International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org || PP. 07-09

Gesture Recognition Based Virtual Mouse and Keyboard

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Abstract: *Human Computer Interaction (HCI) is the study of how people and computers interact with eachother. It is the design of the interfaces between people and computer by using the concepts of computer technology.In this work, Human Computer Interaction software is developed where cursor movement and keyboard functionscan be controlled using a web camera and computer vision technology. The virtual mouse and keyboard remove the need for a physical device and thus reduces the amount of e-waste being produced and also it is very useful for specially abled people because the virtual mouse requires only one finger movement to control the cursor of the computer. The main device used in the design is a web camera which will be continuously utilized by Python based software to monitor the gestures made by the user. According to these gestures, the mouse and keyboard functions are implemented. The web camera reads the hand image and according to the movement of the finger, the cursor of the computer also moves. Similarly, precision and hand position interface is used for virtual keyboard. It detects the hand position and the functions are performed depending on where the hand position fixes upon.*

Keywords *- Computer vision technology, gestures, Human Computer Interaction, Python*

I. Introduction

A mouse is a hand held pointing device which is used in order to detect the two-dimensional movements relative to a surface. This movement done by the mouse is then converted into the movement of a pointer that allows controlling of the Graphical User Interface (GUI) on a computer platform. Keyboard is a device used to input some text in the computer. It is the most basic way to communicate with a computer and falls in the category of input devices [1]. However, even though they are accurate, there are many limitations that are present within these hardware devices. A computer mouse is considered as a consumable hardware device and it may need some kind of replacement due to few defects when seen in long run. These defects can include either the degradation of mouse buttons that can cause inappropriate clicks, or the case when computer may not be able to detect the whole mouse itself. Similarly, in a keyboard, the buttons may stop working and it may have to be replaced. Despite the limitations, computer technology is still continuously in growth and with that comes the growth in the importance of the human computer interactions. Ever since the developments of a touch screen technology, the world demands the same type of technology to be applied on every technological device present [2]. Virtual mouse and keyboard will soon start replacing the physical mouse and keyboard to promote the convenience provided by it and still being able to accurately interact and control the computer system. Therefore, this work develops a software application by using the coding technique which is considered latest when compared with others- Python and open-source computer vision library which is also known as the OpenCV. The scope of this work is as mentioned below:

- Real time application
- It useful for people who have disabilities in their hand.
- It removes the necessity of having the physical keyboard and mouse

II. Methodology

The first thing in methodology is to turn on the camera which will automatically take place after the program is run. Once the camera is on, the hand should be placed in front of it such that the camera can capture the image of full hand. The image capturing process is a continuous process and when seen from the back-end, it will look like a video of multiple images. The next step is frame extraction which is extracting of particular frame from the video of images which will then be checked by a part of code to see if the frame has at least a little resemblance to the human hand or not. If not, the frame will not proceed further. After the frame extraction is the Convex Hull algorithm which states that if we have a certain set of points in a plane then the Convex Hull will be the smallest polygon that will contain all the points. Hand has two parts i.e., convex points (tip of the finger) and convexity defects (trough between two fingers). Convex Hull algorithm will convert the extracted image frame toa skeleton like structure and will count the total number of convex points and convexity defects, and then it

will connect the points to form a smallest polygon to determine the gesture made by the user. This process is carried out using the formula: $X_k^i = (X_{k-1} * B^i) \cup A$ (1) where X_k represents the current image, X^{k-1} represents previous image, B represents the vertical position of the hand (y-axis), A represents the horizontal position of hand (x-axis) and * is the convolution. Here B will have four predefined values by which 'i' will also automatically take four values and k will start from 1 up to the condition $X_k^i = X_{k-1}$ is satisfied. Finally, after the gesture is recognized, thecursor movement will take place according to the movement of the index finger and on extending the thumb the mouse click function will happen. In keyboard, the clicking of keys will take place using the hand positioning.

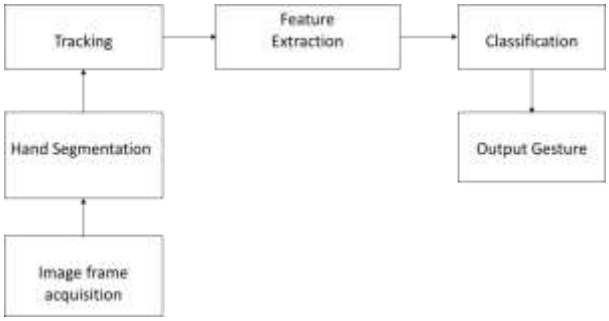

Figure.1 Block diagram of the proposed methodology

III. Results And Discussions

As seen in Fig.1 and Fig.2, the webcam is able to locate and determine the hand gesture using the convex hull algorithm and accordingly, the cursor movement takes place. With the help of the cursor movement user is able to type words through keyboard as well. The proposed virtual mouse and keyboard depends only on the hand gestures to perform the functions of mouse and keyboard. It also reduces the hardware cost by replacing the physical mouse and keyboard. These modern technologies are being developed and used, which is helping in making the society life better including the productivity and lifestyle. Therefore, this work is an approach to theHuman Computer Interaction, to make communicating with computers more efficient and easier.

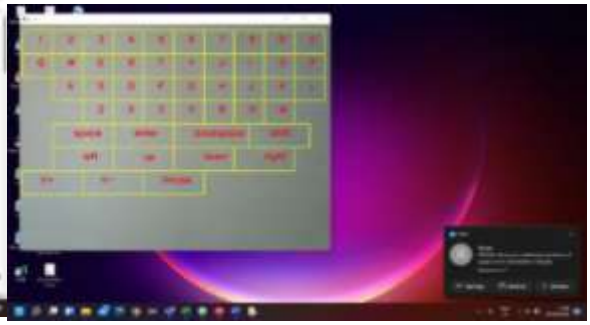

Figure.2 Virtual mouse Figure.3 Virtual keyboard

IV. Requirements

One of the most important requirements for the work includes the webcam present in the devices which have their own specifications including the mega pixels. Better the mega pixel better will be the clearance of the image captured. Devices should have basic system and software requirements as mentioned below:

Hardware requirements

- Computer Desktop or laptop
- Web cameraSystem requirements
- Processor: Dual Core/i3 and above
- RAM: 2GB and above

- Speed: 500 MHz and aboveSoftware requirements
- Programming Language: Python
- Version: Python 3.7
- Operating system: Windows 7 and above/ MacOSLibraries used
- OpenCV
- Numpy
- Pyautogui
- Mediapipe
- Autopy
- Imutils
- Json

V. Conclusion

This paper proposes a virtual mouse and keyboard that uses a web camera to detect the hand gestures. The frames captured from the web camera undergo a series of image processing techniques so as to improve the quality of the image frames. The convex hull process is used to detect defects. These defects are then used to map the mouse functions. The keyboard functions are implemented using the hand position interface. Mouse functions like cursor movement, left click and keyboard functions like printing the alphabets, numbers, other characters and volume Up/Down functions are implemented. There are several advantages of the work which includes its usefulness to the specially abled people and also to the people affected by stroke. Another advantage is that this work removes the need for a physical mouse and keyboard which in-turn reduces the e-waste produced. There are few disadvantages that come through as well. The user may face difficulties while trying to make long conversations or explanations using only gestures. It may also take a lot of time to make long conversations. The improvisation in this case can be done by including voice recognition with the gestures, so instead of using only fingers to type, voice can be used in parallel as well.

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