AIR CANVAS USING AI

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ABSTRACT:

People are using electronic devices like screens, where we can write, draw and represent various structures, symbols, arts, painting, etc. Either by using mouse or by typing. The project takes advantage of this gap and introduces a new system called the air canvas which focuses on developing a motion-to-text converter that can potentially serve as software for intelligent wearable devices which enables users to draw in mid-air using their hands. The system incorporates object detection techniques in OpenCV to track the hand position and allow real-time drawing. It will be a powerful means of communication for the deaf. All you have to do is think what you want to express or show, and then just move your finger accordingly. The existing project which allows us to draw using a stylus or pen this technology or methodology which takes a lot of process and time. Avoiding or decreasing these limitations we came up with this project that uses new technologies and easy methodologies like Mediapipe which is used to detect the hand gestures under the category of Computer Vision. We are using Python since it is easy to make use of the syntax and understanding the basics as well as it can be implemented in any OpenCV supported languages, NumPy to handle data related to strokes, shapes, or any other canvas elements and it can provide a convenient way to represent and manipulate image processing. Deque stores the strokes and make it visible in the canvas, Mask Window to mask the background and show the text. System Camera is used to track the hand and create drawings just by moving their fingers on the air in front of the camera in a certain distance according to what the user wants to express and this works by monitoring to determine the landmarks of hand, then the finger tips are taken for modes like selection, drawing and clearing the canvas.

KEYWORDS: -

Canvas, OpenCV, Python, Computer Vision, NumPy, Deque, Mask Window.

1. INTRODUCTION: -

Writing is an assimilated form of communication that can be used for expressing and exchanging ideas, information in a clear way. It is used for various purposes like sharing, collaborating, educating, Influencing, understanding other's needs. It can be done in many ways verbally, non-verbally or visually. Writing has a definite purpose and point, and it supports that point with specific information that is logically connected and arranged.

The objective of the "Virtual Air Canvas" project is to develop a system that utilizes OpenCV and Python to create a digital canvas where users can draw and interact with virtual objects using hand gestures, providing an innovative and immersive way of artistic expression and interaction with digital content.

The traditional form of writing is using pen & paper. Slowly we came into an era where `writing became more digitised where we use QWERTY keyboard. This keyboard has numbers, alphabets and symbols. Now this keyboard is given as an input device to a computer where an user is supposed to type whatever he wants to write and those writings will be displayed on a monitor. Now in this period we all widely use touch screens like smartphones, Tablets etc. Touch screens are devices which allow the user to move their fingers or stylus pen on its screen according to what he wants to express to give input to the system/device. Even after these, developments in Human-Machine interactions are needed because of the rapid growth in the usage of augmented and virtual reality.

Air Canvas is a digital drawing tool that allows users to create art using their free hand, without the need for physical pens or paper. In this Air Canvas the user is supposed to just think what he wants to create on the canvas and move their fingers on the air in front of the camera in a certain distance according to what the user wants to express.

Overall, the project is to bridge the gap between human actions, captured through a camera, and their translation into digital strokes, in real-time, with a focus on accuracy, adaptability to variations, and providing artists with a more intuitive way of creating digital art which makes use of innovative technology and straight forward techniques.

2. LITERATURE OVERVIEW: -

[1] "Finger Tracking for the Digital Desk**"** suggested a method in which Augmented segmented desk interface approach for interaction was proposed. This system makes use and a video projector and charge-coupled device (CCD) camera so that using the fingertip; users can operate desktop applications. In this system, each hand performs different tasks. The left hand is used to select radial menus, whereas the right hand is used for selecting objects to be manipulated. It achieves this by using an infrared camera. Determining the fingertip is computationally expensive, so this system defines search windows for fingertips.

[2] "Movement Recognition using LED" is a system with camera to detect the movement of LED fitted on the tip of the finger. System can recognize the pattern drawn on the screen by the LED. It comes with advantage of fast movement tracking and results are much accurate but the disadvantage is the LED must be red LED only and no other things like red LED present in front of camera rather than red LED.

[3-4] "Hand Recognition with Kinect Sensor**". "**Robust Hand Recognition with Kinect Sensor**",** Kinect sensor used for getting depth and colour information to detect hand movements. It is still a challenging problem to gesture recognition. Kinect sensor work efficiently with the large object but for tiny little object it may failed to work. The system proposed used the depth and colour information from the Kinect sensor to detect the hand shape. As for gesture recognition, even with the Kinect sensor. It is still a very challenging problem. The resolution of this Kinect sensor is only 640×480. It works well to track a large object, e.g., the human body. But following a tiny thing like a finger is complex.

[5] "Air Canvas Through Object Detection Using OpenCV in Python" the researchers have developed air canvas system consists of a hardware component and a software component. The hardware component includes a stylus that can be detected by a camera mounted above the canvas. The software component uses OpenCV to process the video stream from the camera and detect the position of the stylus in real-time. To detect the stylus, we use object detection techniques in OpenCV. We train a Haar Cascade classifier to detect the stylus in the video stream. The classifier is trained on a set of positive and negative samples of the stylus and background, respectively.

[6] Babu, S., Pragathi, B.S., Chinthala, U. and Maheshwaram, 2021, September. "Subject Tracking with Camera Movement Using Single Board Computer". In 2020 IEEE- YDCON (pp. 1-6). In this work [6] presents a system that is able to track subjects and accordingly an in real time. The system replicates a camera operator by detecting humans or objects and pan accordingly to track and record them. This subject

tracking camera system can be implemented in classroom lectures to help teacher's record video without the aid of any camera operator, or to ease the work of a camera operator in particular.

[7] Shetty, M., Daniel, C.A., Bhatkar, M.K. and Lopes, O.P., 2020, June. "Virtual Mouse Using Object Tracking". In 2020 5th International Conference on Communication and Electronics Systems (ICCES) (pp. 548-553). In this paper [7] they proposed a Computer Vision based mouse cursor control system, which uses hand gestures that are being captured from a webcam through an HSV colour detection technique.

[8] Chen, M., Al Regib, G. and Juang, B.H., 2020. "Air-writing recognition—Part I: Modelling and recognition of characters, words, and connecting motions". IEEE Transactions on Human-Machine Systems, 46(3), pp.403-413. In this paper [8] Air-Writing refers to writing of linguistic characters or words in a free space by hand or finger movements. Here recognition of characters or words is accomplished based on six - degree of - freedom hand motion data. Isolated air-writing characters can be recognized similar to motion gestures although with increased sophistication and variability.

[9] Kaur, H., Reddy, B.G.S., Sai, G.C. and Raj., A.S., 2019. "A Comprehensive overview of AR/VR by Writing in Air". In this paper [9], Dependency injection OpenCV is used to sketch on the camera with a virtual pen, i.e., any marker may be used to draw using the contour detection technique centred on the mask of the desired cultured reference marker. The research is all about how often people could identify alphabets and numbers written in the open air

[10] Zhou, L., 2019. "Paper Dreams: an adaptive drawing canvas supported by machine learning" Doctoral dissertation, Massachusetts Institute of Technology). In this paper [10] it has the potential to empower a large subset of the population, from children to the elderly, with a new medium to represent and visualize their ideas. Paper Dreams is a web-based canvas for sketching and storyboarding, with a multimodal user interface integrated with a variety of machine learning models. By using sketch recognition, style transfer, and natural language processing, the system can contextualize what the user is drawing; it then can colour the sketch appropriately, suggest related objects for the user to draw, and allow the user to pull from a database of related images to add onto the canvas.

3. METHODOLOGY: -

The Objective is to Create an interactive system that allows users to draw freely in the air. The system uses an RGB camera to detect and track the fingertip's motion on a screen. The first step is to detect the fingertip, and there are various methods for doing so.

3.1 Fingertip Detection

The primary objective of our work is to create a precise fingertip detection system. Initially, we identify the entire hand, followed by a two-step region segmentation process, which comprises skin segmentation and background subtraction. This system is designed to operate with high accuracy in real-time applications, with background subtraction potentially implemented through faster RCNN methods. The determination of the center of gravity (CoG) holds significant importance, as it plays a crucial role in recognizing specific hand gestures for executing various operations. To achieve this, our proposed system leverages two distinct centroid calculation algorithms, and the final CoG result is obtained by averaging the outputs of both methods. Specifically, we employ the distance transformation algorithm, where the pixel with the highest intensity signifies the center of gravity. This research aims to deliver a robust solution for accurately detecting fingertips, enabling applications such as real-time gesture recognition and freehand drawing.

3.2 Fingertip Tracking

In the realm of fingertip tracking, we have refined our approach to ensure efficiency and real-time performance. After detecting the hand region and center of gravity, we've moved away from the computationally intensive Faster R-CNN handheld detector and opted for the KCF tracking algorithm. This algorithm translates the detected fingertip into the HSV color space, making it more trackable. Once we've successfully tracked the fingertip in the air, we take measures to clean up the tracked image by applying morphological operations. Then, we identify contours, but the pivotal step in this process is drawing lines. We achieve this by creating a Python deque, which acts as a memory store for the fingertip's position in each frame. These stored points are used to create a continuous line using OpenCV's drawing functions. This optimized approach ensures accurate and real-time fingertip tracking, which is particularly valuable for applications like real-time air drawing.

3.3 Writing Hand Pose Detection

Hand pose detection is a crucial component in the process of enabling aerial writing. Unlike conventional writing, where the pen's movements define a clear sequence, aerial writing lacks such tangible cues. Therefore, accurately recognizing the hand's position and distinguishing it from other gestures becomes vital for this unique mode of communication. To achieve this, our system relies on a methodology that counts the number of raised fingers. By doing so, we can differentiate between a hand engaged in writing and a hand involved in other activities, establishing the foundation for effective aerial writing. This recognition of the hand's pose and its role in the communication process is an essential step in making aerial writing an intuitive and functional mode of interaction.

3.4 Hand Region Segmentation

In the hand region segmentation process, once we've successfully isolated the hand using the method mentioned earlier, we use a two-step approach. This includes skin segmentation and background subtraction. By combining the results of these steps, we obtain a final binary image of the hand. Our proposed algorithm works efficiently in real-time and delivers reasonably accurate segmentation results. Despite variations in skin colours among individuals, we've noticed that there is a common range of colours among different skin types, even though skin luminosity varies significantly. When it comes to background subtraction, we leverage the accurate hand detection provided by the Faster R-CNN handheld detector, followed by skin colour filtering near the boundaries of the detected hand. This initial process already yields a fairly good segmentation result. The subsequent background subtraction step primarily aims to eliminate skin-coloured objects that might be within the bounding box of the recognized hand but are not part of the hand itself, thus further refining the segmentation.

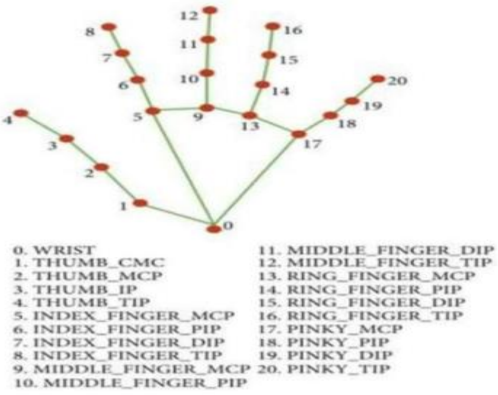


Fig: - Landmark Detection

3.5 Hand Centroid Localization

Accurately pinpointing the centre of gravity (CoG) for the hand is a crucial aspect of our system. We employ two algorithms to estimate the initial CoG, and the final CoG is determined by averaging these two estimates. The first algorithm utilizes a method called distance transformation to find the initial CoG (xc1, yc1). In this technique, each pixel in the image is represented by its distance from the nearest edge pixel, measured using Euclidean distance. The pixel with the highest intensity in this transformed image is designated as the CoG. This process ensures the precise identification of the hand's centre of gravity, which is essential for subsequent system operations. Colour Tracking of Object at Fingertip. To track a coloured object at the fingertip, our system undergoes a specific procedure. Initially, it converts incoming webcam images into the HSV (Hue, Saturation, Value) colour space. This conversion is essential for accurately recognizing coloured objects on the hand. The system employs tracking bars to define the HSV colour range for the specific-coloured object placed on your finger. By doing this, it establishes a precise colour range for tracking purposes. This method ensures the system can accurately track and identify the object based on its colour, making it ideal for various interactive applications.

3.6 Contour Detection of the Mask of Colour Object

After we've identified the mask representing the coloured object on the air canvas, the next step is to pinpoint its central position, crucial for accurate line drawing. To achieve this, our system applies specific morphological operations to the mask. These operations serve to clean up the mask, removing any unwanted imperfections and making it smoother and more clearly defined. Once the mask is refined, the system can easily detect its outline or contour, which is necessary for drawing precise lines based on the object's position. This entire process ensures that our system can create detailed and accurate drawings interactively using the coloured object.

3.7 Drawing the Line using the position of the Contor

The fundamental idea behind this computer vision project involves using a Python deque to store the position of the outline in each frame. We then use these accumulated points to draw a line on the canvas using OpenCV's drawing tools. Once we know the position of the outline, we can make decisions based on it. For example, we can decide whether to activate buttons or start drawing on the canvas. Some buttons are situated at the top of the canvas, and when the pointer enters that area, they are triggered according to their designated function. This approach provides an interactive and responsive way for users to control actions by simply moving within the canvas space.

4. PROPOSED SYSTEM: -

Harnessing the power of Python in conjunction with the OpenCV module, a sophisticated system has been meticulously crafted for the detection of fingertips and real-time tracking of finger movements. The procedural workflow begins with the initial identification of the fingertip, followed by a continuous tracing of its trajectory as it moves through space. This groundbreaking approach seamlessly translates finger movements into a visible path displayed on the screen, enabling users to articulate and write in the air with unparalleled fluidity. By embracing this innovative system, interruptions are minimized, and the archaic reliance on paper is entirely eradicated. One of the standout features of this system lies in its remarkable capacity to store the entire movement electronically. This functionality not only enhances user convenience but also serves as a digital alternative for note-taking and drawing. The freedom of motion afforded by this technology opens up new possibilities for creative expression, providing users with a dynamic and interactive platform for expressing ideas and creating digital content. Set up the required hardware, such as a camera or sensor, for hand tracking. Import the necessary libraries and dependencies, including OpenCV and Media Pipe. Configure the canvas parameters, such as size and resolution. Start capturing video frames initialize the video capture stream to obtain frames from the camera. Preprocess each frame, if required, for improved hand tracking performance. Convert the frame to the appropriate format for further processing. Apply hand tracking use the hand tracking model provided by Media Pipe to detect and track hand landmarks. Retrieve the hand landmarks, such as fingers, palm, and wrist, from the model's output. Perform any necessary transformations, such as scaling or normalization, on the landmark coordinates. Map hand movements to the canvas define the mapping between the hand movements and the canvas coordinates. Calculate the position of the hand on the canvas based on the detected landmarks. Update the position of the drawing tool, such as a virtual on the canvas accordingly. Draw on the canvas implement the drawing functionality, such as line or shape rendering, on the canvas. Detect the user's desired drawing action, such as pressing a button or making a specific gesture. Update the canvas based on the hand movements, allowing the user to draw in the air. Display the canvas render the canvas with the drawn content on the screen or display device. Continuously update the canvas as the user moves their hand in the air. Ensure a smooth and responsive visual feedback to provide a seamless drawing experience. Handle user interactions implement user interactions, such as clearing the canvas or changing the drawing tool. Define the gestures or commands recognized by the system to perform specific actions. Continuously monitor the user's input and respond accordingly.

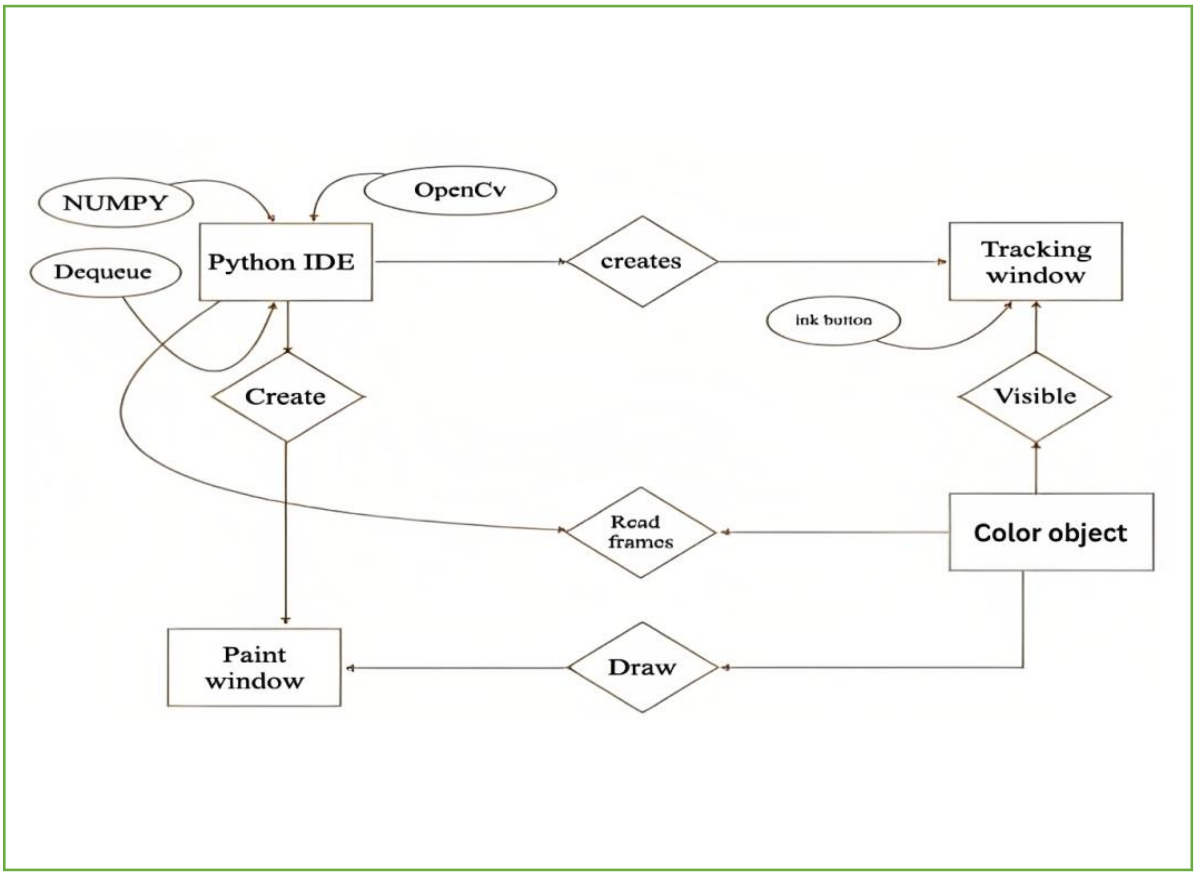
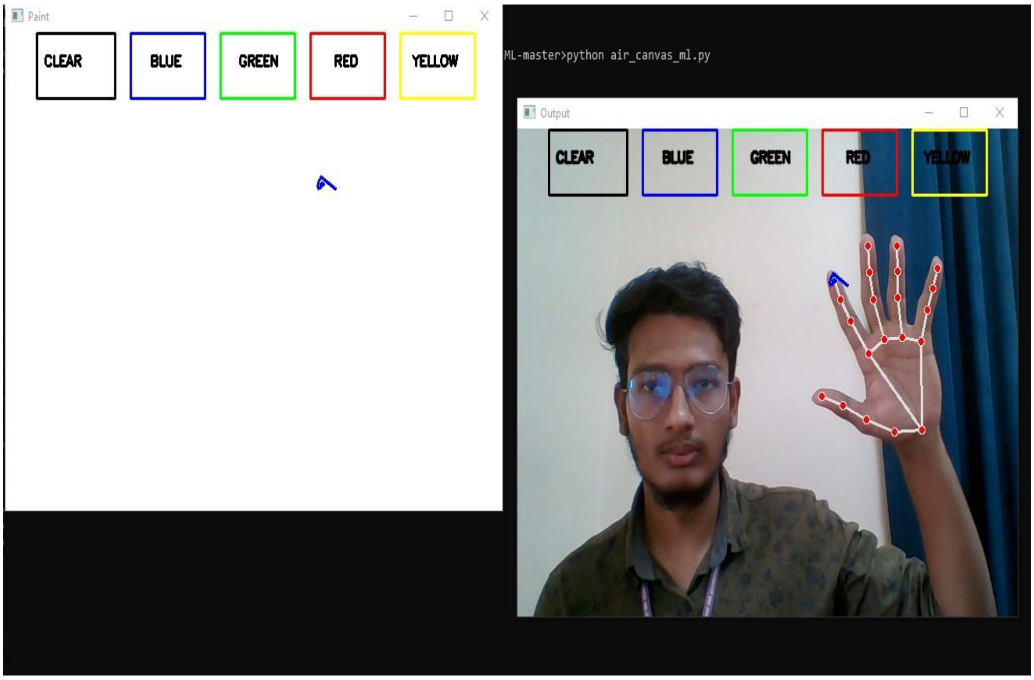


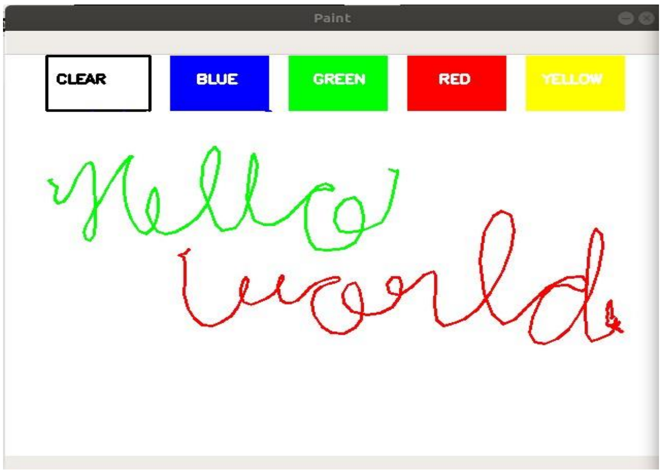
Fig:- System Architecture

5. CONCLUSION:-

The "Virtual Air Canvas" project represents an innovative application that transforms the traditional approach to drawing and painting by harnessing the power of hand gestures in front of a webcam. This creative platform provides users with a unique and interactive way to express their artistic ideas on a digital canvas. The intuitive interface of the application includes a variety of colour options and convenient feature to clear the canvas, enhancing the user's ability to experiment with different styles and techniques. While the project offers an exciting and novel drawing experience, it may encounter challenges in low-light conditions. The reliance on hand gestures, which are tracked by the webcam, could be affected by the availability and quality of ambient light. This limitation may be addressed through optimizations in the tracking algorithm or additional features to enhance performance in varying lighting environments. In conclusion, the "Virtual Air Canvas" project not only introduces an exciting way to create digital art but also hints at the transformative impact of gesture-based interaction across various domains. While challenges such as low-light conditions may need consideration, the project's potential applications underscore its significance as a forward-thinking and versatile technological innovation.

6. RESULTS :-





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