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Gesture-Controlled Virtual Keyboard using OpenCV for Specially-Abled

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ABSTRACT: The advancement of technology has led to computing being integrated into mobile devices like smartphones and palm tops. However, the traditional QWERTY keyboard remains unchanged as the primary input device. This paper proposes a virtual keyboard application that utilizes image processing to create a visual representation of a keyboard. The virtual keyboard will be functional and accessible by using a camera to capture hand gestures as typing inputs. The same concept applies to the development of a virtual mouse that will use finger recognition as inputs. The camera will capture hand movements to control the mouse. The virtual keyboard and mouse will be created by fetching the image of a keyboard or mouse using the camera, and capturing the typing or mouse movements.

KEYWORDS: Human-Computer Interaction, Colour Detection, Web camera, Gesture Recognition, Image Processing, Green Colour Object.

I. INTRODUCTION

In the present-day scenario, most of the mobile phones are using touch screen technology to interact with the user. But this technology is still not cheap to be used in desktops and laptops. Our objective was to create a virtual mouse system using a Web camera to interact with the computer in a more user-friendly manner that can be an alternative approach for the touch screen. 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 with respect with the location of the finger caps. The only problem was that the right click and left click functions were very much difficult using this process. Open cv is basically an open source computer vision and machine learning software library. Numpy is python library that provides a simple yet powerful data structures. Keras is basically neural network library and tensorflow is the open- source library for a number of various tasks in machine learning.

The basic algorithm we are going to use in this project is Svm Hog and convolutional neural network which is svm hog is histogram of oriented gradient is used for features extraction in the human detection process, while linear support vector machine (svm) are used for human classification.

II. LITERATURE SURVEY

Computer vision based mouse is to control the mouse tasks and recent challenges, erden et al. [1] have been investigated a camera and computer vision based technologies, such as image segmentation and gesture recognition. To overcome the limitations of erden et al.[3]this project, we have taken inspirational from the Hojoon Park which is inspired by computer vision-based technology that has the capability to control mouse movements in web camera. However, he used finger-tips to control the mouse cursor and the angle between the thumb and index finger was used to perform clicking actions. Chu-Feng Lien had used an intuitive method to detect hand motion by its Motion History Images (MHI). In this approach, the only fingertip was used to control both the cursor and mouse click. In his approach, the user needs to hold the mouse cursor on the desired spot for a specific period of time for clicking operation [2]. Kamran Niyazi et al used Web camera

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to detect color tapes for cursor movement. The clicking actions were performed by calculating the distance between two colored tapes in the fingers. In K N Shah et al. [9] have represented some of the innovative methods of the finger tracking used to interact with a computer system using computer vision. They have divided the approaches used in Human-Computer Interaction (HCI) into two categories.

- HCI without using interface.
- Moreover, they have mentioned some useful applications using finger tracking through computer vision.

In this study described the motivation and the design considerations of an economical head-operated computer mouse. In addition, it focuses on the invention of a head-operated computer mouse that employs two tilt sensors placed in the headset to determine the head position and to function as a simple head-operated computer mouse. One tilt sensor detects the lateral head-motion to drive the left/right displacement of the mouse. The other one detects the head's vertical motion to move up and down with respect to the displacement of the mouse. A touch switch device was designed to contact gently with operator's cheek. The operator may puff his cheek to trigger the device to perform a single click, double clicks, and drag commands. This system was invented to assist people with disabilities to live an independent professional life.

III. PROBLEM STATEMENT

Computer vision-based mouse can easily be applied to the web services, smart home systems, robot manipulation, and games. That is why tracking nonrigid motions from sequential videos have been a great interest to the computer vision community. We grew up interacting with the physical objects around us. How we manipulate these objects in our lives every day, we use gestures not only to interact with objects but to interact with each other and this brings us a step closer to Human-object relationship by using gesture recognition technique. In this research still webcam has been used to recognize the gestures. There is no need for 3D or stereo cameras and above research has also been tested on low-cost 1.3-megapixel laptop webcam.

The work is dedicated to a computer vision-based mouse that acts as an interface between the user and various computing devices in the dynamic environment. This paper presents the technique to perform numerous mouse operations thus obviating the need for hardware used for interaction between the user and the computing device. The same approach can be applied to endless tasks such as browsing images, playing games, changing T.V channels, etc. There is a threshold value for distance (in meters) between the user and camera which can further be varied according to the camera's resolution. It means if the subject who wants to be recognized with his hand gestures in some environment, the subject has to come close to certain fixed distance to the camera. This research was done on 1.3- megapixel webcam with a threshold value of 2m.

IV. ARCHITECTURE OF VIRTUAL KEYBOARD

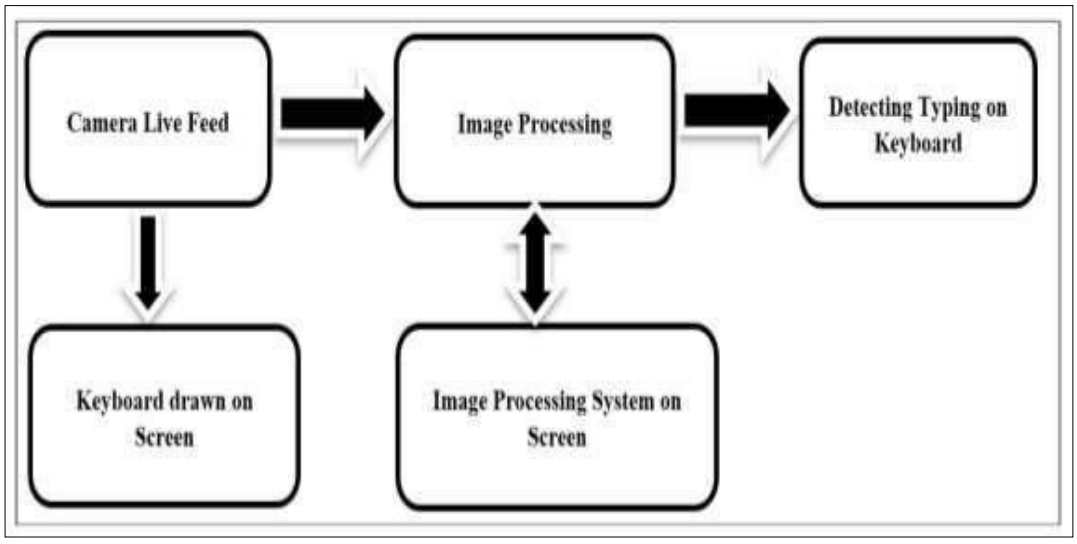

Figure 1 – Block Diagram for Keyboard I

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The keyboard will be displayed on the desktop screen.

- The camera will be used to capture live feeds of the fingers/cursor on screen to type
- Thus, by processing the Image, in real time the typed words on the keyboard will be detected.
- Those words will then be displayed on the desktop.

V. FLOW DIAGRAM GESTURE-CONTROLLED VIRTUAL KEYBOARD

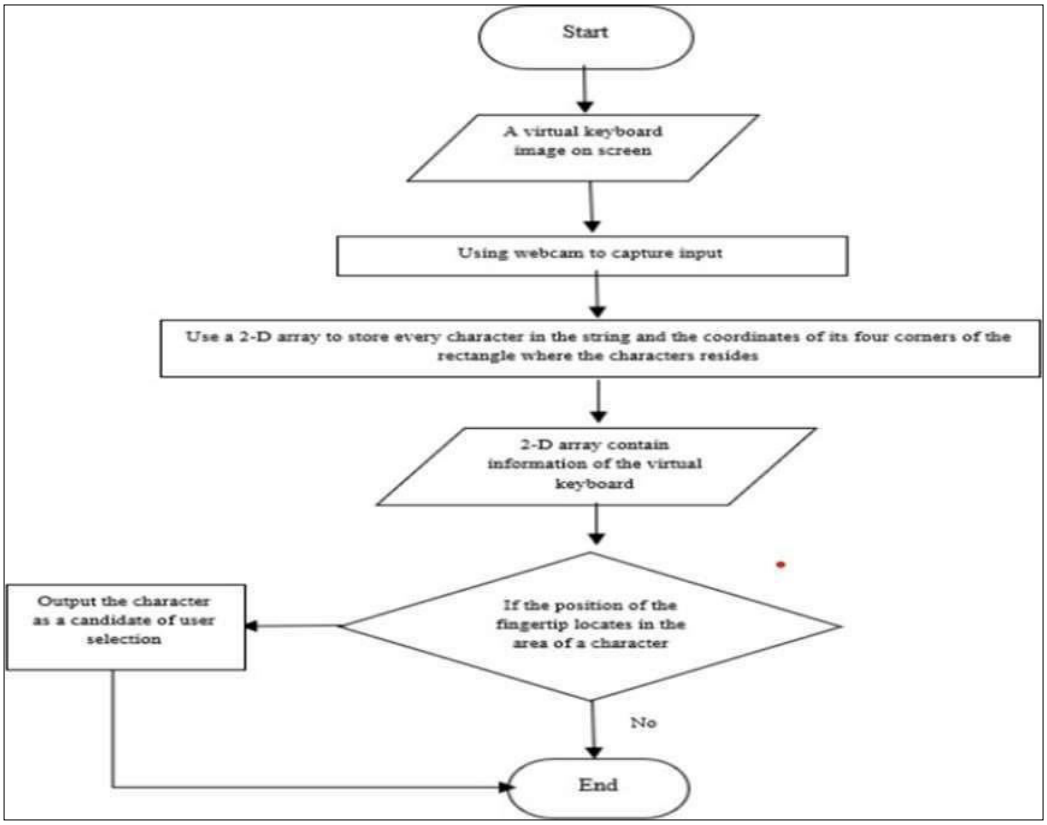

Figure 4- Flow Diagram of Keyboard

The flow chart diagram describes the flow of functions which take place in the system. It shows the flow of execution of how the command is issued and that how the command is being handled and how the processing and the required output function is performed.

VI. METHODOLOGY GESTURE-CONTROLLED VIRTUAL KEYBOARD

- **OpenCV**

OpenCV is a computer vision library which contains image-processing algorithms for object detection. OpenCV is a library of python programming language, and real-time computer vision applications can be developed by using the computer vision library. The OpenCV library is used in image and video processing and also analysis such as face detection and object detection.

- **DETECTING BACKGROUND**

Given the feed from the camera, the 1st thing to do is to remove the background. We use running average over a sequence of images to get the average image which will be the background too.

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- **BACKGROUND SUBTRACTION**

Background subtraction involves calculating a reference image, subtracting each new frame from this image and thresholding the result which results is a binary segmentation of the image which highlights regions of non-stationary objects.

- **CONTOUR EXTRACTION**

Contour extraction is performed using OpenCV's inbuilt edge extraction function. It uses a canny filter. You can tweak parameters to get better edge detection.

- **CONVEX HULL AND DEFECTS**

Convex hull points are most likely to be on the fingers as they are the extremities and hence this fact can be used to detect no of fingers. We are finding the deepest point of deviation on the contour.

- **FINGRETIP DETECTION (COLOR TAPE)**

We estimate the locations of the user's fingertips (in image-space) based on geometrical features of the contours and regions obtained. Detect the locations of the user's fingertips. Detect whether any fingertips are in contact with the tabletop.

- **TOUCH DETECTION**

We are given as input the estimated positions of the user's fingertips and must output which of those tips are estimated to be in contact with the keyboard mat. We used a technique called shadow analysis. For Keyboard Mapping Touch Point to Keystrokes- In this we map touch to keystroke and recognized the character. For Mouse Tracking and Finger Detection – We are tracking and counting the no of finger. Gesture Recognition - Click gesture – Single click, Double click Keystroke-Send the keystroke to operating system.

VII. HARDWARE AND SOFTWARE DETAILS

- **Hardware used in project are:**

  - Laptop with Operating system: Windows 10, with 8GB RAM used (4GB preferable)
  - Processor required intel i5 10 gen or above
  - Webcam:
  - Web cam is used to capture and recognizes an object in view and tracks the user's hand gestures using computer vision techniques. As input, it sends the data to system.
  - Technology used - Python,Python libraries
  - The camera acts as digital eyes seeing what the user sees. It also tracks the movement of hand.

- **Software used in project are: -**
- IDLE (Any)

  - **Library used in project are: - cv2:**
  - Capturing video using OpenCV NumPy:
  - NumPy is a Python library **used for working with arrays**. Imutils:
  - A series of convenience functions to make basic image processing functions such as
  - translation, rotation, resizing, skeletonization, and displaying Matplotlib images
  - Easier with OpenCV and both Python 2.7 and Python 3. Json:

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- Python has a built-in package called json, which can be used to work with JSON data.
- It's done by using the JSON module, which provides us with a lot of methods which among loads () and load () methods are going to help us to read the JSON file.

Pyautogui: Pyautogui is a library that **allows you to control the mouse and keyboard to do various things**. It is a cross-platform GUI automation Python module for human beings. **Wx: :** Python provides wxpython module which **allows us to create high functional GUI.**

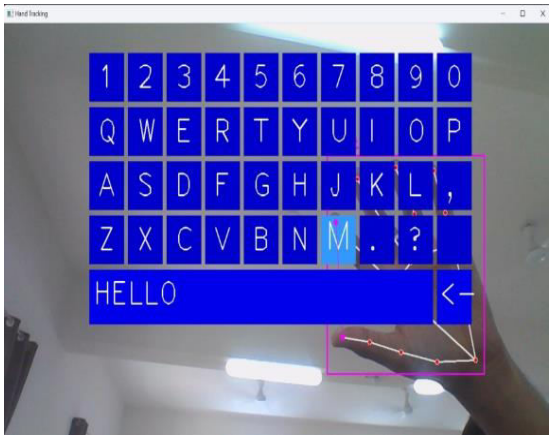
VIII. ALGORITHM USED GESTURE-CONTROLLED VIRTUAL KEYBOARD

- The primary aim of the proposed Hand Gestures-based Virtual Keyboard system is to allow users to control mouse cursor and keyboard functions through eye movement and hand gestures, respectively, instead of using a physical mouse or
- Keyboard. This system is developed on the machine learning domain, using open CV libraries with Haar cascade algorithm and MediaPipe framework.
- The Haar-cascade algorithm is typically used for protest detection, especially in identifying faces, people on foot, items, and outward appearances in an image, and is primarily utilized for face detection.
- To train a cascade function, the Haar cascade uses a Machine learning method that requires a large number of positive and negative images. In feature extraction, it employs training data to identify features, where the Haar cascade features are rectangular frames that traverse across pictures to match features.

```
import cv2
import pygame
from time import sleep
from cvzone.HandTrackingModule import HandDetector
from pynput.keyboard import Key,Controller
import subprocess

pygame.mixer.init()
cap = cv2.VideoCapture(0)
cap.set(3, 1200)  # Width
cap.set(4, 800)  # Height
detector = HandDetector(detectionCon=0.8)
hover_sound = pygame.mixer.Sound("KBSOUND.wav")
keyboard = Controller()

class Keys():
    def __init__(self,pos,text,size=[80,80]):
        self.pos = pos
        self.text = text
        self.size = size
```

```
    def draw(self,img):
        x,y = self.pos
        w,h = self.size
        cv2.rectangle(img,self.pos,(x+w,y+h),(204, 0, 0),cv2.FILLED)
        cv2.putText(img,self.text,(self.pos[0]+20,
                    self.pos[1]+60),cv2.FONT_HERSHEY_PLAIN,4,(255,255,255),2)
        return img

keyboard_layout = [
    ['1','2','3','4','5','6','7','8','9','0'],
    ['Q', 'W', 'E', 'R', 'T', 'Y', 'U', 'I', 'O', 'P'],
    ['A', 'S', 'D', 'F', 'G', 'H', 'J', 'K', 'L', ','],
    ['Z', 'X', 'C', 'V', 'B', 'N', 'M', '.', '?', ' ']
]
```

IX. DESIGN AND IMPLEMENTATION OF GESTURE CONTROL



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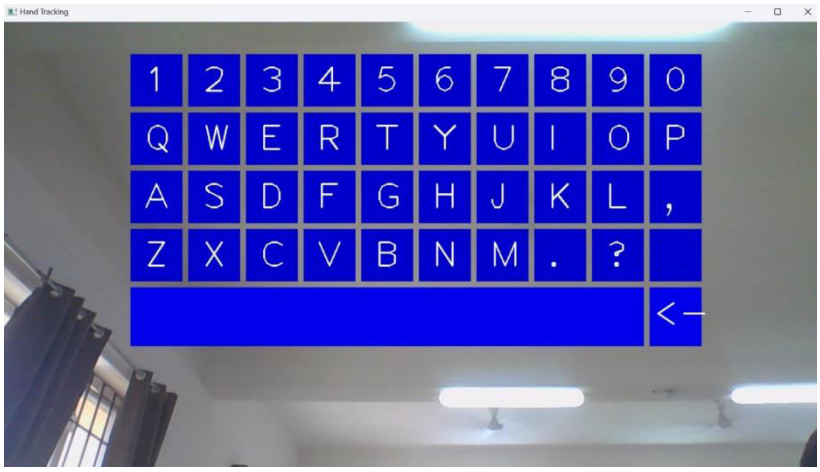

Fig : Systematic Gesture-Controlled Virtual Keyboard using OpenCV for Specially-Abled

X. CONCLUSION AND FUTURE SCOPE

In this study, a virtual mouse application based on object tracking was developed and implemented using a webcam and the Python programming environment with OpenCV libraries. This technology has numerous applications in areas such as augmented reality, computer graphics, gaming, prosthetics, and biomedical engineering. We created a system that takes in inputs from colored fingertips movements on the screen to control the mouse cursor, captured in real-time through a camera. We have to make pinch gesture on the screen to open file and applications/software. The results indicate that if the vision algorithms can perform well in a range of environments, our system will function more effectively, potentially improving presentation experiences and reducing workspace. Our aim was to create this technology as affordably as possible, while also ensuring compatibility with a standardized operating system, with the potential to aid patients who lack mobility in their limbs. The overarching goal was to develop a virtual mouse and keyboard using hand gesture recognition and image processing to control the movement of the mouse pointer according to hand gestures.

Our future goal is to integrate voice recognition into the keyboard for better convenience. The project's upcoming work will focus on enhancing the Fingertip Detection module to be insensitive to variations in lighting and determining the 3D posture of the panel for the purpose of augmenting 3D objects in reality. In the future, we will make use of other graphic features, like the character shape and icon feature, in the human-computer interface to identify touch events on the projected screen. Our future plan includes adding more functionality such as expanding and reducing windows, closing windows, and so on, by utilizing the palm and multiple fingers.

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