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A Real-Time Gesture-Based System for Handwritten Math Problem Solving Using Computer Vision and Generative AI

**Abstract**

This project presents a novel system that integrates real-time hand gesture recognition with generative artificial intelligence to interpret and solve handwritten mathematical expressions. The application utilizes a webcam interface to capture live video, where hand landmarks are tracked using OpenCV and the **cvzone.HandTrackingModule**. Specific hand gestures are mapped to functional commands—such as drawing with the index finger and clearing the canvas with a thumbs-up gesture—allowing users to write math expressions in mid-air without physical input devices.

Once a complete expression is drawn, a predefined gesture (open palm excluding the pinky) triggers the system to capture the virtual canvas. The drawn image is then processed and sent to Google’s Gemini 1.5 Flash model using the Generative AI API. The model interprets the mathematical content and returns a solution, which is displayed in real time via a responsive Streamlit interface.

This system demonstrates a touch-free, interactive approach to math problem-solving, combining intuitive gesture-based interaction with advanced AI reasoning. The application holds strong potential for use in educational technology, particularly in smart classrooms and accessibility-focused learning tools, where traditional input methods may be limiting or impractical.