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Whiteboard Application Using Machine Learning Model

Mr. V. Narasimha, K. Sandeep, V. Eshwar, Saba Zareen
UG Student, Department of CSE, CMR College of Engineering & Technology, Hyderabad, Telangana
Associate Professor, Department of CSE, CMR College of Engineering & Technology, Hyderabad, Telangana

Abstract: ***The Whiteboard Application Using OpenCV is a digital platform designed to replicate the functionality of traditional physical whiteboards while harnessing the capabilities of computer vision technology. This application allows users to draw, write, and collaborate in a digital space, enhancing remote communication, creative expression and interactive learning experiences. The application supports real-time collaboration, allowing multiple users to engage in synchronous drawing and annotation on a shared canvas. The integration of collaborative features promotes remote teamwork, virtual brainstorming, and interactive educational sessions. The application includes an undo/redo functionality that maintains a history of actions, enabling users to correct mistakes or explore different design iterations without limitations. The user interface (UI) is designed for ease of use and efficient navigation. The intuitive interface ensures that users, regardless of their technical proficiency, can seamlessly access and employ the application's features.***

Keywords: mediapipe, numpy, OpenCV, Python, Machine learning and Anaconda Prompt.

I. INTRODUCTION

The whiteboard application is used to train our laptop or our screen to read whatever the user will be writing Infront of the screen in the air and that will be displayed on it. We will use some of the machine and deep learning libraries which includes open cv algorithms and functions are used for various tasks related to image processing, computer vision, and user interface development.

To track the detected hand over time, we use various tracking algorithms, such as optical flow, deep sort, to estimate the motion of pixels between consecutive video frames, allowing you to monitor the hand's movement freely. Weal souse CNN algorithm to train dataset of hand motions images to recognize specific gestures. And a user interface which is like a software on which all this can be happen and usedby the end users. These traditional whiteboard software requires highly cost devices, Needs the latest device equipment which are not affordable to every user The primary goal of the project is to create software that prioritizes user-friendliness and affordability, ensuring accessibility and ease of use for variety of users. To provide a virtual teaching board platform that uses hand gesture recognition in air to write on screen. To make the teaching process more effective we developed different user interfaces with functionalities like selection and drawing, Selecting colors for writing and Eraser for erasing with the help of OpenCV, Media Pipe, NumPy libraries and Python in this Project. Hand movement recognition acts as a pathway for computers to interpret human body language, fostering a stronger connection between machines and humans. The user advocates for enhancing user- friendliness by enabling computer systems to be controlled using manual gestures. They use the application which involves the integration of advanced computer vision and machine learning techniques to recognize and interpret gestures, facilitating users in creating and manipulating digital content effortlessly through hand gestures. It features a user-friendly interface suitable for individuals of varying skill levels and utilizes libraries like MediaPipe, NumPy, and OpenCV for gesture recognition within a whiteboard application. We have to perform gesticulate at the forefront of camera so thatthe project can recognize hand moment with thehelp of mediapipe library.

II. RELATED WORK

This application tracks users hand movement from live web cam and use OpenCV colour features to track hand movement and implement draw, erase and write on screen features. The main objective of this The goal is to design an environment enabling freehand drawing in the air, leveraging a webcam to capture RGB images frame by frame. This system detects the fingertip, monitors its movements across the screen, and translates hand gestures into drawing actions each time the hand is within the camera's view.

This tool is created by utilizing several techniques and methodologies related to computer vision, hand tracking, and user interaction.

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A. *Hand Tracking*

It makes use of a hand tracking module to detect and track hand landmarks in real-time. This likely involves computer vision techniques, possibly based on Convolutional Neural Networks (CNNs) for hand landmark detection.

B. *User Interface Design*

The code implements a simple graphical user interface (GUI) that displays the webcam, the drawing canvas, and the selected header image The system's interface dynamically adapts and evolves in response to hand motions and user interactions, ensuring a seamless and responsive user experience.

C. *Gesture Recognition*

This recognizes hand gestures by analyzing the locations of specific landmarks on the hand. Different finger configurations are used to determine whether the user is in selection mode or drawing mode. This is achieved by checking the whereabouts of individual fingers.

D. *Drawing on Canvas*

The user can draw on the canvas using their hand gestures. It captures the hand position and user's input text is displayed on the canvas. Different colors and brush thicknesses are used for writing and erasing.

E. *Image Processing*

Some image processing techniques are used, such as converting the canvas to grayscale, creating an inverted binary image, and combining it with the original frame to achieve a drawing effect.

F. *Real-time Video Processing*

The code continuously captures frames from the webcam, processes the hand landmarks in real-time, and updates the display accordingly. This involves using OpenCV for video processing.

G. *Aim-based Classification*

The goal is to establish an open canvas for freehand drawing in the air, utilizing an RGB camera to identify and track the fingertip's movements across the screen whenever the hand is brought into view. To enhance real-time performance in tracking fingertip movements on the screen, we opt for the KCF tracking algorithm over the computationally intensive faster R-CNN handheld detector, which improves frame rates and overall tracking efficiency. Each frame is analyzed using the MediaPipe library to extract hand landmarks, numbered from 0 to 20, which serve as key points for hand pose identification. These landmarks are subsequently input into a pre- programming gesture recognition network to accurately recognize hand-gestures.

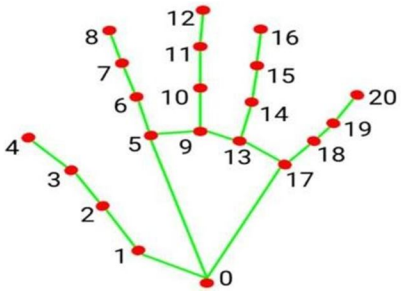
III. METHOD AND EXPERIMENTAL DETAILS

While testing the model, we first look whether it is recognizing all the hand landmarks when all the fingers are up and also ensure you have the "Header" folder containing header images in the same directory as your Python script. Each landmark have x, y & z. So to test, we use x & y co-ordinate to find information or to find location for the landmark on hand. Now we first use the two fingers, Index and Middle for selection mode by raising only these two fingers and assigning x1, y1 as lmList[8][1:] for Index finger and x2, y2 as lmList[12][1:] for Middle finger by which it can able to perform the selection. Similarly, when only Index finger is detected then it changes into drawing mode. Also testing how smoothly it is drawing on the screen.

1) *If Selection Mode:* In this step we test whether finger-tip values are detected and if they are two fingers up then selection process will start. User can select color from the header and each selection will have different colors and eraser.
2) *Drawing Mode:* For this we check whether index finger is up or not and find position of the finger and take input as color and draw on screen. This is shown in figure one which demonstrates the 21 hand points as identified by MediaPipe used for recognizing hand gesture. MediaPipe uses a single- shot palm detection model to recognize the region of the hand, after which it performs exact point localization of 21 3D palm coordinates within this area. These key points from zero to twenty play vital roles in identification of hand poses and are fed into pretrained gesture recognition network. The MediaPipe pipeline combines several models: a palm detection model responsible for extracting an oriented hand bounding box, and a hand landmark model designed for obtaining high-quality 3D key points on hands in the cropped image region.

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A. Training of the Model



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

Fig 1: Landmark Detection Table

SELECTION MODE

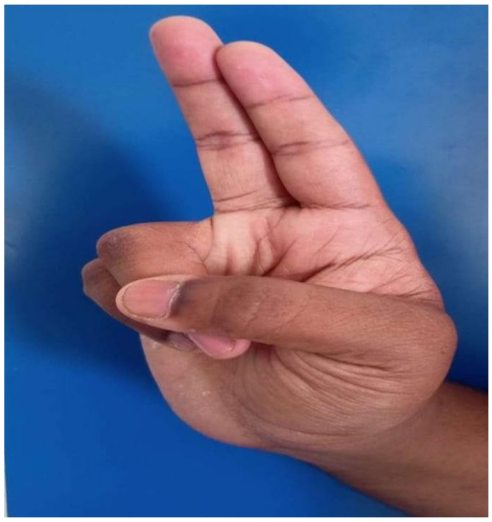


Fig 2: Using this hand gesture, we can select the toolbar.

DRAWING MODE



Fig 3: Using this hand gesture we can write on the screen. tools to

B. Erasing Mode

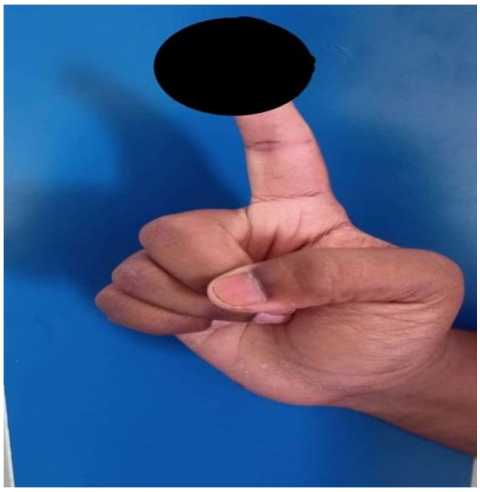


Fig 4: Using this hand gesture we can erase the drawings on the screen.

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IV. RESULTS AND DISCUSSION



Figure 5: Interface of the application

Figure 5 shows the Graphical User Interface of the application which includes a canvas on which our text will be displayed on writing, a header consisting of three different colors to choose for writing, an eraser to clear the text and a mode which displays selection or drawing based on the action performed.



Figure 6: Selection of the color

Figure 6 shows the selection of the color red by using two fingers index and middle, where that color gets captured and can access it for writing on the screen. Mode also displays selection as we are selecting from the header.

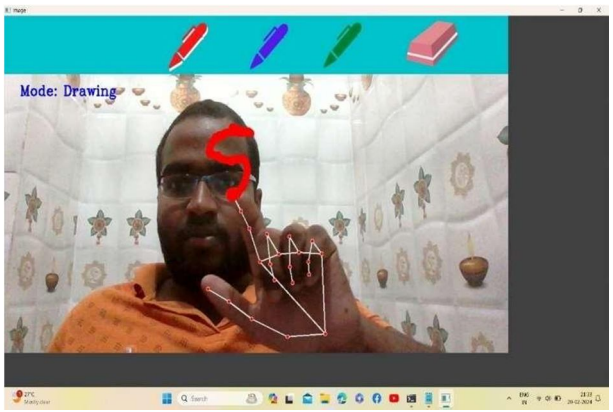


Figure 7: Drawing on the screen

Figure 7 shows the writing of the text based on our hand movements and this can done by using only index finger. Mode also displays drawing, as it detects the writings on the screen.

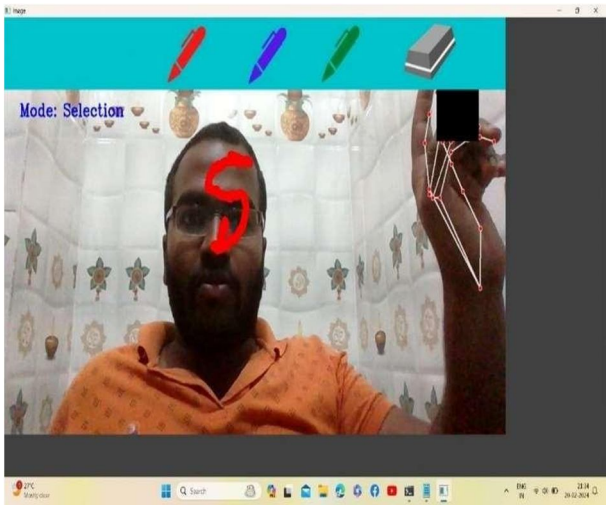


Figure 8: Selection of the eraser

Figure 8 shows the selection of the eraser to clear the written text on the screen. This also done similarly as show in the figure 6.

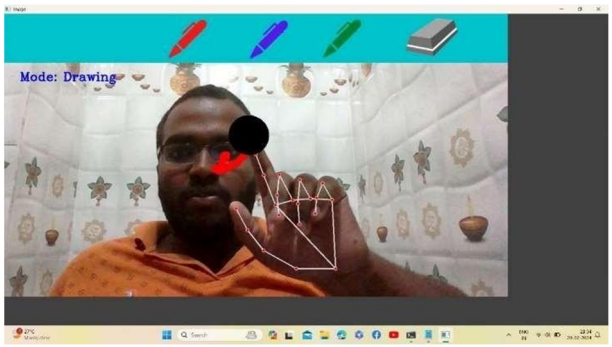


Figure 9: erasing the text

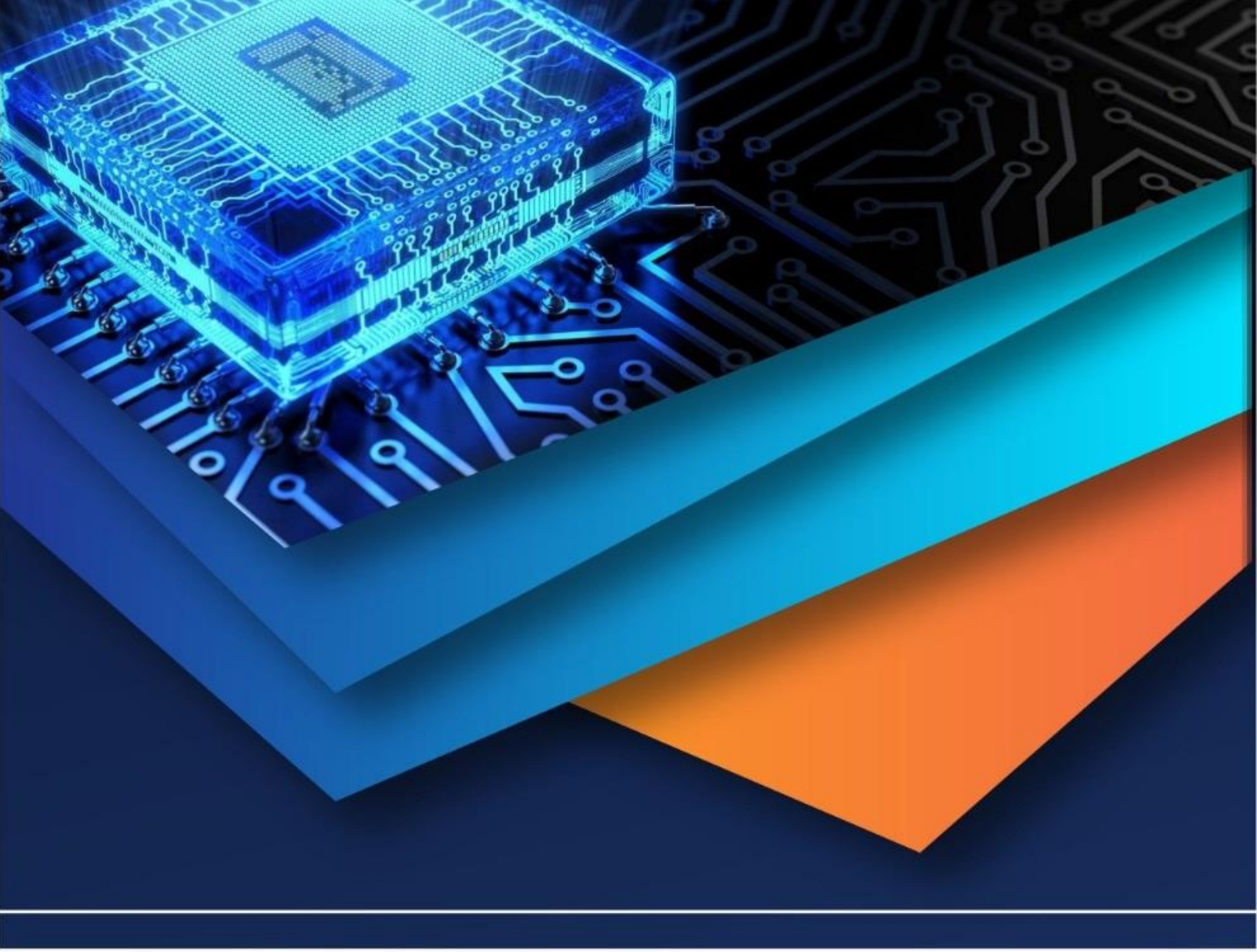
Figure 9 shows the erasing of text written on the display using only index finger and tip which shows black color indicates this erasing mode. Based on the movement of the hand on the text it starts erasing.

V. CONCLUSION

The Whiteboard application using machine learning model project provides an exciting and interactive canvas for users to express themselves, explore their artistic talents, and engage with technology in a creative way. By seamlessly combining hand tracking, gesture recognition, and various interactive features, this project offers a unique and enjoyable drawing experience, making it suitable for both entertainment and educational purposes. Whether used as a creative outlet, a tool for communication, or a gaming platform, this project promises to captivate users and immerse them in a world of digital artistry.

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