

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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- [0,0,0,0,0] -> '='
- [1,0,0,0,1] -> 'C' (clear)

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., $2 + 3 \rightarrow 23$).
- 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.