Gesture Control UI: A Virtual HCI Program

This project transforms a standard webcam into a sophisticated, hands-free controller for your computer using real-time gesture recognition. **Features**

This application features a custom on-screen UI to seamlessly switch between three distinct functional modes, all following a consistent "Gesture" theme:

1. Gesture Mouse

An advanced virtual mouse with professional-grade features for precise cursor control.

- **Smoothed Movement:** Cursor motion is smoothed to eliminate jitter from hand tracking.
- **Cursor Lock:** The cursor automatically freezes its position when a pinch is initiated, allowing for highly accurate clicks.
- **Normalized Pinch-to-Click:** Utilizes a robust, normalized pinch detection (relative to the hand's size in the frame) that works accurately regardless of the hand's distance from the camera.

2. Gesture Canvas

A real-time virtual drawing board that allows you to draw on your screen with your finger.

- **Predictive Line Smoothing:** Implements a line smoothing algorithm by averaging recent points, resulting in more fluid and less shaky drawings.
- **Pinch-to-Draw:** An intuitive gesture to start and stop drawing.
- **On-Screen Clear Button:** A dedicated UI button to instantly clear the canvas.

3. Gesture Modeler

An interactive module for manipulating a virtual 3D cube in real-time.

- **Two-Handed Scaling:** The distance between two hands controls the size (zoom) of the cube.
- **One-Handed Rotation:** A "pinch and grab" gesture allows you to intuitively rotate the cube on its X and Y axes by moving your hand.
- **Persistent State:** The cube's rotation and scale are maintained even when hands are not detected in the frame.

Core Dependencies

This project relies on several key Python libraries, each with a specific purpose:

- **OpenCV (opencv-python):** The backbone for all video capture from the webcam, image processing, and for drawing the custom UI elements (tabs, buttons, text) directly onto the video frame.
- **MediaPipe (mediapipe):** Google's powerful framework used for the core task of real-time hand and landmark detection. It provides the 21-point skeleton that all gesture logic is built upon.
- **NumPy (numpy):** Used across various controller modules for high-performance numerical calculations, such as vector math for gesture normalization, smoothing algorithms for the cursor and canvas, and 3D matrix rotations for the cube.
- **PyAutoGUI (pyautogui):** Provides the programmatic control over the mouse cursor (movement and clicks), which is essential for the "Gesture Mouse" mode to interact with the operating system.

Tech Stack

- **Language:** Python
- **Core Libraries:**
  - OpenCV
  - MediaPipe
  - NumPy
  - PyAutoGUI

Setup and Installation

To run this project locally, please follow these steps:

1. **Clone the repository:**
   git clone https://github.com/your-username/Gesture-Control-UI.git
   cd Gesture-Control-UI

2. **Create and activate a virtual environment:**
   # For Windows
   python -m venv venv
   .\venv\Scripts\activate

3. Install the required dependencies:
   The project includes a requirements.txt file to install all necessary libraries with a

single command.
pip install -r requirements.txt

4. **Run the program:**
   python main.py

How to Use

1. Launch the program by running main.py.
2. The program will start in a standard window, displaying your webcam feed.
3. Use your primary (right) hand for all UI interactions, as the program is currently configured to track the first detected hand for UI control to ensure clarity and prevent conflicting inputs.

UI Interaction

- **Switching Modes:** Perform a **pinch gesture** (thumb and index finger together) while your index finger is hovering over one of the mode tabs.
- **Gesture Canvas - Clear:** While in "Gesture Canvas" mode, pinch on the "Clear" button to erase all drawings.

Mode-Specific Gestures

- **Gesture Mouse:**
  - **Move:** Move your index finger to control the cursor.
  - **Click:** Perform a pinch gesture. The cursor will lock its position to ensure accuracy.
- **Gesture Canvas:**
  - **Draw:** Perform a pinch gesture and move your hand to draw.
- **Gesture Modeler:**
  - **Rotate:** With one hand visible, pinch to "grab" the cube and move your hand.
  - **Scale/Zoom:** With two hands visible, move them closer together or further apart.

Demo

(This is the perfect place to add a GIF or a short video showcasing the project in action!)