Robotic Hand Control System

README

## Working Code and Configuration files

**Included Files:**

**Python Code**:

* + mainj.py: Detects finger positions using a camera, updates Firebase, and sends data to Arduino.
  + controller.py: Listens to Firebase for finger position data and sends commands to Arduino for servo control.

**Arduino Code**:

* + GestureControll.ino: Controls five servos based on incoming finger data from the Python scripts.

**Configuration Files**:

* + firebase.json: Contains Firebase credentials. Make sure this file is located in the project root directory.

## Required Libraries and Dependencies

**Python Libraries**:

firebase-admin: Connects Python to Firebase.

cv2 (OpenCV): Handles video capture and image processing.

cvzone: Manages hand detection and finger tracking.

pyfirmata: Allows communication between Python and Arduino over serial.

**Arduino Libraries**:

Servo: Controls servo motors.

Ensure all these dependencies are installed and configured to prevent setup issues.

## Setup Instructions

Required Hardware:

1. Our prototype
2. Compatible computer (MAC preffered): to run the Python scripts, manage Firebase data, and connect to the Arduino for control and testing.
3. Camera for hand tracking (e.g., built-in or USB camera).

Physical Connections:

* + - 1. **Connecting the Servo Motors to Arduino**:

Connect each servo’s signal pin to one of the digital PWM-capable pins on the Arduino (e.g., pins 9, 10, 11, 12, and 13).

Connect each servo’s power and ground pins to the Arduino’s **5V** and **GND** pins. If using multiple servos, ensure there is enough power supply to prevent instability.

Ensure that all grounds are connected in common to avoid grounding issues.

* + - 1. **Connecting Arduino to Computer**:
* Use a USB cable to connect the Arduino Uno to your Mac or computer. This connection will allow the computer to upload code to the Arduino and communicate with it during operation.
  + - 1. **Testing Connections**:
* Confirm that the Arduino is recognized by your computer. Open the Arduino IDE, go to **Tools > Port**, and select the port associated with the Arduino (on Mac, it is often /dev/cu.usbmodem101).

## Software Setup and Installation

**Install Required Python Libraries**:

* Open your terminal and install the following libraries:

pip install firebase-admin opencv-python cvzone pyfirmata

**Arduino Code Setup**:

*  Open the Arduino IDE.
*  Load the servo\_control.ino file.
*  Select the appropriate board and port in **Tools**.
*  Upload the code to the Arduino by clicking **Upload**.

Testing the Setup with Code Execution

* Run the Python Hand Tracking Code:

Start the hand\_detection.py script to detect finger positions using the camera. : python hand\_detection.py

This script will identify hand and finger positions and send data to Firebase.

## 5. Launch and execution guide

**Step 1: Upload Arduino Code**

1. **Open the Arduino IDE** and load the servo\_control.ino file.
2. **Configure Settings**:
   * Select **Board**: Arduino Uno.
   * Select **Port**: /dev/cu.usbmodem101 (or the detected port for your Arduino).
3. **Upload**:
   * Click **Upload** to send the code to the Arduino.
4. **Close the Arduino IDE** after uploading to prevent port conflicts with the Python script.

**Step 2: Open and Configure Python Code in Visual Studio Code**

1. **Open Visual Studio Code (VS Code)**:
   * Navigate to your project directory and open it in VS Code.
2. **Install Python Extension**:
   * If you haven’t already, install the Python extension from the VS Code Extensions Marketplace for enhanced support.
   * This extension provides features like IntelliSense, debugging tools, and error highlighting.
3. **Open the main.py Script**:
   * Find main.py in your project directory and open it in VS Code.
4. **Select the Python Interpreter**:
   * Go to **View > Command Palette** (or press Ctrl + Shift + P).
   * Type and select **Python: Select Interpreter**.
   * Choose the interpreter/environment where you installed the necessary libraries (firebase-admin, opencv-python, cvzone, pyfirmata).

**Step 3: Launch the Python Code**

1. **Open the Terminal**:
   * In VS Code, go to **View > Terminal** or press Ctrl + ~ to open an integrated terminal.
2. **Run the Code**:
   * In the terminal, ensure you are in the directory containing main.py.
   * Run the code by entering: python main.py
   * Alternatively, click the **Run** button at the top of the editor, if available.
3. **Observe Camera and Hand Tracking**:

* The camera feed should open automatically.
* Hand tracking will start, and finger positions will be sent to Firebase.
* Arduino will control the servo motors in real-time based on the detected finger positions.

**Step 4: Testing and Verification**

* **Testing Hand Tracking and Servo Control**:
  + Position your hand in view of the camera feed.
  + Verify that the detected finger states appear in the camera display.
  + Confirm that the servo motors on the Arduino adjust based on the finger data.

**Step 5: Stop the Python Script**

* **Terminate Execution**:
  + Press Ctrl + C in the terminal to stop the Python script.
  + Or, click the **Stop** button in VS Code’s run controls.