INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DEPERTMENT OF CSE

Project Report

Project Title: AI Gym Assistant

Course Code: CSE-3636

Course Title: Artificial Intelligence Lab

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Project Title: AI Gym Assistant

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Introduction

The AI Gym Assistant project addresses the rising demand for personal fitness monitoring tools by providing users with a computer vision-based exercise tracking system. This desktop application uses artificial intelligence and pose estimation to count workout repetitions in real-time, specifically for **arm curls** and **squats**. The system uses a standard webcam and a simple GUI to help users perform and monitor these exercises at home, without any additional equipment or external sensors.

Objectives

- Develop an intelligent fitness assistant that counts exercise repetitions in real time.
- Use computer vision to detect and analyze human movement via webcam.
- Provide a user-friendly interface for selecting between different workout modes (arm curls and squats).
- Track performance accurately and encourage home-based fitness.

Tools & Technologies Used

- Python
- Visual Studio
- OpenCV
- Mediapipe (Google)
- Tkinter
- NumPy
- Python
- Standard Laptop camera

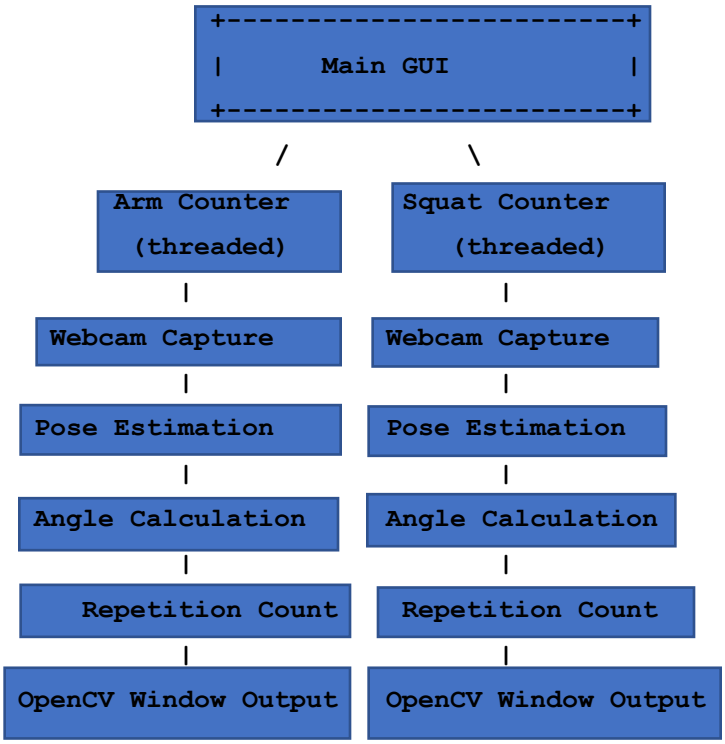
System Design

Overview

The application has three core modules:

- **Pose Estimation** (Mediapipe-based),
- **Exercise Detection** (using angle calculations), and
- **Graphical User Interface (GUI)** for user interaction.

Flow Diagram



Implementation Details

Pose Detection

Using Google's **Mediapipe Pose** solution, the application detects 33 body landmarks in real time and maps joint coordinates necessary for calculating movement angles.

Angle Calculation

The `calculate_angle(a, b, c)` function computes the angle between three points using vector math. This is central to distinguishing motion stages (e.g., "down" and "up").

```python
def calculate_angle(a, b, c):
    a = np.array(a)
    b = np.array(b)
    c = np.array(c)
    radians = np.arctan2(c[1]-b[1], c[0]-b[0]) - np.arctan2(a[1]-b[1], a[0]-b[0])
    angle = np.abs(radians * 180.0 / np.pi)
    if angle > 180.0:
        angle = 360 - angle
    return angle
```

Arm Counter

- Detects shoulder → elbow → wrist angle.
- Registers a **rep** when angle drops below 40° and then rises above 160°.
- Displays live count and pose landmarks.

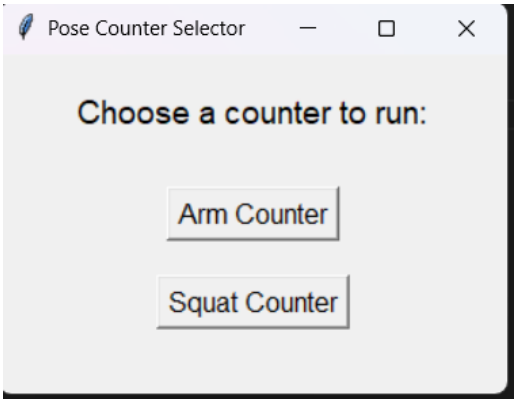
Squat Counter

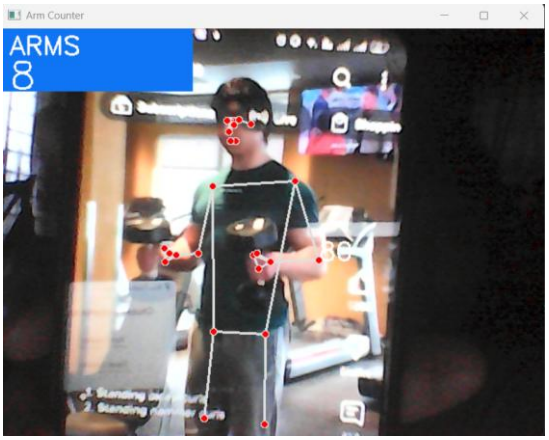
- Detects hip → knee → ankle angle.
- Registers a **rep** when the user squats below 90° and then returns above 160°.
- Also uses live webcam display with overlayed data.

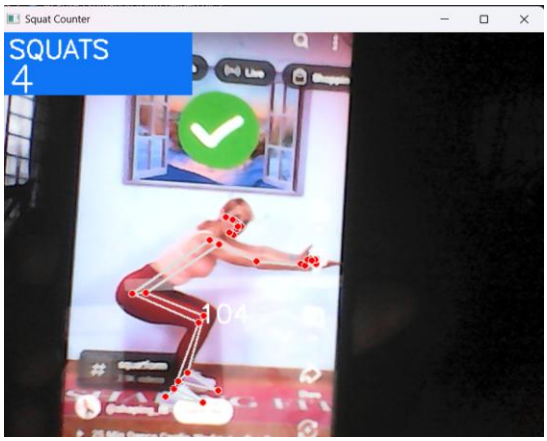
GUI (Tkinter)

A basic menu lets the user choose between "Arm Counter" or "Squat Counter." Multithreading is used to keep the interface responsive while video processing occurs.

Results







Challenges Faced

- Pose estimation can struggle in poor lighting or with background clutter.
- Multithreading GUI with OpenCV windows required careful resource handling.
- Different user body types and camera angles affected accuracy slightly.

Conclusion

The AI Gym Assistant successfully demonstrates how computer vision can be leveraged for real-time fitness tracking. By combining Mediapipe's landmark detection with simple geometry, we built a helpful tool that can motivate and assist users in their workouts without needing any external hardware. The project also shows promise for expansion into a more comprehensive virtual fitness coach.

References

- Mediapipe Pose Documentation
- OpenCV Documentation
- NumPy Documentation
- Tkinter Docs – Python GUI Programming