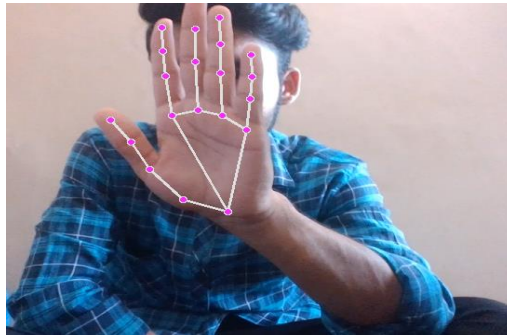


Figure 2. Gesture Control using Hand

By the open palm, the movement of the cursor or tracking location can be controlled.



Figure 3. Click Operation using the Index and Thumb Fingers

With the help of both index and thumb fingers, the clicking operation like right click can be performed.

```
Anaconda Powershell Prompt
(base) PS C:\Users\Obath Solomon> cd .\Downloads\
(base) PS C:\Users\Obath Solomon\Downloads> python test.py
INFO: Created TensorFlow Lite XNNPACK delegate for CPU.
single click
File opened !
single click
File opened !
single click
File opened !
single click
File opened !
single click
File opened !
single click
File opened !
single click
File opened !
|
```

Figure 4. Opening of New File After the Click Operation

Figure 4 depicts that when the click operation is performed, the output message appears in the CMD prompt windows.

9. Result and Discussion

9.1 Result

A virtual mouse using OpenCV and VNC has been implemented. The virtual mouse can be controlled using hand gestures detected by a camera, and the movements can be transmitted to a VNC server to control a remote computer. A camera is set up to detect hand gestures using OpenCV. The camera can be a built-in webcam or an external camera. OpenCV is used to detect hand gestures such as moving left, right, up, or down. These movements can be translated into mouse movements. The mouse control algorithm that maps the detected hand gestures to mouse movements is used. For example, moving the hand left can move the mouse to the left, and moving the hand up can move the mouse up. VNC is used to establish a connection with a remote computer. The VNC server can be run on the remote computer, and the virtual mouse movements can be transmitted to it using a VNC client. The virtual mouse is tested by moving the hand and checking if the mouse moves accordingly on the remote computer.

9.2. Discussion

The idea of controlling a remote computer using hand gestures captured by a camera is an innovative approach to desktop control. The combination of VNC and OpenCV can create a seamless experience for the user, allowing to control a remote computer naturally and intuitively. The implementation of a virtual mouse using VNC and OpenCV can be challenging. One of the biggest challenges is ensuring that the hand gestures captured by the camera are accurate and consistent. This requires careful calibration and testing to ensure that the virtual mouse movements are precise and responsive.

10. Conclusion

Traditional mouse can cause some difficulties while using them. To overcome this, the virtual mouse concept which is an affordable design and the best solution for people to access mouse easily has been proposed. Implementing this concept is easy because of the usage of the in-built web-camera on computers or laptops and default Python libraries, which can be

accessed by all users. It can be concluded that the virtual mouse is the best and only alternative to the traditional mouse in the future. It develops human interaction with computers and helps to improve the lifestyle of this generation, which will lead to gaining more time and reducing human effort.

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Author's Biography

T. Kalai Selvi is working as Assistant Professor (SLG-I) in Department of Computer Science and Engineering at Erode Sengunthar Engineering College, Erode. She has published more than 15 papers in reputed Journals and more than 15 papers in various National and International conferences.

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M. Manikandan is an excellent student from Erode Sengunthar Engineering College currently doing under graduation in Computer Science and Engineering. He attended the national-level symposium and participated in a paper presentation. He has done a project in Mobile Application development.

M. Obath Solomon is an emerging student who is pursuing graduation from Erode Sengunthar Engineering College. He is from the computer science department. He has done workshops in Blockchain development and Mobile App Development. He has completed more than 5 certifications in Infosys Springboard, and has completed a Full Stack Development course.

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