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VIRTUAL BOARD: AIR CANVAS USING OPENCV AND MEDIAPIPE

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Abstract
Air Canvas is a virtual drawing canvas to illustrate your imagination in the air. It makes use of the camera, OpenCV and media pipe libraries to detect and identify the hand gestures. The fingertip of the user is considered as the brush or as the drawing tool that is used to illustrate or write on the canvas. The drawing tool or brush width can be adjusted and the color of the brush can also be changed by moving the cursor over and selecting a color from the toolbar at the top. The aim of air canvas is to use the it as virtual board for teaching and business conferences. Air canvas aims to enhance traditional writing methods by utilizing object tracking, hand gestures, color detection, and segmentation techniques to track finger movements and capture the movement of the colored marker using the camera. The colored object at the fingertip is used as the marker, allowing the system to trace the movement and create digital text or illustrations.

Keywords: Virtual Board, Air Canvas, Python Virtual Canvas, Object Tracking, Gesture Recognition, OpenCV, MediaPipe Artificial Intelligence, writing in air

I. Introduction

Writing serves as a potent medium of communication, allowing individuals to articulate their thoughts and concepts. In contemporary society, writing and typing have emerged as the prevalent means of documenting information. In recent times, scholars specializing in image processing and pattern recognition have delved into the captivating and intricate realm of air writing. This innovative technology holds substantial promise in streamlining automation processes and enhancing human-machine interactions across diverse applications. Advancements in computer technology, coupled with the increasing affordability of high-quality video cameras, have propelled the popularity of object tracking techniques, particularly in automated video analysis. With the advent of sophisticated devices like gesture recognition systems, individuals can now effortlessly control machines and engage in air writing or drawing without physical device contact.

Air Canvas is a virtual drawing canvas that enables users to draw and write without using their hands. The system relies on camera and uses OpenCV and Media pipe libraries are used to detect and track hand gestures. The finger acts as a brush or pen, allowing users to modify the size and color of the brush by hovering over built-in buttons located at the top of the screen. In addition to drawing and writing, the system can also generate text for various purposes, such as sending messages and emails. Air Canvas has the potential to revolutionize communication for the deaf and reduce the use of mobile and laptop devices. The system is built using OpenCV, a computer vision library, and can be developed in any programming language that supports OpenCV. Fingertip detection and finger movement techniques are used to develop the system. By tracing the fingertip trajectory, the system can draw anything on the screen based on the user's finger movements.

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II. Literature

The integration of technology has brought about a transformative impact on the field of education, reshaping traditional learning methods and fostering new avenues for knowledge acquisition and interaction. In recent years, the development of virtual learning environments has provided students and educators with innovative approaches to education. Although the research on air canvas was relatively limited until 2018, subsequent advancements in Artificial Intelligence have led to numerous contributions in this domain and few of them have been closely reviewed.

In a recent study conducted in 2022, Rai, Gupta, Dsouza, and Jadhav [1] introduced a virtual canvas system that leverages OpenCV for gesture recognition and processing. The study demonstrated the feasibility of the system and provided a technical description of its implementation. Users can utilize hand gestures to draw on the virtual canvas, and the system incorporates features such as color selection and brush size adjustment.

Another research paper published recently in 2022 by Kumar, Vaishnavi, Gayatri, Prashanthi, and Supriya [2] details an air writing recognition system that employs MediaPipe and OpenCV for gesture recognition and processing. The paper includes a feasibility study and implementation details of the system. Users have the ability to write in the air using finger gestures, and the system accurately recognizes and displays the written text on a computer screen.

III. Proposed Model

The proposed system utilizes the Mediapipe framework to perform hand tracking, which involves detecting hand landmarks and deriving positional data from them. The system consists of several modules, including colour tracking, trackbars, contour detection, frame processing, and algorithmic optimization.

The colour tracking module leverages the HSV shading space to track a small coloured object at the fingertip, which is achieved by converting the incoming image from the webcam into the HSV colour space. The trackbars are used to obtain real-time values and create a range, which is then passed to the cv2.inrange() function to generate a binary image of the desired colour.

The frame processing module tracks the fingertip and generates points at each position for an air material effect, allowing users to draw in the air. Finally, the algorithmic optimization module ensures that the program runs smoothly and efficiently.

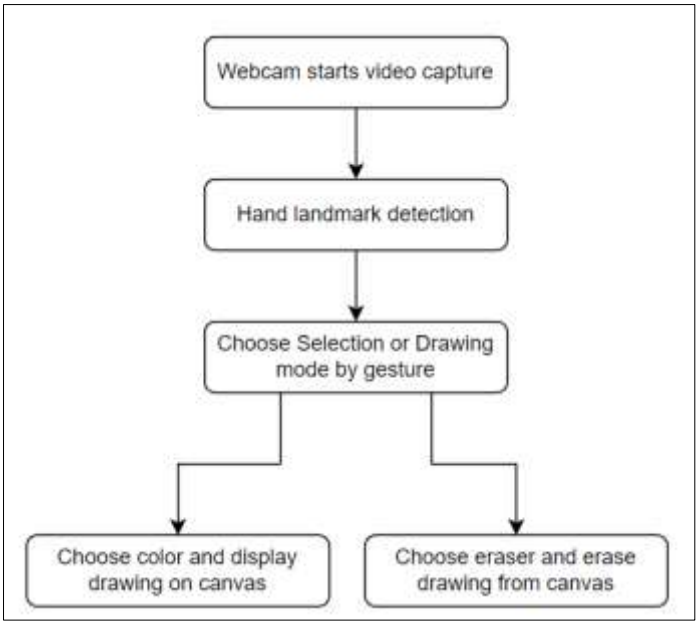

Figure 1: Flow of proposed model

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1. Webcam starts video capture

When you launch the "Air Canvas" application, it activates your webcam to start capturing video. The video capture object of OpenCV library is initialized to access the webcam. The video captured image is flipped to easily adjust to the mirror image on the canvas. Video will be displayed along with the toolbar on the canvas and the movements will be captured once the application is launched.

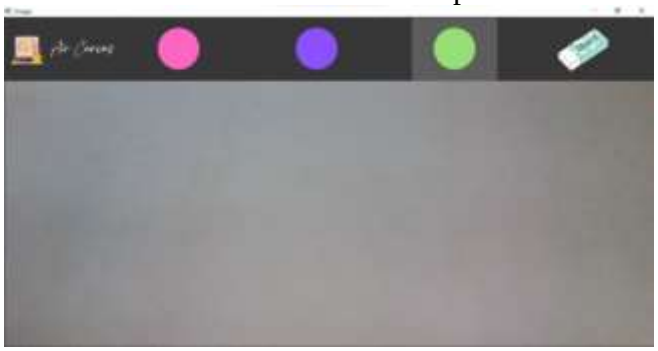

Figure 2: Canvas

2. Hand Landmarks Detection

Advanced computer vision algorithms like MediaPipe and Hand Tracking Module are employed by the application to detect and track specific points on the hand, such as fingertips, palm, and joints. This enables accurate analysis of hand movements. Hand Tracking Module helps to detect the hand and then draws landmarks. These landmarks are numbered and can be useful for gesture detection.

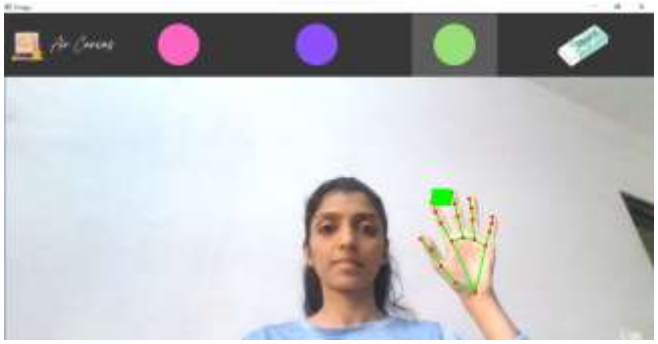

Figure 3: Landmark Detection

3. Choose Selection or Drawing mode by gesture

The application incorporates gesture recognition techniques, leveraging detected hand landmarks. The system identifies distinct hand movements to seamlessly switch between the "Selection" and "Drawing" modes. The position of the fingers that are up are determined using landmarks. If the index and the second finger are up, it is Selection mode. If only the index finger is up, it is Drawing mode. Selection mode enables user to select any option from the toolbar and drawing mode allows user to draw a line from current position to new points where finger is moving.

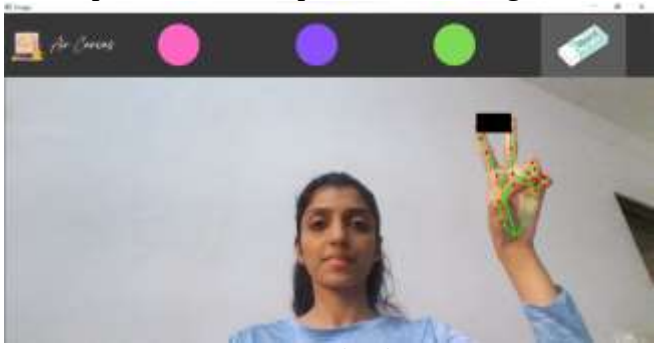

Figure 4: Mode selection

4. Choose colour and display drawing on the Canvas

Within the "Drawing" mode, the application employs computer vision algorithms to track the position of the user's fingertip and the colour selected from the toolbar. By extracting colour information through image processing, the chosen colour is used to draw coloured points freely on the canvas. The program then overlays these strokes onto a virtual canvas by blending them with the real-time video feed.

Figure 5: Illustration

5. Choose eraser and erase drawing on the Canvas

Air Canvas application enables users to switch to the erasing mode by using the selection mode from the toolbar and clicking on the eraser icon. It draws a transparent line when the finger moves thus erasing coloured points. By processing the video frames and selectively removing corresponding drawings from the canvas, the application creates the effect of erasing unwanted strokes.

Figure 6: Erase functionality

IV. Results and Discussion

The proposed system introduces significant advancements and improvements in the domain of interactive learning and computer vision-based writing applications. While previous studies such as [1] and [3] focused on developing virtual canvases and interaction through computer vision air canvas, respectively, our research paper combines the strengths of both approaches by leveraging the capabilities of OpenCV and MediaPipe. This integration results in a more robust and versatile virtual canvas solution, offering enhanced interactivity and user experience.

It overcomes the challenges faced in air writing recognition techniques presented in [2] by employing advanced algorithms and techniques. By utilizing these advancements, we have achieved higher levels of reliability in the recognition system. In comparison to [4], which introduced a virtual air canvas using OpenCV and MediaPipe, our research paper goes beyond the existing work by introducing innovative features that enhance the overall user experience and interaction capabilities.

The study extends the scope of previous work, such as [5], which focused on paint/writing applications through a webcam. In contrast to [6], which proposed a simple approach for scripting in air and display using computer vision, our research paper builds upon this concept by introducing more sophisticated techniques and optimizations. As a result, our solution offers improved

performance and usability. The system differentiates itself from [7] by providing a comprehensive digital writing platform that surpasses the limitations of a traditional virtual board.

Table 1: Comparison table

Paper	**Distinct Feature**	**Challenges mitigated**
[1]	Higher reliability	Limited usability
[2]	Advanced algorithms and techniques	-
[3]	-	Limited usability
[4]	Enhanced experience	-
[5]	-	-
[6]	Sophisticated techniques, enhanced usability	-
[7]	-	Surpasses limitations of a traditional virtual board
Proposed system	Robust virtual canvas, enhanced interactivity, and improved user experience	Surpasses existing virtual air canvas, innovative features, improved usability

V. Conclusion

The system significantly contributes to the field of interactive learning and computer vision-based writing applications. By integrating existing approaches and introducing novel features, our solution offers a robust and versatile virtual canvas platform. Leveraging the capabilities of OpenCV and MediaPipe, we have enhanced interactivity and user experience. This platform creates an immersive and engaging experience, fostering interactive and dynamic learning environments for both instructors and students.

Through the introduction of sophisticated techniques and optimizations, we have improved the performance and usability of our solution, surpassing the simplicity of previous approaches. It goes beyond the conventional virtual board, offering advanced features tailored for effective teaching and learning. The proposed system represents a significant advancement in the realm of interactive learning and computer vision-based writing applications.

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