#### Gesture-Based Math Solver - Code Documentation

# **Project Overview**

This project uses MediaPipe, OpenCV, NumPy, and pyttsx3 to create a real-time gesture-based math solver using hand signs. The camera detects hand poses, maps them to digits or operators, builds an expression, and evaluates it.

#### **Libraries Used**

- cv2: Captures webcam and processes video frames.
- mediapipe: Detects hands and hand landmarks.
- numpy: Used for angle calculation.
- time: For gesture timing and cooldown.
- pyttsx3: For text-to-speech feedback.

# TTS (Text-to-Speech) Setup

pyttsx3 is initialized to provide spoken feedback on each digit/operator entered. The rate is set to 150 wpm.

## MediaPipe Setup

Hands model is initialized with:

- max\_num\_hands=2 (for both hands)
- min\_detection\_confidence=0.7 (minimum 70% confidence required to recognize a hand).

## **Finger Detection**

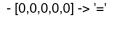
Each hand has 21 landmarks. The thumb requires angle checking, and other fingers are determined by comparing fingertip y-position with the middle joint.

# **Custom Gesture Mapping**

Specific finger patterns map to operators:

- [1,0,0,0,0] -> '+'
- [1,1,0,0,0] -> '-'
- [1,1,1,0,0] -> '\*'
- [1,1,1,1,0] -> '/'

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All other combinations are used to count total fingers from both hands (1 to 9).

## **Debounce & Cooldown**

To prevent accidental inputs, a gesture must be stable for 10 frames and must wait 1.5 seconds before new input is accepted.

# **Expression Building Logic**

- Digits are concatenated (e.g., 2 + 3 -> 23).
- Operators are spaced (e.g., ' + ').
- '=' evaluates the full expression with eval().
- 'C' clears everything.

## **TTS Feedback**

pyttsx3 reads out each gesture to confirm to the user what was entered.

# **UI Overlay**

cv2.putText() shows the expression on the webcam feed.

Press 'Q' to quit.

# Recommendation

- Use min\_detection\_confidence = 0.7 for a balance of precision and flexibility.
- Can increase for more accuracy or reduce for sensitivity.