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FitSpire: An AI-Powered Fitness Companion with Real-Time Posture Correction and Mood-Based Recommendations

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ABSTRACT :

The growing trend towards home-based fitness, driven by demands for convenience and accessibility, has highlighted a critical gap in the fitness landscape: the lack of accessible, professional guidance to ensure correct exercise form and maintain user motivation. Incorrect posture during workouts not only diminishes effectiveness but also significantly increases the risk of injury. To address this, we present FitSpire, an AI-powered fitness application that serves as an intelligent workout companion. FitSpire leverages the MediaPipe framework and the BlazePose model for real-time human pose estimation to analyze user form during exercises like push-ups and bicep curls. It provides immediate, voice-guided corrective feedback to prevent injuries. Furthermore, FitSpire innovates by incorporating user mood as an input to recommend personalized workout routines (e.g., HIIT, Yoga, Stretching), enhancing both physical and mental well-being. Built with a Flutter frontend for cross-platform compatibility and a Python backend for AI processing, the application offers a seamless, engaging, and safe home workout experience. Our results demonstrate the system's accuracy in classifying correct and incorrect postures based on body joint angles, validating its potential to make professional fitness guidance more accessible and effective.

I. INTRODUCTION

Regular physical activity is a cornerstone of a healthy lifestyle, combating issues like muscle atrophy, poor cardiovascular health, and mental stress [1]. However, the rising popularity of home-based fitness, fuelled by the pursuit of convenience and time efficiency, has a significant drawback: the absence of certified trainers to provide real-time feedback on exercise form. The National Safety Council reported 468,000 exercise-related injuries in 2019 alone [1], a number that underscores the persistent risk of exercising without proper guidance.

Existing fitness applications often offer static video libraries or simple repetition counters but fail to address the critical aspect of *form validation*. This lack of real-time, corrective feedback can lead to users reinforcing incorrect movements, nullifying benefits and causing injury.

Our project, FitSpire, is designed to bridge this gap. It is an AI-based fitness companion that uses advanced computer vision to monitor a user's posture in real-time through their smartphone camera. By estimating 33 key body landmarks using the BlazePose model, FitSpire calculates joint angles and compares them to predefined thresholds for correct form, providing instant audio-visual feedback. Beyond posture, FitSpire personalizes fitness by tailoring workout plans to the user's self-reported mood (e.g., stressed, tired, energetic), recommending routines like yoga for relaxation or HIIT for an energy boost. This holistic approach aims to make home workouts not only safer but also more engaging and psychologically attuned.

II. LITERATURE REVIEW

The integration of AI and computer vision into fitness is an emerging field of research. Several studies lay the groundwork for FitSpire.

The work by Dsouza et al. [2] on a "Smart Gym Trainer Using Human Pose Estimation" demonstrates the viability of using CNNs and optical flow for real-time pose estimation in a gym environment. They identified challenges like handling varying body shapes and providing robust feedback, which we have considered in our architecture.

Bazarevsky et al. [3] introduced BlazePose, a lightweight convolutional neural network architecture optimized for real-time body pose tracking on mobile devices. Its ability to predict 33 3D keypoints at over 30 frames per second makes it ideal for our real-time feedback requirement. Similarly, the "Vyayam" system [4] focused specifically on bicep curl tracking using AI, confirming the high accuracy of such approaches compared to manual tracking and their positive effect on user form.

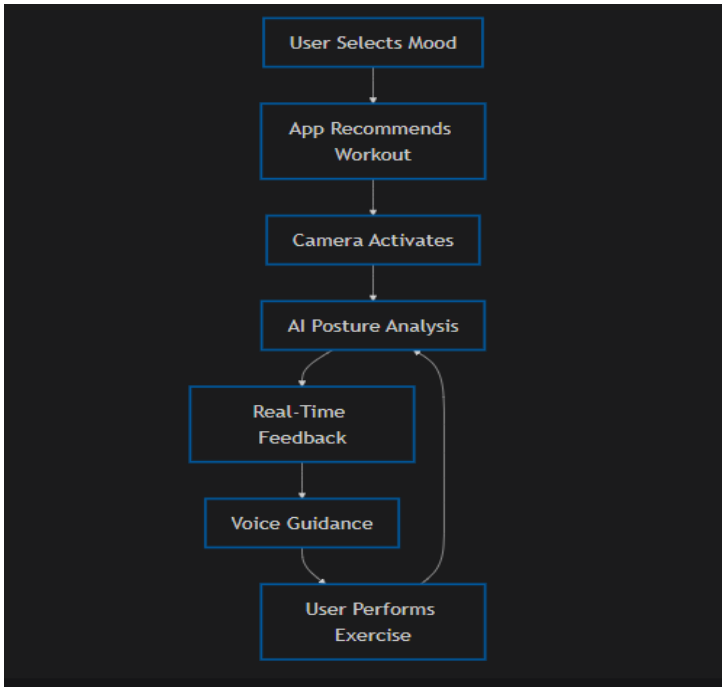
Kanase et al. [5] focused on posture correction by calculating body angles, a method we directly adopt and extend in our pose comparison module. Furthermore, research indicates a growing interest among users, including older adults, in using mobile technology for assisted living and fitness [6], validating our choice of a smartphone-based platform.

While these contributions are significant, they often focus on a single exercise or lack the holistic user experience. FitSpire differentiates itself by combining multi-exercise posture correction with mood-based personalization and multilingual voice guidance, creating a comprehensive fitness solution.

III. METHODOLOGY

The FitSpire system architecture is a multi-modular pipeline designed for efficiency and real-time performance. The workflow is depicted in Fig. 1.

Fig. 1: System Architecture of FitSpire.



A. Image Acquisition

The input is acquired through the user's smartphone camera, accessed via the Flutter camera plugin. The system processes live video frames at a resolution sufficient for accurate pose detection (e.g., 640x480 pixels). Each frame is sent to the pose estimation module for processing.

B. Pose Estimation with MediaPipe & BlazePose

We employ the MediaPipe framework with the pre-trained BlazePose model [3]. For each frame, BlazePose detects a human figure and returns 33 anatomical landmarks (e.g., shoulder, elbow, wrist, hip, knee) with their 3D coordinates (x, y, z) and a visibility score.

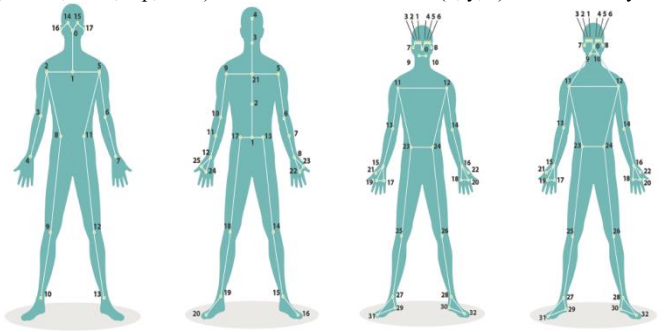


Fig. 2: BlazePose 33 Keypoint Topology [3].

This lightweight model allows for real-time inference directly on a mobile device, ensuring low latency and privacy as video data does not need to be streamed to an external server.

C. Angle Calculation and Pose Comparison

The core logic for form analysis lies in this module. Key joints are identified from the 33 landmarks. For instance, for a push-up, the shoulder, elbow, and hip landmarks are critical.

A geometric function calculates the angle at a joint using three consecutive keypoints. For example, the elbow angle is calculated using the shoulder, elbow, and wrist landmarks.

The calculated angle is compared against a predefined threshold range for that specific exercise and position (e.g., in a correct push-up 'up' position, the elbow angle should be >160° and the hip angle >160°). These thresholds are derived from kinesiology standards and validated datasets.

D. Feedback Generation

Based on the pose comparison, feedback is generated:

- Visual Feedback: The app interface displays a message ("Correct!" or "Lower your hips!").
- Audio Feedback: Using the flutter_tts package, the app provides spoken, multilingual instructions (e.g., "Keep your back straight"), making it hands-free and accessible.

E. Mood-Based Workout Recommendation

Before the workout, the user selects their current mood (e.g., Happy, Tired, Stressed) from a simple UI. This input triggers a recommendation algorithm that maps moods to workout types:

- Tired → Yoga/Stretching: Low-intensity for relaxation.
- Stressed → HIIT: High-intensity to release endorphins.
- Happy → Strength Training: For users feeling energetic and motivated.
- This logic provides a personalized fitness experience that addresses mental well-being.

IV. RESULTS AND DISCUSSION

We tested the posture detection module on standard exercises. The following tables demonstrate the system's ability to differentiate between correct and incorrect form based on joint angles, using sample data from our tests.

The results show a consistent pattern. Correct postures adhere to the predefined angular thresholds, while incorrect postures show clear deviations (e.g., a hip angle below 160° indicates a sagging back). The system successfully identifies the specific joint causing the error, enabling targeted feedback.

Fig.3

Fig4

Fig. 3 & 4: Correct and Incorrect Push-Up Postures.

The mood-based recommendation and voice guidance modules were tested functionally and provided the expected output, successfully creating a dynamic

and interactive user experience.

V. LIMITATIONS AND FUTURE WORK

While promising, the current system has limitations:

1. Environmental Sensitivity: Pose detection accuracy can vary with poor lighting, camera angle, or cluttered backgrounds.
2. Hardware Dependency: Real-time AI processing requires a mid-to-high-range smartphone; performance may lag on older devices.
3. Mood Input: Current mood selection is manual. Future work will integrate automatic mood detection using facial expression analysis.
4. Exercise Library: The initial version supports a limited set of exercises.

Our future work will focus on:

- Integrating with wearable devices (smartwatches) for heart rate and calorie data.
- Adding gamification elements (badges, leaderboards) to boost motivation.
- Expanding the AI model to support a wider variety of exercises.
- Developing a more advanced recommendation engine that adapts workout intensity based on user performance history.

VI. CONCLUSION

FitSpire presents a novel, holistic approach to AI-assisted home fitness. By leveraging the BlazePose model for real-time, accurate pose

estimation, it provides crucial corrective feedback to prevent injuries and improve workout efficacy. Its unique integration of mood-based recommendations and multilingual voice guidance addresses user engagement and mental well-being, aspects often overlooked by conventional fitness apps. Developed with Flutter and Python, FitSpire offers a scalable, cross-platform solution. Our results confirm its technical feasibility in posture analysis. FitSpire demonstrates the potential to make personalized, trainer-quality fitness guidance accessible to everyone, anywhere, ultimately promoting a healthier lifestyle.

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