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AIR BOARD – A VIRTUAL BOARD

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ABSTRACT

The project provides the user a platform through which he/she can sketch along while talking on a video without transferring to an external white board software. Air Board is a virtual user interactive environment providing the means for a speaker to simultaneously demonstrating subject like a black board scenario but in a 3d live space which the system mimics and draws accordingly on the image. Most standard input devises like joysticks, keyboards, trackballs, and light pens do not imitate natural hand motions such as drawing and sketching. During this pandemic period the field of teaching and training has evolved vastly and thus this project would be very useful to the speakers to express his subject by writing of drawing about it while speaking. His fingers or a pen is chosen as a target and its movement is traced along to draw what he needs.

I. INTRODUCTION

Air Board is an interactive environment providing the means for a speaker to simultaneously demonstrate subject like a black board scenario but in a 3d live space which the system mimics and draws accordingly in the video stream using hand detection and gesture classification. With the emergence of virtual and augmented reality, the need for the development of natural human-computer interaction (HCI) systems to replace the traditional HCI approaches is increasing rapidly. In particular, interfaces incorporating hand gesture-based interaction have gained popularity in many fields of application automotive interfaces human activity recognition and several state-of-the-art hand gesture recognition approaches have been developed. However, hand motion gestures as such are not sufficient to input text. This necessitates the need for the development of touch-less air-writing systems which may replace touch and electromechanical input panels leading to a more natural human-computer interaction (HCI) approach. Therefore, to make our system more general and user-friendly, we use video inputs from a standard laptop camera or a web-cam for the air-writing application. This makes the task even more challenging due to the presence of the face in the video frames, which being a moving object of similar skin tone as the hand, makes the detection of the hand and hence the fingertip much more complicated. Fingers chosen as a target and its movement are traced along to draw what one needs. Object tracking is considered as an important task within the field of Computer Vision. The invention of faster computers, availability of inexpensive and good quality video cameras and demands of automated video analysis has given popularity to object tracking techniques. Generally video analysis procedure has three major steps: firstly, detecting of the object, secondly tracking its movement from frame to frame and lastly analyzing the behavior of that object. For object tracking, four different issues are taken into account; selection of suitable objects representation, feature selection for tracking, objects detection and object tracking. In real world, Object tracking algorithms are the primarily part of different applications such as: automatic surveillance, video indexing and vehicle navigation etc. Another application of object tracking is human computer interaction for computer vision like our Air Board for virtual writing using hand detection and tracking.

II. METHODOLOGY

Our proposed system's main purpose is to provide better and user-friendly environment for writing in air while on video stream using a standard laptop camera or a web-cam for the video input, in order to interact with the users on the other side, which may be naïve to understand the things by just hearing it. The task is fairly difficult due to several factors such as hand shape deformation, fingertip motion blur, cluttered background and variation illumination.

Proposed System

To address the aforementioned challenges, our work makes the following contributions:

We propose a new writing hand pose detection algorithm for the initialization of air-writing using the Mediapipe framework of Google for accurate hand detection followed by hand segmentation and finally counting the number of raised fingers based on geometrical properties of the hand. In this media pipe module, for hand pose detection, we basically follow two major steps:

- First is to detect a palm, in front of the camera.
- Next is to calculate and drop the hand landmarks in the video stream.

This entire application is built fundamentally on contour detection. It can be thought of as something like closed colour curves on compromises that have the same colour or intensity, it's like a blob.

In this project we use colour masking to get the binary mask of our target colour pen, then we use the contour detection to find the location of this pen.

When we work with it then it is a matter of literally connecting the dots, we just have to draw a line using the x, y co-ordinates of the previous position of the pen with new x, y dots and that's how we get our Air Board. Below is a flowchart of how we are integrating all of it to come up with a solution as mentioned earlier.

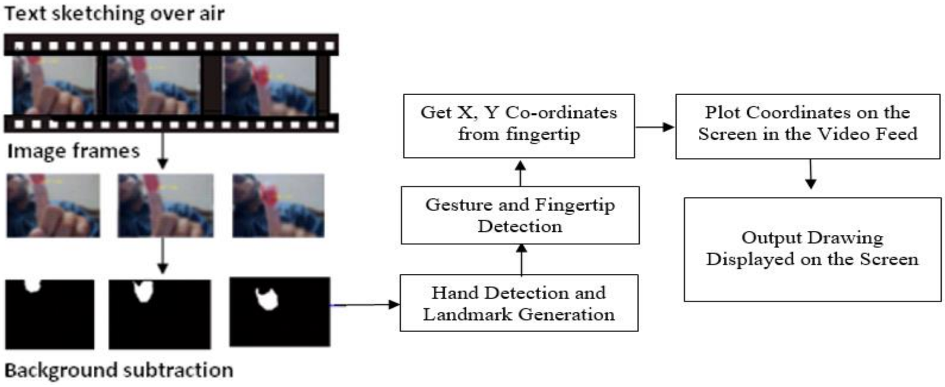

Figure 1: Flowchart of the Proposed System

Pose Classification

As our main purpose is to provide a user-friendly system, so we needed some generalized and simple hand poses that is easier for the user to make and system to recognize. That's why we came up with a set of gestures i.e.

1. Index finger – To Draw/Erase
2. Index + Middle Finger – To Select out of other colors or eraser.
3. Index + Middle + Ring Finger – To Increase the font/eraser size.
4. Thumbs down – To Decrease the font/eraser size.

Now, once we have the hand landmarks, then we start with checking out which of the following condition is set true. This becomes an easy task, as we can check that based on the cords of the hands. And eventually it turns out so quickly on the output screen that it gives a sensation of real-time drawing similar to a classroom whiteboard scenario.

III. MODELING AND ANALYSIS

In order to deliver a quality product, we tried to integrate some open-source tools that is available in the current market. The whole project is made up using Python programming language. First of all, for video capturing and image-frame processing we imported OpenCV module of Python. Then comes the hard task that is the hand detection, things got really simpler, as we came across the Mediapipe open-source framework of the Google; this helped with the hand detection and landmarks recovery from the image-frames.

Mediapipe's hand detection approach basically focuses on 2 important aspects:

• Palm Detection

Detecting hand is rather a complex task, than detecting a face, as face contains high contrast patterns near eyes, mouth. So, it tries to train a palm detector instead, since estimating bounding boxes of objects like palms and fists is very simpler than detecting hands. And finally using it we get a precision of about 95.7% for detecting a hand within an image frame.

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• **Hand Landmark Recovery**

After the hand detection over the whole image-frame, its subsequent hand landmark model performs precise key-point localization of 3D hand coordinates inside the detected hand regions with the help of regression models, that is direct coordinates prediction for 21 hand-knuckle landmarks. These are as follows:

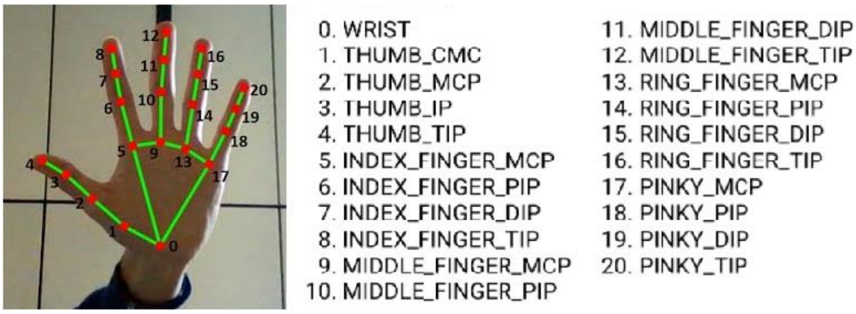

Figure 2: Hand Landmarks.

Altogether the Media Pipe Hand Tracking Flowchart [Figure 1] works in its entirety to give the hand landmarks as the output. Later on, for the public usage, we integrated the entire previously developed OpenCV application with a Flask framework of Python3 and now the results can be visible on the web app. To make life much simpler and to reach it out to maximum audience only thing left is to deploy over a cloud platform.

IV. RESULTS AND DISCUSSION

As per the discussions made above, when finally implemented putting all the things together, we finally get our system fully functional been ready for testing. Later on, we test it based on various scenarios and we find that it passes in all test cases including hand detection and changing mode based on the classification performed over the hand poses of the user. And thus, we can say that the system is ready to be used as a virtual board aka Air Board.

Figure 3: Hand Detection.

Figure 4: Writing Mode.

Figure 5: Selection Mode.

V. CONCLUSION

We described the system architecture for a virtual reality interface for interactive sketching. The system (AirBoard) exploits characteristics of hand gesture recognition and sketching. In the proposed system, we presented a new framework for the recognition of mid-air finger writing using web-cam video to pass on the input. We have utilized the media pipe module in an efficient manner, such that we are able to propose a new writing hand pose detection algorithm for the initialization of air-writing. Extensive experiments on our proposed system revealed the superior performance of the fingertip detection and tracing approach over state-of-the-art trackers while achieving real-time performance in terms of frame rate. More robust fingertip detection techniques can also be explored to perform the overall task at a much more pocket friendly rate for the user.

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