VIRTUAL AI BOARD

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Abstract **- In the era of the digital world and virtual classrooms, the traditional art of writing is being replaced by digital writing. It requires the use of a keyboard, touch-screen surface, digital pen, stylus, using electronic hand gloves, etc. Despite the availability of many teaching tools (online whiteboard), the need for technical setups like touch screen supporting PCs is high, which is also quite expensive. To solve this issue, we come up with virtual writing using object tracking. In the field of Computer Vision, Object tracking is one of the important technique. The invention of faster computers, availability of inexpensive and good quality video cameras, and demands of automated video analysis have given popularity to object tracking techniques. The project takes advantage of the above-mentioned technique and focuses on developing a virtual AI board, which is an effective teaching tool to illustrate concepts accurately. This AI board uses hand gesture recognition and hand landmark tracking with the use of machine learning libraries like OpenCV and mediapipe in python programming.**

Keywords**: Video Capturing, Hand landmark tracking, OpenCV, mediapipe, Masking, Virtual writing, Drawing tools, alpha blending.**

I.INTRODUCTION

The interaction between human and computer became a very huge concern as technology seemed to change all over the years. Writing with a finger on a touch-based interface is intuitive because it follows the metaphor of traditional writing. Recent advances in object tracking technology make it possible to track hand and finger motions without user-worn devices like data gloves, LED light, markers, etc., and additional peripheral devices like Kinect sensors, LEAP motion controllers.

The main objective behind the invention of finger tracking systems is centered around the idea that computers must be made easier to use and to operate using natural language and gesture interactions. In a typical computing system, the keyboard and mouse stood as prime devices to input information into the system.

Virtual writing provides a viable alternative interface for touch-sensitive devices that are not available or affordable. Compared with other digital writing methods, virtual writing avoids the usage of external devices by replacing them with computer vision and hand gesture recognition that enables natural communication between user and computer through natural movements.

In this paper, we propose a system for virtual writing that recognizes the user's hand and tracks hand landmarks for providing the user with gesture control features. To enable controlled writing, we used hand landmarks of index and control fingers. It includes some additional inbuilt drawing tools to illustrate concepts effectively.

II. RELATED WORK

The accuracy and control flow of hand tracking is critical for real-time interactive applications. LED-based air writing has been proposed to support finger movement tracking [3]. However, wearing an LED light might feel uncomfortable for a long session of interaction.

Kinect-based finger-writing character recognition system [2] allows people to input characters by writing in the air virtually. It deals with the hand segmentation model, which takes advantage of depth, colour, and

motion information. Even though the fingertip detection is less sensitive to noise along the segmented hand contour, but it can handle only hand poses.

Leap [1], a small USB peripheral device, is designed to track fingers (or stick-like objects such as a pen or a chopstick) precisely in a desktop environment. The smaller tracking volume and higher resolution of Leap differentiate itself from Kinect, which is designed for body and face tracking in a living room-like environment. The use of external peripheral devices like LEAP motion controllers are quite expensive than a system camera/ webcam.

Controller-free tracking creates an user interface that gives a good workflow. Using computer vision and its modules or libraries can help us develop real-life applications in the field of machine learning and can also improve efficiency and consistency in our day-to-day work.

Virtual Sketch [5], enables the user to draw by using OpenCV to capture the motion of a coloured marker with a camera. An object at the tip of the finger is mainly used as the marker. The object tracking and detection processes are used to track the coloured marker. In our proposed system, we have eliminated the use of additional peripheral devices by replacing them with OpenCV and mediapipe which includes palm detection and hand landmark tracking models.

III. PROPOSED SYSTEM

The proposed virtual writing system consists of two main parts. First part involves hand recognition and landmark tracking, and the second part takes care of image processing.

A. Hand recognition and landmark tracking

Virtual AI board tracks hand and hand landmarks using mediapipe. MediaPipe Hands utilizes an ML pipeline consisting of multiple models working together. A palm detection model processes the given frame and returns the frame with recognized hand. This processed frame is fed as input to the hand landmark model which processes the recognized hand to localize the 21 3D hand-landmark coordinates and returns the frame with recognized hand landmarks.

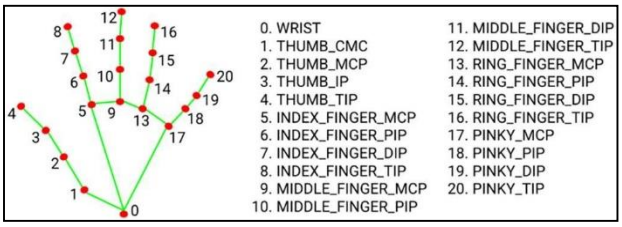

Figure 1. Hand landmarks

B. Image processing

Alpha blending technique is used to embed tool image on the frame window. In this process, we combine two images by specifying the opacity to create an embedding appearance.

Image masking is a technique that performs AND of the values for each pixel of the input images src1 and src2.

Figure 2. Alpha blending of tool image with frame window

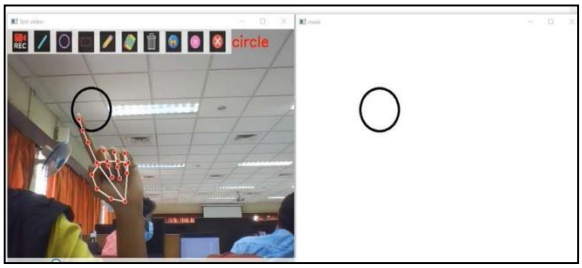

Figure 3. Masking of frame and mask window

IV. SYSTEM METHODOLOGY

A schematic diagram (fig 3.1) of the virtual AI board represents the data flow and explains how the functionalities connect each other.

A. Capturing video from camera

Live Streaming Video is captured frame by frame from the camera and it is flipped horizontally. These frames are color converted to RGB and fed as input to the hand recognition model.

B. Hand gesture recognition

This module recognizes the user's hand and its landmarks from the given input image. They are used to provide control features like selection of tools and performing the respective function etc.

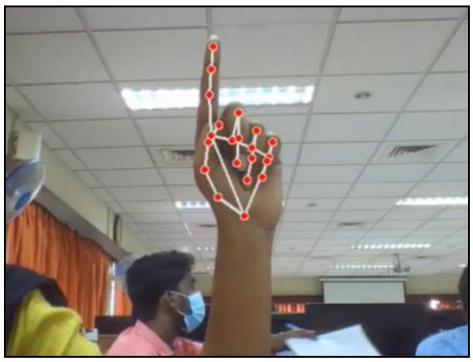

Figure 4. User hand with traced hand landmarks

C. Image processing

User can select the tool given on the tool image which

is embedded onto the frame window using alpha blending technique. According to the selected tool, the respective operations are performed on the frame window followed by image masking to copy the contents of frame window on mask window (White board).

D. Drawing tools

Drawing tools provided are listed as follow consists of line, circle, rectangle, draw, all-clear, play, pause, save, record, erase, and exit.

User selects the tool using the tip of his/her index finger. Once the tool gets selected, the user may drag their hand to the desired initial position and raise his/her

control finger to perform defined function which is checked with the help of **control function**. The control function takes the coordinates of landmark [8] and landmark [9] shown in figure (1) as input and returns the Boolean value which is used to check whether the control finger is raised or not.

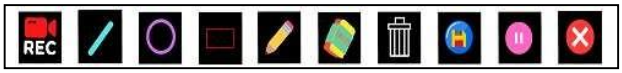

Figure 5. Tool image

V. WORKING

Virtual AI Board allows the user to recognize hands and tracks hand landmarks to write virtually. Streaming Video is captured frame by frame from the camera and fed as input to the hand recognition model. This model processes the image and returns the recognized user hand and its landmarks from the given input image. These hand landmarks are used to provide virtual control over the application interface.

The user should use the tip of index finger to select the tool from the tool image embedded on the frame window using alpha blending technique. Once the tool gets selected, the user may drag their hand to the desired initial position and the user needs to raise his/her control finger to draw. The user could only be able to draw on the frame window and thus to display the drawn content on mask window, image masking of both windows is

done simultaneously.

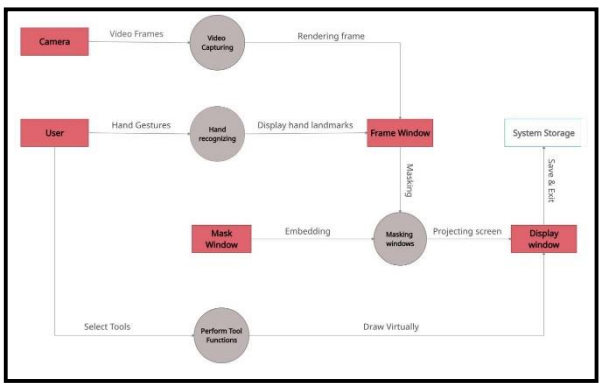

Figure 6. Data flow diagram

VI. SYSTEM IMPLEMENTATION

This project is implemented in Windows 10(64-bit Operating System). The supported devices are Desktop with webcam or a laptop with inbuilt camera. Python programming language is used for implementation purpose, since it has wide range of machine learning modules. Jupyter notebook is the environment used. In this project, we have used various library available in Python. Module cv2 is used for computer vision, mediapipe for Hand gesture recognition, PIL for image processing, img2pdf for conversion of .jpg file to .pdf file and os module for file handling.

VII. EXPERIMENTAL RESULTS

After successful running of the program, two windows frame and mask are created and displayed to the user. Lecture notes and recordings are saved in the local storage successfully for reference purposes.

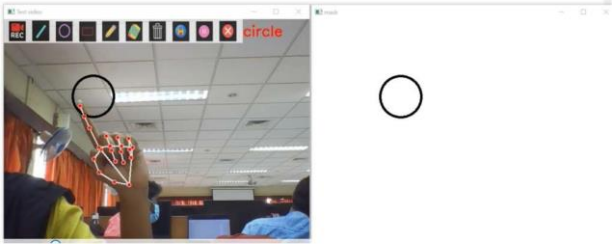

Figure 7. Draw circle

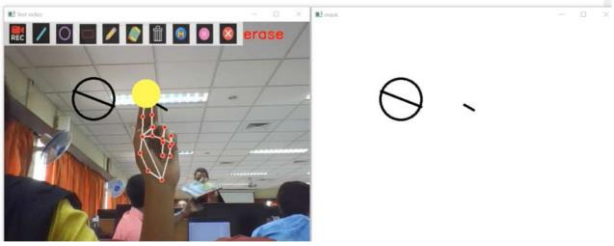

Figure 8. Erase contents

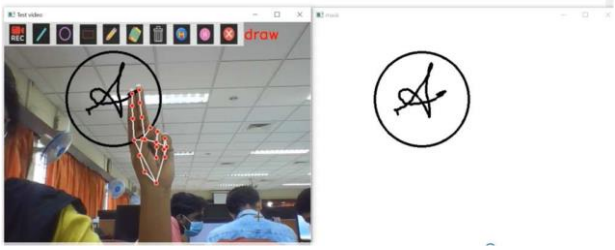

Figure 9. Free handwriting

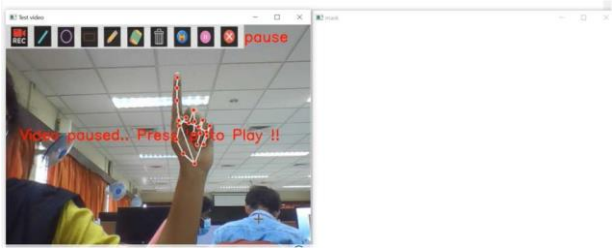

Figure 10. Pause Video stream

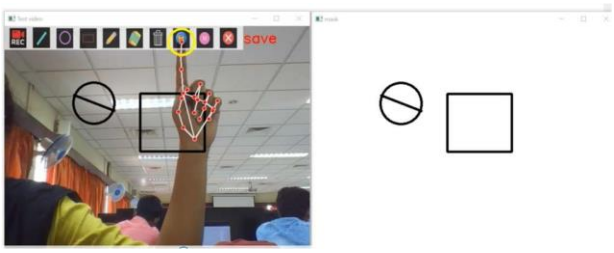

Figure 11. Capture screenshot to save notes

VIII. CONCLUSION AND FUTURE WORK

In this project, we attempted to develop controller free air-writing method that uses hand landmarks, which can be used as an alternative for touch-based interfaces, especially when touch features are not available in the user's system. Developing this system, we provided a very simplified and economic solution for virtual writing using computer vision which is one of the emerging fields of research in the domain of Gesture Recognition. It is developed in such a way that a simple Webcam is sufficient to identify and track the user hand to draw virtually. The proposed system was implemented in a way such that it can only record video lectures without audio. Hence furthermore we need to provide adaptive support to both audio and video data streaming simultaneously at a very low latency. As a future work, efforts can be taken to improve the system in live streaming using web sockets.

IX. REFERENCE

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