Gesture Analysis in Online Meeting Using Ml

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Abstract – This project presents the integration of a finger-counting analysis feature into a web application to enhance user interaction. By leveraging machine learning and computer vision techniques, our system detects and interprets finger-count gestures in real-time. The lightweight, client-side application communicates with the meeting platform via a secure API. We also discuss development challenges and propose solutions, highlighting the potential of this feature to bridge the gap between physical and digital meeting experiences.

Keywords: finger-counting analysis, web application, machine learning, computer vision, real-time gesture detection, client-side application, secure API, digital meeting experiences, user interaction, meeting platform.

I. INTRODUCTION

The rapid growth of virtual communication has made online meetings a vital part of modern life. However, the lack of physical interaction can hinder effective communication and collaboration. Gesture analysis offers a promising solution by leveraging machine learning (ML) to bridge this gap and enhance the online meeting experience.

Gesture recognition focuses on identifying and interpreting human hand movements to enable intuitive interaction in virtual environments. Using computer vision and machine learning techniques, the system analyzes gestures in real-time, providing users with advanced functionality such as virtual writing, highlighting, and navigation during online meetings. This integration improves productivity and creates an immersive communication experience.

Gesture analysis enhances user interactions by enabling the execution of specific tasks without traditional input devices. In a meeting, participants can use hand gestures to draw attention to a particular point, make annotations, or even navigate presentation slides.

Fig 1.1 Gesture Analysis

By combining computer vision with ML, the system ensures real-time gesture detection. Technologies like OpenCV, MediaPipe enable accurate hand tracking, while ML models interpret the recognized gestures to trigger predefined functions. This capability transforms virtual meetings into more interactive and collaborative spaces. However, challenges like environmental variability, gesture misclassification, and system latency must be addressed to ensure robust and seamless performance.

This project implements various techniques to develop a virtual drawing application. It employs computer vision with OpenCV for capturing video, flipping images, and drawing shapes, while a custom hand detection tracker (Tracker) identifies hand landmarks and gestures. The handDetector class extracts keypoints using findHands and findPosition, and determines finger states with fingersUp. The system uses gesture-based interaction to toggle between modes like selecting tools or drawing. It processes images using thresholding, bitwise operations for blending, and maintains a canvas for persistent drawings. Additionally, color and tool selection are dynamically updated via preloaded images.

1.1 Computer Vision

Computer vision is a field of technology that helps machines see, understand, and process visual

information like images or videos. It works by using techniques to detect objects, recognize patterns, and track movements. This is similar to how humans use their eyes and brain to interpret the world around them.

Computer vision integrates techniques from image processing, machine learning, and deep learning to perform tasks like object detection, recognition, segmentation, and motion tracking. Key processes include image enhancement (like resizing, filtering, and noise reduction), feature extraction (to identify patterns or regions of interest), and classification (to interpret extracted features).

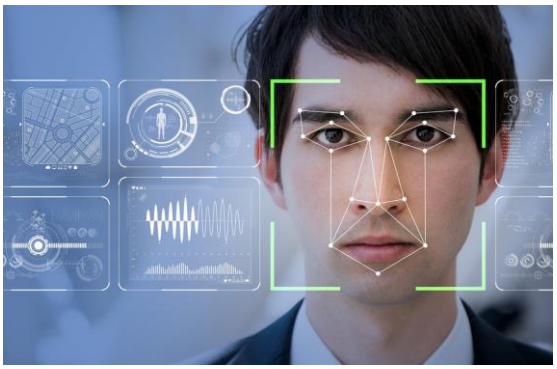

Fig 1.2 Camera detection

In gesture recognition, computer vision methods enable dynamic tracking of body parts, such as hands or fingers, to identify patterns or movements. This capability empowers intuitive interactions, facilitating innovations in gaming, virtual environments, assistive technology, and creative tools. By using techniques like machine learning, systems can recognize complex gestures, even in real-time.

1.2 Keypoint Detection Algorithm

Keypoint detection involves identifying distinct points in an image, such as edges, corners, or joints, that are stable and invariant to transformations like scaling or rotation. These points are essential for tracking and interpreting features in images.

In gesture recognition, keypoint algorithms detect critical hand points like fingertips and joints using machine learning models. The spatial relationships between these points enable gesture classification, allowing for intuitive interaction in applications like virtual drawing and augmented reality.

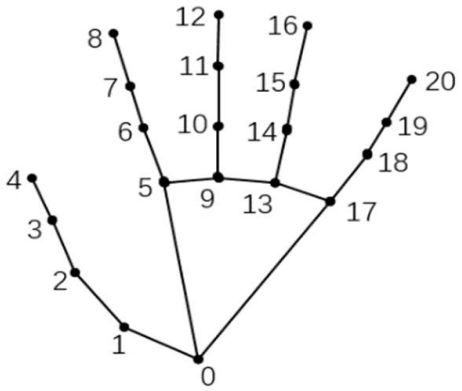

Fig 1.3 Hand Key Points

In gesture recognition algorithms, keypoint detection is fundamental to interpreting human movements and gestures. These algorithms identify key points such as fingertips, joints, and other distinct features that are crucial for recognizing gestures. By detecting these key points, the system can track and analyze movements, allowing it to understand user input in real-time.

The process typically begins by extracting features from an image or video, followed by detecting key points using machine learning models or computer vision techniques. Models like MediaPipe are widely used for their ability to detect and track key points accurately. Once key points are detected, the relationships between them—such as the distance between fingertips or the angles between joints—are analyzed to classify specific gestures. This is the basis for applications like virtual drawing, gesture-based control, and sign language recognition

II. LITERATURE REVIEW

S.NO	TITLE OF THE PAPER	AUTHOR NAME	YEAR OF PUBLICATION	METHODOLOGY USED	ADVANTAGES	DISADVANTAGES
1	Computer Vision in the Metaverse	Kemal Gökhan NALBANT, Şevval UYANIK	2021	The paper employs CNNs for gesture recognition, using preprocessing techniques like background	High accuracy in diverse environments, robust deep learning techniques, and	Resource-intensive training and performance challenges in real-time applications.

				subtraction and edge detection to enhance feature extraction and model training	generalizability	
2	Computer Vision-based Grasp Pattern Recognition with Application to Myoelectric Control of Dexterous Hand Prosthesis	Chunyuan Shi, Dapeng Yang, Jingdong Zhao, Hong Liu	2017	This review highlights various methods, from rule-based to deep learning, emphasizing dataset diversity, feature extraction, and multimodal systems for improved accuracy.	Its broad coverage of methods and applications, aiding researchers in system selection	It lacks implementation details and benchmarks for specific solutions.
3	A Review of the Hand Gesture Recognition System: Current Progress and Future Directions	Noraini Mohamed, Mumtaz Begum Mustafa , Nazean Jomhari	2021	The methodology explores the integration of computer vision algorithms for real-time tracking of gestures and body movements within virtual environments.	Strengths lie in immersive XR integration and scalable AI models for diverse applications	Challenges include computational demands, privacy risks, and latency issues impacting real-time experiences.
4	Machine Learning-Based Approach for Hand Gesture Recognition	M. Deepika, Shilpa Choudhary, Sandeep Kumar, Kodi Srinivas	2023	This paper combines visual grasp pattern analysis with myoelectric signals, using ML algorithms to classify and control prosthetic hand movements.	Improved prosthetic control precision and usability through vision-based techniques	Dependency on consistent environmental conditions and sensor accuracy.
5	Hand Gesture Tracking and Recognition based Human-Computer Interaction System and Its Applications	Kai Li,Jun Cheng, Qieshi Zhang, Jianming Liu	2018	The work uses computer vision techniques like contour analysis and SVM classifiers to track and recognize gestures for diverse human-computer interaction applications.	Enhanced user interaction and system adaptability to various tasks	Potential accuracy reduction in cluttered backgrounds and the need for extensive training datasets.

III. PROBLEM DEFINITION

In online meeting platforms, there is a lack of intuitive tools that allow participants to create real-time sketches or visual representations during discussions, limiting effective collaboration and communication. Traditional tools, such as mouse-based drawing or pre-prepared visuals, often feel unnatural and cumbersome for brainstorming, quick diagram creation, or interactive explanations.

The challenge lies in designing a gesture-based system that can accurately recognize and track hand movements, translating them into digital sketches in real-time. This requires robust computer vision algorithms, to identify hand features and enable

precise control over drawing actions. Additionally, the system must integrate seamlessly into existing platforms while providing features like color selection, line thickness adjustment, and erasing for enhanced functionality.

This project addresses these challenges by developing a computer vision-driven, hand gesture recognition system that bridges the gap between natural physical gestures and digital sketching capabilities, making online collaboration more interactive, accessible, and efficient.

IV. PROJECT IMPLEMENTATION

The implementation of the gesture analysis feature for an online web meeting involves integrating real-time gesture recognition using advanced machine learning and computer vision techniques. The system employs a lightweight library, OpenCV, to process video streams captured from the user's webcam and a pre-trained gesture detection model, like Mediapipe, is utilized to detect and interpret gestures efficiently. The web application's frontend is developed using modern frameworks such as React.js, ensuring a responsive and user-friendly interface. For seamless interaction with the meeting platform, a secure API is implemented using technologies with HTTPS and token-based authentication ensuring secure communication. The credentials and messages for users are stored in firebase. Real-time gesture transmission is facilitated using WebSocket to minimize latency, providing immediate feedback and interaction. Additionally, the application undergoes rigorous testing across diverse devices and browsers to ensure robustness and compatibility. This implementation bridges physical gestures and digital interactions, enhancing the user experience in virtual meeting environments.

V. EXPERIMENTAL RESULTS

The online meeting platform leverages finger gesture analysis to enable interactive sketching and erasing by manipulating the coordinate point detected at the fingertip. The system employs a key point detection algorithm to accurately track the index finger's movement, allowing users to produce real-time sketches or erase them seamlessly.

This functionality enhances collaboration in virtual environments by allowing users to create and modify visual content directly through natural hand movements. It eliminates the need for physical tools, offering a contactless and accessible solution for brainstorming, teaching, and interactive discussions.

By dragging the detected fingertip, the system generates a continuous line, creating a rough sketch displayed in the camera view. This interaction mimics the experience of using a drawing tool, offering a natural and intuitive interface for users to visually communicate ideas during online meetings.

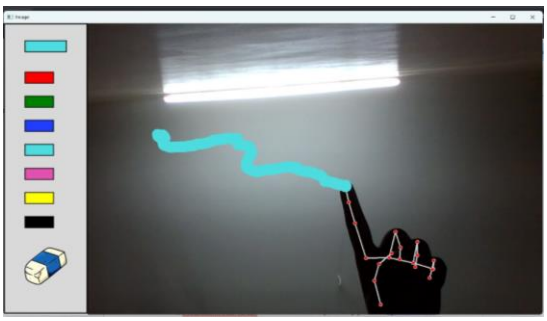

Fig 1.4 Sketching

The erasing process is facilitated by altering the fingertip's position or using a specific hand gesture to toggle the eraser mode. Once activated, the system removes sections of the sketch with precision, providing flexibility for users to refine their drawings.

Fig 1.5 Erasing

The system also supports customization options like selecting colors. These features provide a comprehensive toolkit for creating professional and visually engaging sketches in online meeting scenarios.

VI. FUTURE IMPLEMENTATION

The future plan is to enable blind individuals to participate seamlessly in online meetings by incorporating voice commands. These commands will allow users to navigate the platform effortlessly, such as joining meetings, muting/unmuting, and

interacting with features like screen readers for content accessibility. This integration aims to foster inclusivity by ensuring that visually impaired participants can engage effectively in virtual environments.

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