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Expressive Digital Paint / Writing Using Mediapipe & OpenCV

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ABSTRACT: The “EXPRESSIVE DIGITAL PAINT/WRITING USING MediaPipe & OpenCV” is an interactive and innovative project that enables users to create digital artwork or write on a virtual canvas by leveraging computer vision technologies. This application utilizes the Media Pipe library for hand tracking and gesture recognition along with OpenCV for image processing. The goal is to provide users with a hands-free, intuitive, and engaging platform. The proposed project focuses on developing a real-time painting application using hand gestures, leveraging the capabilities of MediaPipe and OpenCV. The primary objective is to employ hand gesture recognition for various applications, such as industrial automation control, sign language interpretation, and rehabilitation equipment for individuals with upper extremity disabilities. The system utilizes colour markers on the user's fingertips, tracked by a web camera, allowing the user to draw on a canvas by moving their index finger. The existing system also incorporates number recognition through hand gestures.

KEYWORDS: Hand Gesture Recognition, Computer Vision, Paint, MediaPipe, OpenCV, digital painting.

I. INTRODUCTION

Currently, people and machines interact mostly through direct contact methods such as the mouse, keyboard, remote control, touch screen, and other similar devices, whereas people communicate primarily through natural and intuitive non-contact methods such as sound and physical motions. Many researchers have attempted to help the computer identify other intentions and information using non-contact methods like as voice, facial expressions, physical motions, and gestures. A gesture is the most crucial aspect of mortal language, and gestures also play a significant role in mortal communication. They're considered to be the simplest way for humans and computers to communicate. Sign language recognition, robotics, and other applications fall under the category of gesture recognition. Two methods are typically used for Gesture recognition for HCI applications. The first is based on wearable or direct physical approaches, while the second is based on computer vision and does not require any sensors to be worn. The data-glove, which is made up of sensors to capture hand motion and location, is used in the wearable or direct contact technique. The vision-based technique uses the camera to provide contactless communication between humans and machines. Computer vision cameras are simple to operate and inexpensive. However, due to differences in hand sizes, hand position, hand orientation, lighting conditions, and other factors, this approach has certain limitations. In this paper, we introduce a virtual paint application that uses hand gestures for real-time drawing or sketching on the canvas. Hand gesture-based paint application can be implemented using cameras to capture hand movement. To accomplish activities like as tool selection, writing on the canvas, and clearing the canvas, an intangible interface is created and implemented using vision-based real-time dynamic hand gestures. The images of the hands are taken with the system's web camera and processed in real time with a single-shot detector model and media pipe, allowing the machine to communicate with its user in a fraction of a second

II. RELATED WORK

A two-level approach to recognize hand gestures in real-time with a single web camera as the input device. The low level of the approach is focused on the posture recognition with Haar-like features and the AdaBoost learning algorithm. The Haar-like features can effectively describe the hand posture pattern with the computation of "integral image". The AdaBoost learning algorithm can efficiently speed up the performance speed and construct a strong classifier by combining a sequence of weak classifiers. Based on the cascade classifiers, a parallel cascade structure is implemented to classify different hand postures. From the experiment results, we find this structure can achieve satisfactory real-time performance as well as very high classification accuracy above 90%. For the high-level hand gestures recognition, they proposed the context-free grammar to analyse the syntactic structure based on the detected postures.[1]

A pointing gesture-based interaction solution for smart wearable glasses. A two-stage CNN-based method is proposed to detect fingertips from egocentric videos in all application scenarios. A large-scale pointing gesture dataset was collected and carefully designed to be general, complete, and representative. The Faster R-CNN based hand detection and multi-point fingertip method resulted in an 80% overlap rate of hand detection and a fingertip detection error of 12.22 pixels in a 640*480 image. The system implements an input system for egocentric vision using pointing and a few simple gestures, effectively and efficiently allowing interaction with the wearable glasses by considering the fingertip as a pen.[2]

A revolutionary approach to traditional writing methods, allowing note-taking without the need for a mobile phone. It's particularly beneficial for specially-abled people, senior citizens, and those who struggle with keyboards. The system can control IoT devices and enable air drawing, making it an excellent software for smart wearables. It uses augmented reality to bring text to life and obeys only the user's control gestures. Future enhancements include the use of object detection algorithms like YOLO v3 for improved fingertip recognition and the application of AI advancements to boost the efficiency of air writing.[3]

An application can be put to use in many fields which doesn't need a lot of expertise in typing and also is efficient as it takes a brief amount of time to convey the user's thoughts. It creates a space for the users to draw anything they wish using a single finger among the available choice of colours while using two fingers to make a choice in a very convenient and effortless manner. The principle reason of the project is to demonstrate Human computer interaction and is built using python, NumPy and OpenCV.[4]

The painting with hand gestures application's main goal is to deliver the user an AI-based application that allows the user to draw anything on canvas with the free hand using the index fingertip. The application also provides the option for the user to choose the colour of his choice to draw on the canvas.[5]

A program that permitted client to perform hand signals for simple programming control. A dream-based hand Gesture framework that requires no unique markers or gloves and can work continuously on a item PC with minimal expense cameras. In particular, the framework can follow the tip places of the counters and pointer for each hand. The inspiration for this hand Gesture was a work area-based volume control framework in which a client has some control over volume and cursor route in Realtime utilizing normal hand movements.[6]

The application allows users to draw anything they want using a single finger, offering a wide range of colour choices. Users can also make selections easily and uncomplicatedly using two fingers. This project has potential applications in various fields due to its structured and efficient design. [7]

The Mark Air project is a hands-free note-taking solution that could revolutionize the writing process. It eliminates the need for physical interaction with cell phones, enhancing communication and providing a user-friendly interface. The program can control Internet of Things (IoT) devices and offers an immersive experience with air painting. It can be implemented within smart clothing software to enhance digital engagement. The program integrates discovery algorithms like YOLO v3 to improve fingerprint recognition capabilities, enhancing speed and precision. The ongoing advancements in Artificial Intelligence further enhance the potential for hands-free writing techniques. Security is a top priority, with advanced measures implemented to prevent unauthorized use and ensure a safe, trustworthy experience.

Overall, this program has immense potential to revolutionize writing and communication practices in the digital age. [8]

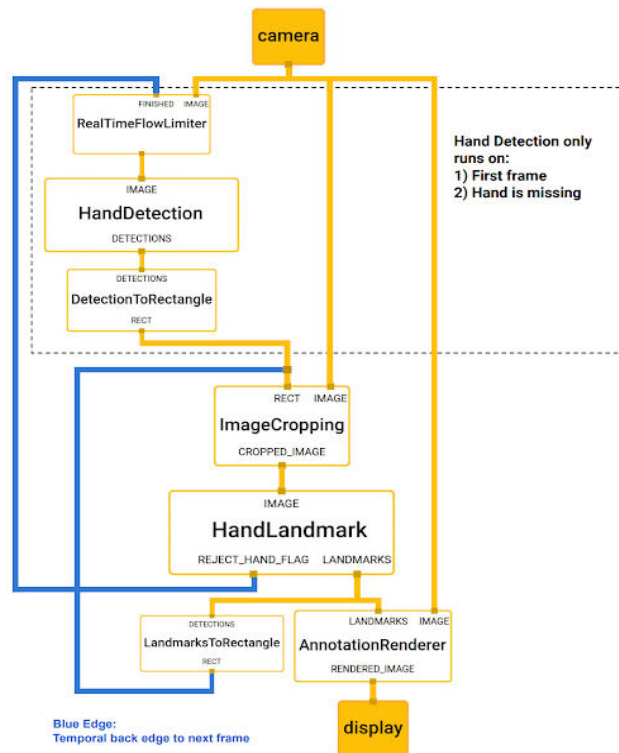
The project has the potential to revolutionize traditional writing methods. It offers benefits for people with hearing impairments, reduces smartphone-related issues, and minimizes paper wastage. While our system is already impressive, they acknowledge some areas for improvement, such as introducing handwriting recognition and refining fingertip detection further.[9]

Google introduces a real-time on-device hand tracking solution for AR/VR applications, utilizing two models in the MediaPipe framework. The palm detector provides a hand bounding box, and the hand landmark model predicts a high-fidelity 2.5D hand pose. The pipeline achieves real-time performance on mobile devices without additional hardware, offering an open-source solution for Android, iOS, Web, and desktop platforms. The hand landmark model outputs 21 landmarks, a hand presence probability, and handedness classification. The solution includes datasets for diverse scenarios, and the open-source pipeline encourages development in gesture control and AR/VR applications. [10]

MediaPipe Hand Land marker detects hand landmarks in images, locating key points for visual effects. It processes still images, video frames, or live feeds and outputs handedness and hand landmarks in image and world coordinates. The model bundle, trained on real-world and synthetic images, includes palm detection and hand landmarks models. To optimize efficiency, the palm detection model is triggered selectively in video or live stream mode, reducing unnecessary computations. This approach enhances real-time performance.[11]

III.METHODOLOGY

A highly efficient ML solution that runs in real-time and across a variety of different platforms and form factors involves significantly more complexities than what the above simplified description captures. To this end, we are open sourcing the above hand tracking and gesture recognition pipeline in the MediaPipe framework, accompanied with the relevant end-to-end usage scenario and source code, here. This provides researchers and developers with a complete stack for experimentation and prototyping of novel ideas based on our model.



Get coordinates of fingertips on the screen: The application constantly records the position of those landmarks on the screen and returns them. Based on the returned values we give the user the ability to change functionality. We use Tkinter to build a UI where the users can change modes by altering the coordinates of the landmarks on the screen.

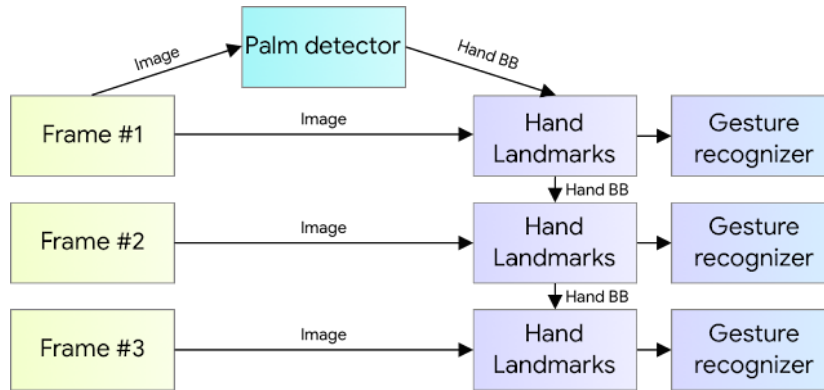


Fig 2: Program flow

Understand gestures: The application is built in such a way that different gestures shown in front of the camera are detected and the corresponding actions are performed. Such gestures which are introduced in the application are:

- 1 Finger up - Draw
- All Fingers Up – Standby

The project presented in this paper Majorly focused on development of AI-enhanced hand gestures for dynamic presentations, structured into two primary stages: gesture recognition and Virtual Painting.

IV. EXPERIMENTAL RESULTS



Fig 1: Standby

- Here the application standby mode for easy colour, other tool selections.



Fig 2: Draw

- We can select any colour, Brush size for drawing



Fig 3: Colour Change

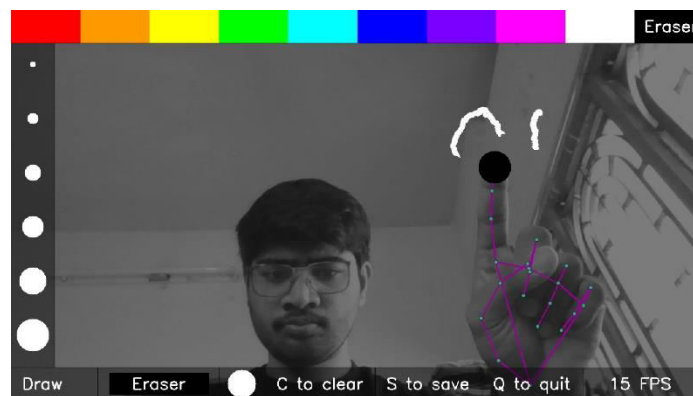


Fig 4: Eraser

- We can erase and clear the whole canvas Aswell

V. CONCLUSION

Gesture recognition allows for the most natural human machine connection. Gesture recognition is also crucial for the development of new human-computer interaction modes. It makes it possible for humans to interact with machines in a more natural manner. Gesture recognition has a wide range of applications, including deaf and dumb people's sign



language recognition, robot control, and so on. The image processing skills of OpenCV are presented. The ultimate objective is to develop a computer vision machine learning application that encourages people to digitize their skills. Man-Machine-Interaction (MMI), is the relationship between a human and a computer or, more specifically, a machine. Because the machine is useless without proper human use, The amount and breadth to which the system can operate and execute defined user purposes efficiently was referred to as system usability, while the system functionality referred to the range of operations or services that is delivered to users by the system.

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