AI FITNESS COACH AGENT

Team No : 16

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ABSTRACT

Physical fitness is essential for maintaining a healthy lifestyle, yet many individuals struggle with performing exercises correctly without professional guidance. Incorrect posture during workouts can lead to injuries and reduce the effectiveness of training. This project, AI Fitness Coach Agent, proposes an artificial intelligence–based system that analyzes exercise videos, detects body posture, and provides feedback on whether the form is correct or incorrect.Using computer vision techniques (Mediapipe/ OpenPose) and machine learning models (Random Forest / Deep Learning), the system learns to classify exercise movements. The expected outcome is a virtual fitness coach that can guide users in maintaining proper form and consistency, making personal training more accessible and affordable.

INTRODUCTION & PROBLEM STATEMENT

Background

The increasing popularity of home workouts and online fitness tutorials has made it easier for people to exercise without going to the gym. However, lack of professional supervision often results in poor exercise form, leading to injuries, muscle strain, or reduced results. This not only demotivates individuals but also slows down their fitness progress. Therefore, there is a strong need for an intelligent system that can guide users and ensure safe, effective workouts.

Importance of the Problem

- Proper exercise form is essential to prevent injuries.
- Human trainers are not always accessible or affordable.
- AI and computer vision can act as a **virtual trainer**, bridging this gap.

Problem Definition / Objectives

The main objective of this project is to build an **AI Fitness Coach Agent** that can:

1. Analyze a video of a person performing an exercise.
2. Extract body keypoints using pose estimation techniques.
3. Classify whether the exercise is being performed correctly or incorrectly.
4. Provide corrective feedback to the user.

PROPOSED METHODOLOGY

Building using PreTrained Model

The proposed system will use a **computer vision + machine learning pipeline**:

1. **Dataset**
    - Exercise datasets containing videos or pose keypoints of different exercises
    - Each exercise sample will be labeled as **correct** or **incorrect form**.
2. **Preprocessing**
    - Convert video frames into keypoints using **Mediapipe Pose** (33 landmarks) or **OpenPose**.
    - Normalize coordinates to account for differences in camera angle or body size.
3. **Feature Extraction**
    - Extract joint angles (e.g., elbow, knee, back alignment).
    - Time-series features like repetition speed and smoothness.
4. **Classification Model**
    - Train a **Random Forest Classifier** (baseline) or a **Neural Network** (LSTM) to distinguish between correct and incorrect postures.
    - Example: A squat with knees going inward would be labeled “incorrect.”
5. **System Flow**
    - **Input:** User uploads an exercise video.
    - **Processing:** AI extracts body keypoints → checks against trained model.
    - **Output:** “Correct form” or “Incorrect form with feedback.”

This pipeline ensures a structured and efficient workflow from raw video input to final feedback. It not only helps in posture correction but also lays the foundation for expanding the system to multiple exercises and real-time analysis in the future

Building Scratch Model

Step 1: Collecting Dataset

- We need videos/images of people performing exercises, along with **labeled body keypoints**.
- Link : https://www.kaggle.com/datasets/hasyimabdillah/workoutfitness-video
- These datasets give both raw frames and the coordinates of joints (used for training).

Step 2: Breaking Videos into Frames

- **Tool used:** OpenCV.
- Each video is split into single images (frames).
- For each frame, we already have the ground-truth joint locations from the dataset.

Step 3: Designing the Model

- **Technology:** Convolutional Neural Networks (CNNs) in TensorFlow/Keras or PyTorch.
- What the model does:
    - Takes an image as input.
    - Outputs a **heatmap** (a probability map) for each joint (like left elbow, right knee).
- Example: If we track 17 joints, the model outputs 17 heatmaps.

Step 4: Training the Model

- **Loss Function:** Mean Squared Error (MSE) between predicted and true heatmaps.

Step 5: Extracting Keypoints from Predictions

- Once the model predicts heatmaps, we take the **highest probability point** in each heatmap → gives the **(x, y) coordinate** of that joint.

Step 6: Using Keypoints for Exercise Classification

- The extracted keypoints become **features**.
- We pass them into a **Random Forest Classifier** or **Neural Network**.
- The classifier decides:
    - Correct posture → continue.
    - Incorrect posture → raise an alert with feedback.

FLOWCHART

Input Video (Uploaded by User)

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Pose Estimation (Building Custom Pose Estimation Model)

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Keypoint Extraction (Joint angles, Positions)

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Feature Extraction (Angles, Speed Smoothness)

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Classification Model (Random Forest)

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Feedback Output (Correct / Incorrect)

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Alert

EXPECTED WORKING

1. The user uploads a video of themselves performing an exercise.
2. The system extracts body keypoints (joints) from each frame using **Mediapipe/OpenPose**.
3. Features such as joint angles, limb positions, and motion dynamics are calculated for posture analysis.
4. A **machine learning model** (Random Forest or Neural Network) classifies the exercise as **correct or incorrect**.
5. The system provides instant feedback, alerting the user to correct posture if needed.

CONCLUSION

The **AI Fitness Coach Agent** aims to serve as a **virtual trainer**, helping users correct their posture and avoid injuries while exercising at home. By combining computer vision and machine learning, the system provides real-time or video-based analysis of exercise form. The project contributes towards making fitness guidance more accessible, affordable, and safe, especially for individuals who cannot always rely on human trainers.

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