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Gesture Recognition Based Virtual Mouse and Keyboard

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Abstract - Nowadays computer vision has reached its pinnacle, where a computer can identify its owner using a simple program of image processing. In this stage of development, people are using this vision in many aspects of day to day life, like Face Recognition, Color detection, Automatic car, etc. In this project, computer vision is used in creating an Optical mouse and keyboard using hand gestures. The camera of the computer will read the image of different gestures performed by a person's hand and according to the movement of the gestures the Mouse or the cursor of the computer will move, even perform right and left clicks using different gestures. Similarly, the keyboard functions may be used with some different gestures, like using one finger gesture for alphabet select and four-figure gesture to swipe left and right. It will act as a virtual mouse and keyboard with no wire or external devices. The only hardware aspect of the project is a web-cam and the coding is done on python using Anaconda platform. Here the Convex hull defects are first generated and then using the defect calculations an algorithm is generated and mapping the mouse and keyboard functions with the defects.

Introduction

In this study, finger tracking based a virtual mouse application has been designed and implemented using a regular webcam. The motivation was to create an object tracking application to interact with the computer and develop a virtual human computer interaction device. The basic objective is to develop a virtual mouse and keyboard using the concepts of hand gesture recognition and image processing which will ultimately move the mouse pointer according to the hand gestures, similarly with the help of the gesture can use keyboard functions which will be defined as per the convenience of the user. Reducing the cost of hardware. This approach will make tasks trickier and more easier like creating 3D models, browsing the imaginary part in medical world during surgery and one best thing is that without touching anything it can work even in architectural designs and in automated building.

The Computer webcam is capturing the video of the person sitting in front of the computer, there will be a small green box which will be generated in the middle of the screen. In that green box, the objects shown will be processed by the code and matched with it if it matches then a red colored border will be generated, which means the computer has identified the object and then by moving the object the mouse cursor can be moved. This will not only help in the security of the computer but also help in generating a virtual computational experience. Here in the place of different objects, using hand gestures one gesture will be moving the cursor, the different gesture will be used for right click and different for left click, similarly with a simple gesture can do the keyboard functions virtually that may have been done on some keyboard as a physical aspect. It the gesture does not match the box will show an only green box when the known gesture is observed a red border will occur.

The rest of the article is organized as follows it will present few related works on virtual keyboard and virtual mouse system, and illustrates methodology, discusses about the results of our study and finally, section V concludes our work result.

METHODOLOGY

The methods used in each & every part of the system proposing in this paper are explained separately.

In this paper, we use the Python language for the implementation of algorithm. We use the OpenCV library for image processing. The algorithm use two types of methods for implementation of mouse control. One includes the usage of color caps and other uses the recognition of bare hand gesture recognition.

A. Camera - Camera The built-in camera on a laptop or the webcam on a computer are the frames that the system uses to operate. The system will capture webcam video in real-time by establishing the video capture object. The device index for this system would be "0" in order to employ a single camera. Additional camera device indexes could be added with 1, 2, and so on. The system will get frame-by-frame data from this camera.

B. Color Detection & Masking In this proposed system, color detection is done by detecting color pixels of fingertips with color caps from the frames that were captured by the webcam. This is the initial and fundamental step of the proposed system. The outcome of this step will be a grayscale image, where the intensity of the pixels differs the color cap from the rest of the frame and the color cap area will be highlighted and will be tracked. The gesture will be detected from the tracking of these color caps.

IV. GESTURE RECOGNITION

A. Mouse Movements At first, calculation of the center of two detected color objects which is done by the coordinates of the center of the detected rectangle. To create a line between two coordinates, the built-in OpenCV function is used and to detect midpoint equation given below is used: $M = (Xa+Xb\ 2\ , Ya+Yb\ 2\ )$

(1) This midpoint is the tracker for the mouse pointer and the mouse pointer will track this midpoint. In this system, the coordinates from camera captured frames resolution is converted to screen resolution. A predefined location for the mouse is set, so that when the mouse pointer reaches that position, the mouse started to work and this may be called open gesture. This allows the user to control the mouse pointer.

B. Mouse Clicking The proposed system uses close gestures for clicking events. By holding the same position more than 5 seconds, the user can perform a Double click. And for the right button click again the open gesture is used. To perform the right button click, the single finger is good enough. The system will detect one fingertip color cap then it performs a right button click.

C Mouse Scrolling To scroll with this system, user needs to use the open gesture movement with two fingers with color caps. If the users use their two fingers together & changes its position to downwards, it will perform scrolling down. Similarly, if its position is changed to upwards, it will perform scrolling up. When two fingers move up or down the color caps gets a new position and new coordinates. By the time all two color caps get new coordinates, it performs scrolls. If their y coordinate values decrease, it will perform scrolling down and if the values increase, it will perform scrolling up.

We use Harcascade algorithm to detect eyeballs and recognize eye gestures and move our eyeball in the direction we want the cursor to move. As the eyeball move in left, the left cursor works, when we blink, It clicks respectively

Key Board - The method employed for this keyboard function is the hand position system, which means that the computer uses video to record the hand position. A tiny virtual keyboard is allocated to the active video window. Using the hand position technique, the keyboard functions that have been mapped can be chosen and then executed. A math function is then used to determine the hand's position that the computer can recognise.

LITERATURE SURVEY

In 2020 Vantukala VishnuTeja Reddy1 , Thumma Dhyanchand2 , Galla Vamsi Krishna3 , Satish Maheshwaram developed article titled Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition in which they propsed Video Extraction section in which is state the video taken by web cam is taken using the Video Capture function, extracted video has a size of 512x512 pixel. Then, it is used for further processing of the image. The optimum number of frames that are extracted per second are 12. The extracted frame image is in BGR(Blue, Green, Red) format. This image is converted to HSV(Hue, Saturation, value) format..

In 2019 Ms. Saily Bhagat1, Ms. Tanvi Patil2, Ms. Varsha Singh, published a paper on Eye Gaze Direction Evaluation to Operate a Virtual Keyboard for Paralyzed People which state that HaarCascade method was used to extract features of face, and Integral Projection method was used to get the position of the eye movement. Based on their experiment, the ratio between the duration of normal writing and duration of typing using their system for two words is 1:13
Capturing By using an infinite loop the webcam captures each and every frame till the program termination. The frames from the real-time video are processed from BGR to HSV color space.

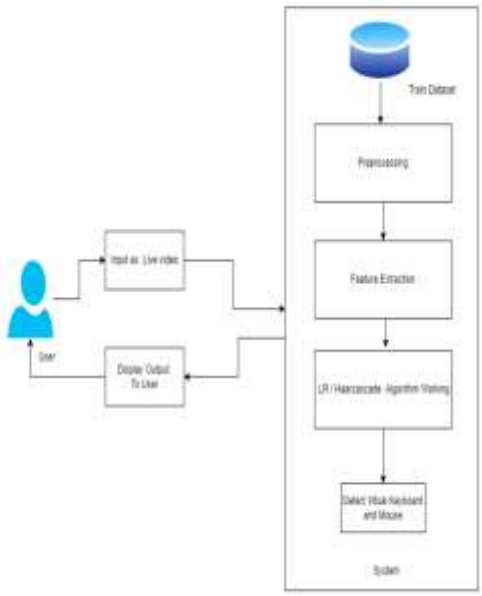
In 2020 Vantukala VishnuTeja Reddy1, Thumma Dhyanchand2, published a paper on Mouse Control Mouse Control is performed with the help of pyautogui library. The fuctionalities of mouse that are performed in the project are cursor control, left click, left double click, right click, up scrolling and down scrolling. Three fingers are used for the mouse control operations in case of color caps. Those three fingers are index, middle finger and ring finger. Blue colored cap is inserted on index finger. Green color cap is inserted on middle finger and red color cap is inserted on ring finger.

In 2019 Jing-Hao Sun,Ting-Ting Ji,Shu-Bin Zhang published a paper on Research on the Hand Gesture Recognition Based on Deep Learning The paper realizes the segmentation of hand gestures by establishing the skin color model and AdaBoost

classifier based on haar according to the particularity of skin color for
hand gestures, as well as the denaturation of hand gestures with one frame of video being cut for analysis. In this regard, the human hand is segmentd from the complicated background, the realtime hand gesture tracking is also realized by CamShift algorithm. Then, the area of hand gestures which has been detected in real time is recognized by convolutional neural network so as to realize the recognition of 10
common digits.

In 2020 Kadir Akdeniz1 , Zehra C¸ ataltepe1,2. published a paper on Dynamic and Personalized Keyboard for Eye Tracker Typing Patients who suffer from Amyotrophic lateral sclerosis (ALS) or stroke cannot talk and express their everyday basic needs and requests. They can communicate using eye trackers since they can still use their eyes and sometimes move their heads. This study suggests new methods for improvements in both speed and ease of use for eye tracker software. The first one is letter prediction to improve the speed, and second one is a new design that obviates the need of blinking with eye trackers, thus providing more comfortable and longer sessions of writing

SYSTEM ARCHITECTURE



1.User login or Register:

•This step involves authenticating the user's credentials or allowing them to create a new account if they don't have one.

•User login ensures that the system can identify and associate the user's settings and preferences with their account.

2.Live video cam of laptop or PC:

•This step involves accessing the camera of the laptop or PC to capture live video input.

•The video stream will be used for further processing and analysis in subsequent steps.

3.Preprocessing:

•Preprocessing techniques are applied to the video frames to enhance the quality of the images and reduce noise.

•Common preprocessing techniques include resizing the frames, adjusting brightness and contrast, and applying filters to improve image quality.

4.Feature Extraction:

•Feature extraction involves identifying relevant features or patterns from the preprocessed video frames.

•In the context of computer vision, features could include edges, corners, textures, or any other visual characteristics that can be used to distinguish objects.

5.Haarcascade algorithm:

•The Haarcascade algorithm is a popular technique used for object detection and specifically designed for detecting features such as faces.

•It utilizes a pre-trained cascade classifier that identifies specific patterns or features within an image or video stream.

•The Haarcascade algorithm has been widely used for face detection due to its efficiency and accuracy.

6.Detect Face:

•Using the Haarcascade algorithm, this step involves detecting and localizing faces within the video frames.

•The algorithm identifies facial features and determines the position and size of each detected face.

7.Detect virtual mouse and keyboard:

•This step involves using computer vision techniques to identify and track virtual mouse and keyboard movements within the video frames.

•Object detection or tracking algorithms can be employed to recognize specific hand gestures or finger movements to simulate mouse and keyboard actions.

8.Display the output:

•The output of the system can be displayed in various ways, depending on the application.

•For example, the system may overlay visual elements, such as virtual mouse pointers or virtual keyboards, onto the video frames.

•The output can be displayed on the screen in real-time, allowing the user to interact with the virtual mouse and keyboard.

This system architecture allows users to login or register, utilize their laptop or PC's camera for live video input, perform preprocessing and feature extraction on the video frames, apply the Haarcascade algorithm to detect faces, detect virtual mouse and keyboard actions, and finally display the output with virtual elements overlaid on the video frames.

Feature extraction

Feature extraction works in a similar fashion to neural network recognizers. However, programmers must manually determine the properties they feel are important. This approach gives the recognizer more control over the properties used in identification. Yet any system using this approach requires substantially more development time than a neural network because the properties are not learned automatically.

Preprocessing :

The purpose of preprocessing is to discard irrelevant information in the input data, that can negatively affect the recognition. This concern speed and accuracy. Preprocessing usuallyconsistsbinarization, normalization, sampling, smoothing and denoising.

Haar cascades, first introduced by Viola and Jones in their seminal 2001 publication, ***Rapid Object Detection using a Boosted Cascade of Simple Features***, are arguably OpenCV's *most popular* object detection algorithm. Sure, many algorithms are more accurate than Haar cascades (HOG + Linear SVM, SSDs, Faster R-CNN, YOLO, to name a few), but they are still relevant and useful today. One of the primary benefits of Haar cascades is that they are just so fast — it's hard to beat their speed. The *downside* to Haar cascades is that they tend to be prone to false-positive detections, require parameter tuning when being applied for inference/detection, and just, in general, are not as accurate as the more "modern" algorithms we have today.

That said, Haar cascades are:

1. An important part of the computer vision and image processing literature
2. Still used with OpenCV
3. Still useful, particularly when working in resource-constrained devices when we cannot afford to use more computationally expensive object detectors

Proposed System

The Mouse uses a convex hull process for its working, defects are captured or read, using this defects the functions of the mouse are mapped. The process of this image recognition process solely focuses on defects and conditional statements, the convex hull takes the gap of the fingers as
defects, so it can be used for multiple gestures and mapping commands. The following steps are followed for the use for
gesture recognition and its mouse functions
x In the first step , the web cam will start and the video and what is present in front of the camera can be seen x. In the next step the user has to keep their hand in the required border made on the screen. x In this step the different hand gestures will be
shown by the user, these gestures will be not any kind of a gesture but those which have been trained to the computer from the beginning. If the gesture matches then a green coloured border will be generated and by moving the hand the mouse cursor will also move. There are total four different kind of gesture, one is used to move the cursor, another one is used to do the right click, another one is used for left click, and another gesture for scrolling up and down. When no hand is placed in the bordered region a comment will show that there is no object placed. The similar gestures may not match sometime this is due to the reason that the user is not showing the gesture accurately or there are a few noise which are affecting the inputs. The gestures count the defect using Convex Hull method and relates with the object used for mapping. The gesture hence shows the defects which in turn help in left and right click options defect=5 then right click, defect=3 then left click.

KeyBoard

The process used for this keyboard function is a bit different than the Convex hull process, here the hand position system is used that is, the video that is capturing used the position of the hand is captured by the computer. In the open video window a miniature virtual keyboard is mapped. Using the hand position technique the keyboard functions can be selected which have been mapped and using this process the keyboard function executed, a math function is used to judge the position of the hand and turn it into a matrix location which makes the position recognisable for the computer. The following steps are followed for the use for gesture and its Keyboard functions : In the first step the web cam will open and the user can see the camera window. The alphabets and other keyboard essentials are seen in the red borders With proper hand gesture the alphabets of the keyboard can be moved and do computer functions also x With a open palm the keyboard can be moved left to right to get all the alphabets and keyboard functions. By putting the finger over the designated key the can type the required alphabet or keyboard
functions.

Expected Result

This paper is useful to finger tracking based a virtual mouse application has been designed and implemented using a regular webcam. So we can reduce interaction with physical devices such as mouse and Touch pad and also develop a virtual human computer interaction device.

CONCLUSION

This project is proposing a system to recognize the hand gesture and replace the mouse and keyboard function. That includes the movement of the mouse cursor, the drag and click with the keyboard features like printing alphabets and other keyboard functions. The process of skin segmentation is utilized to separate the colour image of hand with its background. Remove arm method, which effectively solves the situation of taking into the whole body into the camera. In general, the proposed algorithm can detect and recognize hand gesture so that it can operate mouse and keyboard features and also create a real world user interface. 3d printing, Architectural drawings and even doing medical operations from anywhere to everywhere. This project can be easily applied and its application can be very vast in medical science where computation is required but couldn't fully be implemented due to lack of human computer interaction.

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