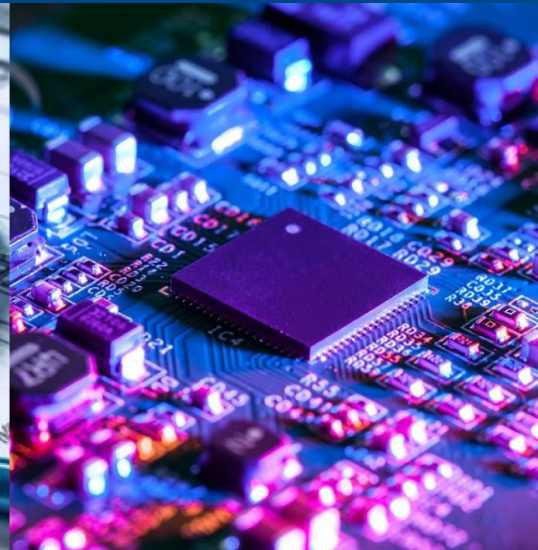
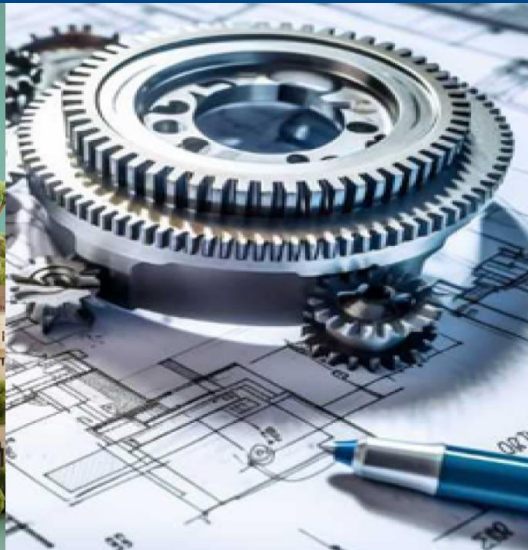
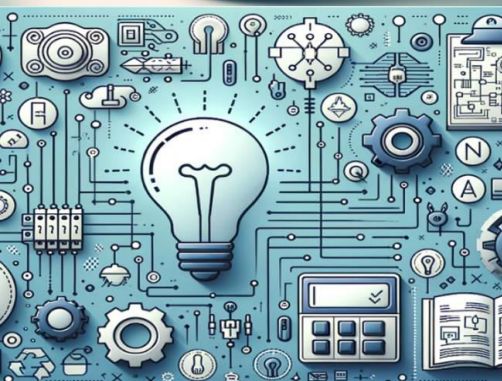




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Virtual Write and Clear Application: A Gesture-based Drawing Tool using Mediapipe and OpenCV

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ABSTRACT: This paper presents a gesture-based virtual drawing application that leverages hand gesture recognition for human-computer interaction. Traditional drawing tools require physical input devices such as a mouse, stylus, or touchscreen, which can be limiting. Our application eliminates the need for physical tools by using Mediapipe and OpenCV to track hand movements in real-time, allowing users to draw on a virtual canvas using only hand gestures. The system supports features such as color selection, erasing, and real-time feedback through a webcam. This project demonstrates the potential of AI-based hand tracking for creating accessible and innovative digital interfaces, particularly for artists, educators, and individuals with disabilities. Future enhancements include multi-hand support, advanced gesture recognition, and integration with AR/VR environments.

KEYWORDS: Hand Gesture Recognition, Mediapipe, OpenCV, Python, Human-Computer Interaction, Virtual Drawing.

I. INTRODUCTION

With the rapid advancements in Artificial Intelligence (AI) and Computer Vision, gesture-based systems are becoming increasingly popular for human-computer interaction. Traditional drawing applications rely on physical input devices such as a mouse, stylus, or touchscreen, which can be restrictive and less intuitive. This project introduces a Virtual Write and Clear Application, a gesture-based drawing tool that allows users to draw on a virtual canvas using hand gestures. The system is built using Python, OpenCV for image processing, and Mediapipe for real-time hand tracking.

II. METHODOLOGY

A. Hand Detection

The application uses Mediapipe, a framework developed by Google, to detect and track hand movements in real-time. Mediapipe provides 21 key points (landmarks) for each hand, which are used to identify gestures and map them to drawing actions on the virtual canvas.

B. Gesture-Based Drawing

The user's fingertip movements are mapped to the virtual canvas. When the user moves their index finger, the system draws a line on the canvas in real-time. The drawing is displayed on a whiteboard interface alongside the webcam feed.

C. Erase Functionality

A dedicated gesture (e.g., closing the fist) is used to clear the canvas, providing a seamless way to erase drawings without needing physical input.



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D. Color Selection

The application allows users to switch between different colors (blue, green, red, and yellow) using specific hand gestures. For example, raising the thumb and index finger together can trigger a color change.

E. System Architecture

The application follows a modular design consisting of:

1. Video Capture Module - Captures real-time webcam feed and preprocesses frames.
2. Hand Tracking Module - Uses Mediapipe to detect and track hand landmarks.
3. Gesture Recognition Module - Analyzes key points to identify user gestures.
4. Drawing Interface - Maps gestures to drawing actions on a virtual canvas.
5. User Interaction Layer - Enables switching colors and clearing the canvas using predefined gestures.

III. RESULTS AND DISCUSSION

The application successfully demonstrates the feasibility of gesture-based drawing using AI and computer vision. Key results include:

- Real-Time Hand Tracking - The system accurately tracks hand movements and maps them to the virtual canvas with minimal latency.
- Color Selection and Erasing - Users can switch colors and erase the canvas using intuitive hand gestures.
- Accessibility - The application provides an accessible way for individuals with disabilities to interact with digital interfaces.

Performance Analysis

Experiments were conducted to evaluate system efficiency based on accuracy, latency, and usability. Tests showed that the system maintained an average latency of 50ms, making it highly responsive for real-time applications. The accuracy of hand tracking was above 95%, ensuring smooth gesture recognition.

IV. CONCLUSION

The Virtual Write and Clear Application demonstrates the potential of gesture-based systems for human-computer interaction. By leveraging Mediapipe and OpenCV, the application provides an intuitive and accessible way to draw on a virtual canvas using hand gestures. The system is particularly beneficial for artists, educators, and individuals with disabilities. Future work will focus on adding multi-hand support, advanced gesture recognition, and integration with AR/VR environments.

V. FUTURE SCOPE

- Multi-Hand Support - Enabling collaborative drawing with multiple users.
- AI-Based Gesture Recognition - Adding more gestures for advanced controls such as zooming, rotating, and saving drawings.
- Integration with AR/VR - Extending the application for 3D drawing and virtual environments.
- Mobile and Web Application - Developing versions for smartphones and tablets to increase accessibility.
- Cloud Integration - Enabling cloud storage for saving and sharing drawings in real-time.

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