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Fit Mentor AI

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Abstract: *Fitness and health are vital components of modern lifestyles, and technology has increasingly contributed to improving personal fitness routines. "Fit Mentor AI" is an innovative project that leverages artificial intelligence (AI) and machine learning (ML) to monitor and analyze exercise form using a device's camera. By detecting and tracking key body points, the system evaluates posture, alignment, and movement to provide real-time corrective feedback, reducing the risk of injury and improving workout efficiency. Unlike traditional fitness apps, which require manual input or pre-recorded videos, "Fit Mentor AI" uses pose estimation algorithms to provide data-driven insights. This project is designed to make fitness coaching accessible, affordable, and effective, bridging the gap between users and professional trainers.*

Keywords: Exercise Form Correction, Human Pose Detection, Body Movement Analysis, Real-Time Feedback System

I. INTRODUCTION

In recent years, advancements in artificial intelligence (AI) and machine learning (ML) have enabled innovative applications in various domains, including healthcare, education, and fitness. With the rise of digital fitness platforms and at-home workout routines, maintaining proper exercise form has become an essential yet challenging aspect of effective fitness training. Improper form during exercises not only reduces workout efficiency but also increases the risk of injuries.

"Fit Mentor AI" addresses this issue by offering an AI-powered solution that uses a device's camera to monitor body movements. The system detects key body points and evaluates posture, alignment, and movement accuracy during exercises like squats, push-ups, and lunges. By providing personalized corrective feedback, the system helps users improve their form, enhance workout effectiveness, and prevent injuries.Fit Mentor AI aims to act as a virtual personal trainer, capable of observing a user's physical movements using the device’s camera, detecting key points on the body, analyzing posture, and delivering real-time feedback. The system leverages pose estimation algorithms to capture skeletal key points (like elbows, knees, and shoulders) and uses this data to evaluate whether a user is executing an exercise properly. Instead of just counting repetitions or providing general instructions, Fit Mentor AI adds a layer of form validation—highlighting posture errors and helping users correct them immediately.

The main advantage of this system is its accessibility and real-time interactivity. Unlike traditional fitness trainers or specialized gym setups, this solution can work using just a smartphone or tablet camera. Users simply set up their device to capture their full body during exercise, and the system does the rest—tracking, analyzing, and offering corrections. Whether the user is at home, in a gym, or even outdoors, Fit Mentor AI brings smart training assistance right to their fingertips.

Another key aspect of this project is its decision to avoid continuous real-time AI model training, which can be resource-intensive and complex. Instead, the application uses pre-trained pose estimation models (such as those offered by Google’s MediaPipe or similar frameworks) to detect body joints and applies custom algorithms to evaluate angles between joints. This allows for lightweight processing and faster feedback delivery, making it suitable even for lower-end mobile devices.

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II. LITERATURE REVIEW

2.1 Existing Systems

Traditional Several fitness applications currently exist, but most focus on tracking general metrics like calories burned and workout duration rather than providing detailed feedback on exercise form.

Examples include:

- MyFitnessPal and Nike Training Club: These apps provide workout plans but lack capabilities for form correction.
- Peloton and Mirror: While these platforms offer instructor-led sessions, they rely heavily on human intervention for feedback.
- Freeletics and Zenia: These AI-powered apps provide some level of personalization but are limited in their exercise coverage and hardware requirements.

2.2 AI-Based Solutions for Exercise Monitoring

- Several AI-powered fitness platforms like Zenia and Freeletics offer exercise guidance with varying levels of personalization.
- These systems utilize computer vision and pose estimation techniques to track body movements during workouts.
- Although effective to some extent, many require specific hardware setups or external sensors for real-time feedback.

2.3 Limitations of Existing Systems

- Manual Input Dependency: Many applications rely on users to input workout data, which may introduce errors or inconsistencies.
- Hardware Requirements: Real-time pose tracking solutions often demand advanced hardware (e.g., depth cameras or high-end GPUs), reducing accessibility.
- Limited Exercise Coverage: Most fitness apps focus on a fixed range of common exercises and lack support for diverse workout routines.
- Lack of Real-Time Form Correction: Apps with pre-recorded videos or static guidance cannot provide live feedback based on the user’s form.

2.4 Research Gaps

Feature	AI-Based Solution (Fit Mentor AI)	API-Based Solution (e.g., Standard Fitness APIs)
Data Requirement	Requires image datasets for model training	Uses pre-processed data from external APIs
Computational Power	High (Model training, pose estimation, angle calculation)	Low (Simple API calls for pre-defined metrics)
Implementation complexity	Moderate to High (Requires algorithm development and training)	Low (Direct integration with minimal custom logic)
Cost	Moderate to High (Depends on model complexity and tools used)	Low (Most APIs have free tiers or minimal charges)

• Existing research focuses heavily on AI-driven agricultural solutions, but fewer studies explore API-based approaches for plant monitoring.
• Agricare aims to bridge this gap by leveraging real-time data from APIs to assist farmers in tracking plant growth, optimizing resource usage, and improving crop health.

III. PROPOSED SYSTEM

3.1 Overview

The proposed system, Fit Mentor AI, is an AI-powered fitness assistant designed to analyze human posture during exercise and provide corrective feedback using only a camera-enabled device. The system is lightweight, works offline on consumer-grade hardware, and does not require wearable sensors or real-time video streaming. It is primarily designed to assess static or captured frames during exercises like squats, lunges, and push-ups. The system architecture comprises five major components: image acquisition, pose detection, angle computation, posture classification, and feedback generation.

1. Image Acquisition

The system begins by capturing an image or a single frame from a video using the device's camera. The user is guided through initial setup steps to ensure full-body visibility and adequate lighting. This ensures the input image includes all necessary body parts for reliable pose estimation.

2. Pose Detection using MediaPipe

The core of the system uses the MediaPipe Pose framework developed by Google, which extracts 33 key body landmarks from the input image. Each landmark is represented as a 2D (x, y) coordinate, normalized with respect to the image dimensions. These keypoints represent critical joints such as shoulders, elbows, wrists, hips, knees, and ankles.

3. Joint Angle Calculation

Using the extracted keypoints, the system calculates specific joint angles using geometric formulas (primarily based on the cosine rule and vector mathematics). For instance, the angle at the knee is calculated using the positions of the hip, knee, and ankle points. These angles are crucial in determining whether the user's body alignment matches the ideal form for a given exercise.

4. Posture Classification

The calculated angles are compared against predefined thresholds derived from fitness standards and physiotherapy references. A rule-based classification model determines if the posture is within acceptable limits. For example, a squat with a knee angle between 90°–120° and a straight back is considered correct. If one or more joints exceed or fall below the ideal range, the system flags the form as incorrect and identifies the problematic joints.

Optionally, a supervised machine learning classifier (e.g., decision tree or SVM) can be trained on a labeled dataset of correct and incorrect forms to enhance the classification process.

5. Feedback Generation

Once a posture is classified, the system generates real-time feedback based on the detected issues. Feedback is presented in both textual format (on-screen messages) and optionally as audio prompts using a text-to-speech engine. Examples include:

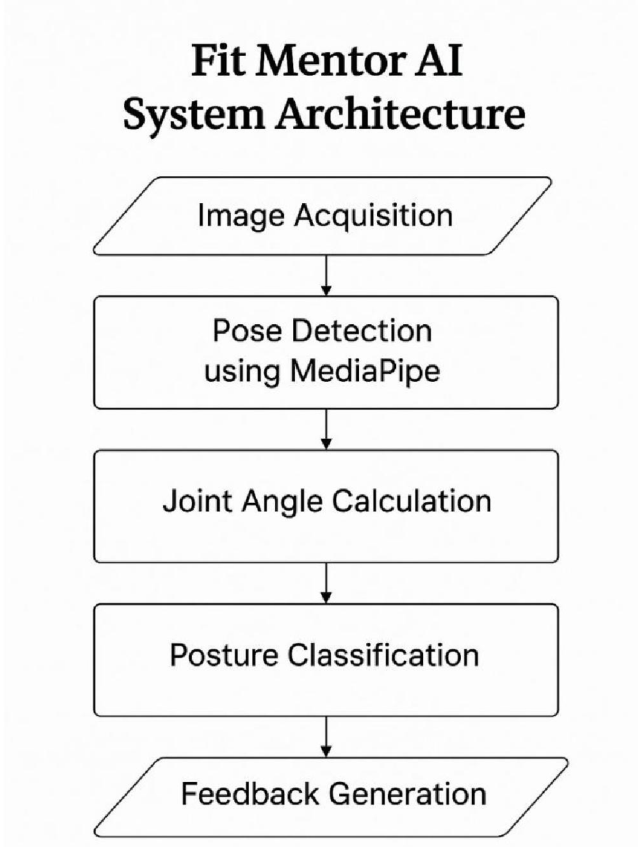
• "Keep your back straight."
• "Lower your hips further."
• "Knees are not aligned."

This immediate, user-friendly feedback helps guide users toward performing the exercise safely and correctly, even without a physical trainer.

3.2 System Architecture The system consists of:

1. User Interface: A web or mobile app for farmers to input plant details and receive reports.

2. Backend System: Manages API requests and processes data.
3. API Integration Layer: Fetches data on weather, soil, and plant health.



3.3 Workflow

1. Image Acquisition
The system captures a clear image or frame using the device's camera, ensuring the full body is visible in the frame.
2. Pose Detection (MediaPipe)
The captured image is processed through the MediaPipe Pose model, which detects and maps 33 body landmarks (keypoints).
3. Keypoint Extraction
The model extracts 2D coordinates (x, y) for each key body part including shoulders, elbows, hips, knees, and ankles.
4. Joint Angle Calculation
Using the keypoints, the system calculates angles at specific joints using geometric and trigonometric formulas.
5. Posture Evaluation
The joint angles are compared against predefined ideal angle ranges for specific exercises (e.g., squats, push-ups).
6. Posture Classification
Based on angle thresholds and joint alignment, the posture is classified as either Correct or Incorrect.
7. Feedback Generation
Appropriate feedback is generated, informing the user what needs to be corrected (e.g., "Straighten your back", "Lower your hips").

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3.4 Key Features

• Uses a standard camera to detect and analyze user posture during exercise.
• Calculates joint angles to evaluate exercise form accuracy.
• Classifies posture as correct or incorrect based on angle thresholds.
• Provides real-time feedback using text and voice prompts.
• Operates offline without the need for internet or cloud services.
• Designed to run on smartphones, tablets, and low-power devices.
• Supports multiple exercises including squats, push-ups, and lunges.
• Offers a simple and user-friendly interface for all experience levels.
• Built with a modular structure for easy future expansion and upgrades.

IV. SYSTEM ARCHITECTURE

The proposed system consists of three main components:

1.User Interface Layer: Developed using Flutter, this layer provides a user-friendly interface for exercise selection and feedback visualization.

2.Application Layer: Captures video input and processes it for body movement detection.

3.Machine Learning Layer: Utilizes MediaPipe for pose estimation and Python for backend processing.

4.Data Storage Layer: Stores user profiles and exercise history using Firebase or SQLite.

5.Integration Layer: Enables communication between the app and external libraries.

System Architecture Diagram :

Algorithm

1. Start the application and initialize the camera.
2. Prompt the user to set up their device and select an exercise.
3. Begin capturing video from the camera.
4. Use MediaPipe to detect key body points in each video frame.
5. Analyze the detected key points and calculate angles relevant to the exercise.
6. Compare the calculated angles to predefined correct posture metrics.
7. Provide real-time feedback based on the analysis.
8. Display visual and optional audio cues for corrections.
9. Allow the user to end the session and save exercise data.
10. Exit the application.

V. CONCLUSION

The development of Fit Mentor AI demonstrates the practical application of artificial intelligence and computer vision in improving health and fitness experiences through posture correction. By using only a standard camera and the MediaPipe pose estimation framework, the system successfully detects key body joints, calculates joint angles, and evaluates the accuracy of common exercise forms such as squats and push-ups.

This project effectively eliminates the need for wearables or real-time video processing by focusing on static image-based inference, making it lightweight and accessible for users with everyday devices. The feedback mechanism—delivered via on-screen prompts or voice commands—provides users with actionable suggestions to correct their form, ultimately reducing the risk of injury and enhancing workout effectiveness.

Through structured methodology, careful dataset selection, and modular system design, Fit Mentor AI lays the foundation for intelligent, affordable, and user-friendly virtual fitness assistance. It highlights how modern AI tools can be applied to solve real-world problems in a meaningful and scalable way.

5.1 Summary of Contributions

The Fit Mentor AI project presents a novel approach to posture correction using artificial intelligence and computer vision, designed specifically for users performing exercises without physical supervision. This system contributes to the growing field of AI-assisted fitness and health in the following key ways:

- Developed a camera-based posture correction system that does not rely on any wearables or external sensors.
- Successfully integrated MediaPipe Pose to extract 33 body landmarks and applied mathematical models to evaluate exercise form.
- Implemented angle-based analysis to assess user posture during workouts such as squats and push-ups.
- Built a feedback system capable of delivering correctional advice through text and voice, improving user interaction and guidance.
- Created a lightweight, offline-capable solution that runs on standard consumer devices such as smartphones and laptops.
- Designed a clean and modular system architecture that supports scalability and potential real-time enhancements in future iterations.
- Curated and processed a dataset combining public resources and manually collected samples, labeled for correct and incorrect posture.
- Demonstrated that AI-driven posture evaluation can be both accessible and effective, promoting safe and injury-free fitness training at home.

5.2 Limitations and Future Work

Limitations

While Fit Mentor AI offers an efficient and lightweight approach to posture correction using AI, there are certain limitations:

• The system primarily supports static image or frame-based analysis, which limits continuous real-time tracking of exercises.
• Performance can be affected by poor lighting, low-resolution cameras, or improper camera angles.
• The current version supports only a limited set of exercises (e.g., squats, push-ups, lunges).
• Variations in user body types and clothing may lead to inconsistencies in keypoint detection.
• The classification logic is currently rule-based, which may not adapt well to more complex or nuanced postures.

Future Work

To further enhance the system's capabilities and effectiveness, the following improvements are proposed:
• Integrate real-time video analysis to allow continuous feedback during entire exercise sessions.
• Expand the exercise library to include more complex movements such as yoga poses, plank variations, and functional training routines.
• Use machine learning classifiers or deep learning models trained on larger, diverse datasets to improve the accuracy of posture classification.
• Develop a mobile application version with a built-in voice assistant and workout tracker.
• Incorporate personalization features based on user height, fitness level, or flexibility for more tailored feedback.
• Add performance metrics and analytics to help users track their improvement over time.

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