AI-Based Workout Assistant and Fitness Guide

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Abstract—**Health and Fitness play a vital role in our day-to- day life. This can be attained in many ways, of which exercising is one. Performing exercise can help us maintain very good health, only if carried out properly and in a defined manner; otherwise, the repercussions may have adverse effects on our body. To tackle this issue, we have created a system that keeps track of body movements and provides us with the number of repetitions performed, if done correctly. Our system also provides audio instruction to the user when performing the exercise inappropriately. With the assistance of the user's physical measurements and diet, the system tracks the user's calorie intake and recommends an ideal calorie intake to achieve a normal Body Mass Index to stay fit.**

Index Terms—**Mediapipe Pose Estimation Model, Body Mass Index, Fitness Tracking, Posture Correction, Diet Recommendation**

I.   INTRODUCTION

The emergence of various applications such as smartwatches has helped users track their fitness data, i.e., calories burnt, distance covered, etc. However, tracking body postures during exercise still requires external help from a physician or trainer. This research explores the working and integration of an AI-powered workout assistant and fitness guide, utilizing the Mediapipe body pose estimation model to monitor users' body posture during exercise. It aims to prevent injuries, suggest real-time posture corrections, track repetitions, and measure calories burnt for each exercise performed.

The AI-based Workout Assistant and Fitness Guide features real-time exercise monitoring and posture correction, which enables users to perform various exercise routines, keep track of exercise repetitions, maintain correct postures, and monitor calories burned. Additionally, the system recommends daily diets based on the user's Body Mass Index and calorie requirements, enabling users to maintain good physical health, increase fitness levels, develop healthy eating habits, monitor daily calorie expenditure, and prevent chronic and immediate injuries.

II.   LITERATURE   REVIEW

Several studies have contributed to the development of pose estimation and fitness tracking systems. Bazarewsky et al. [1]proposed BlazePose, a system that generates 33 body key points and operates at above 30 frames per second on a Pixel 2 phone, making it suitable for real-time applications like health trackers.

Papandreou et al. [2] introduced PersonLab, a technique where the model learns to recognize individual key points and forecast their relative displacements, achieving a COCO keypoint averaging precision of 0.665 and 0.687 using single-scale inference.

Cao et al. [3] described a system that learns to link body parts with persons in an image using a nonparametric representation called Part Affinity Fields (PAFs). Their bottom-up approach provides good precision and real-time performance regardless of the number of people in the image.

Toshev and Szegedy [4] proposed DeepPose, a system addressing pose estimation as a problem of joint regression and its successful implementation in Deep Neural Network (DNN) settings. The cascading of DNNs plays a significant role in refining human postures, especially for legs and challenging limb positions.

Taware et al. [5] introduced Fitcercise, a software that detects the user's workout stance, counts prescribed exercise repetitions, and provides personalized advice on improving form. The software detects a person's stance using MediaPipe, analyzes the pose mathematics, and counts workout repetitions using a database and actual video.

III.   SYSTEM ARCHITECTURE

The application contains three main features:

A.   *Virtual Fitness Trainer*

The user selects a specific exercise to perform. If executed precisely, the system tracks repetitions. Otherwise, it generates audio instructions for posture correction. The system utilizes the Mediapipe pose estimation model to detect body key points and analyze the posture in real-time.

B.   *Diet Recommender*

This feature recommends daily meals (breakfast, lunch, dinner) based on the user's current BMI, aiming to achieve a normal BMI. It tracks calorie intake to ensure healthy eating habits and generates an automated grocery list based on the user's selected diet items.

C.   *User Profile and History*

Displays the user's progress, including repetitions per- formed and calorie intake over time. This helps users monitor their

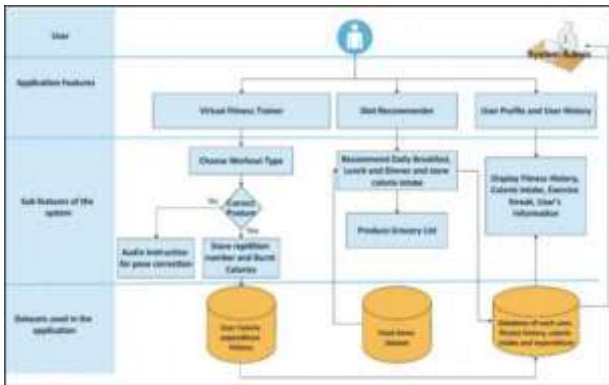fitness journey and make necessary adjustments to their workout and diet plans.

Fig. 1. System Architecture of AI-Based Workout Assistant and Fitness Guide

IV.   ALGORITHM AND MATHEMATICAL MODELING

Our application follows a structured approach to exercise tracking and posture correction:

A.   Exercise Selection and Configuration

- Choose an exercise from the available options.
- Define constraint points of the Mediapipe Model to calculate distances or angles formed by these points for the specific exercise.
- Retrieve body joint coordinates from the Mediapipe pose estimation model.

B.   Angle Calculation

To determine if a posture is correct, we calculate the angle between three key points:

- Assume points L, M, R representing three body joints.
- Compute segment lengths LM, MR, LR.
- For angle LMR, use the formula:

$$LM^2 + MR^2 - LR^2$$

Posture Analysis

- Perform Geometric Analysis and compare with reference data.
- If the posture is correct, increase the exercise count.
- If incorrect, trigger audio posture correction instructions.
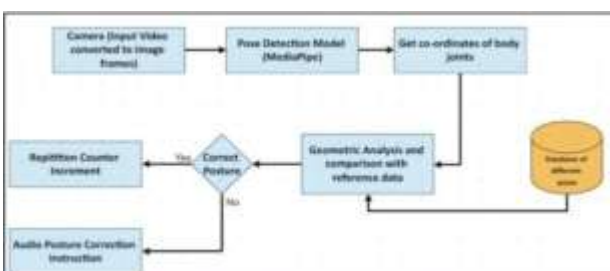- Repeat the process for other exercises.

Fig. 2. Mathematical Model for Angle Calculation Between Three Points

V.   IMPLEMENTATION

The implementation of our system involves several key components:

A.   Pose Detection Module

We utilize the Mediapipe pose estimation model to detect and track 33 body key points in real-time. These key points are used to calculate angles and distances between body joints, which are essential for determining the correctness of exercise posture.

B.   Exercise Tracking System

The system tracks exercise repetitions by monitoring the changes in joint angles and positions. For each exercise, specific thresholds and conditions are defined to recognize a complete repetition. When the user performs an exercise correctly, the repetition counter increments.

C.   Posture Correction Mechanism

Real-time feedback is provided through audio instructions when the system detects incorrect posture. This helps users adjust their form immediately, preventing potential injuries and ensuring effective workouts.

D.   Diet Recommendation Engine

Based on the user's BMI and physical attributes, the system calculates daily calorie requirements and recommends suitable meal plans. The engine offers flexibility for users to select preferred food items while staying within their calorie limits.

VI.   RESULTS AND DISCUSSIONS

$$\vartheta = \arccos 2 \times LM \times MR \quad (1)$$

Our application has shown promising results in tracking exercise repetitions and providing posture correction feedback.

- Convert radians to degrees:

$$degrees = \vartheta \times 180 \quad (2) \frac{}{\pi}$$

The system accurately counts repetitions when exercises are performed correctly and provides timely audio instructions for posture adjustments.

Fig. 3. Exercise Tracking Interface with Repetition Counter

The diet recommendation feature has been well-received, with users reporting improved eating habits and progress toward their ideal BMI. The automated grocery list generation simplifies meal planning and adherence to dietary recommendations.

User feedback indicates that the application effectively reduces dependency on physical trainers and dieticians, pro- viding a comprehensive fitness solution accessible from home

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VII. APPLICATIONS

The AI-Based Workout Assistant and Fitness Guide has several practical applications:

- **Gym Automation:** The application can be implemented on a large scale for gym automation and fitness centers, allowing people to exercise without needing a physical trainer while maintaining the correct posture for each exercise.

- **Health Monitoring:** The software can track daily calorie intake and expenditure, benefiting dieticians and health institutes in monitoring and managing patient health.

- **Home Fitness Solution:** Common users can utilize this software to exercise at home, eliminating the need for an instructor while ensuring proper form and technique.

- **Personalized Fitness:** AI analyzes your fitness level, goals, and performance to create adaptive, dynamic work- out routines tailored to individual needs.

- **Injury Prevention:** Using pose detection (like Medi- apipe), the system provides instant feedback to improve posture and prevent exercise-related injuries.

VIII. CONCLUSION AND FUTURE WORK

The AI-Based Workout Assistant and Fitness Guide success- fully addresses the need for proper exercise guidance and nu- tritional planning. By leveraging AI technologies, particularly the Mediapipe pose estimation model, our system effectively monitors exercise posture, counts repetitions, and provides real-time feedback for corrections.

Future improvements include:

- Exploring camera positioning to handle both standing and seated exercises.

- Enhancing model accuracy by incorporating more posture checks and reference data.

- Extending the application to estimate yoga postures, making it accessible to a broader audience.

- Integrating with other digital devices such as fitness watches for comprehensive fitness tracking.

- Developing advanced analytics to provide deeper insights into fitness progress and health improvements.

Our application reduces dependency on trainers and di- eticians by providing personalized, automated guidance for exercises and diet plans. It supports users in achieving an ideal BMI, improving fitness levels, and promoting healthy eating and exercise habits, making fitness more accessible and effective for everyone.

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