FormFit: AI-Based Real-Time Fitness Training and Posture Feedback System

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Abstract - Home workouts have become increasingly popular as they allow individuals to exercise without the need for gym access, personal trainers, or dedicated equipment. However, performing workouts without supervision often results in incorrect posture, reduced efficiency, and a higher risk of injury. To address this concern, the present work introduces a real-time exercise posture evaluation and feedback system that operates directly in a web browser. The system makes use of the MediaPipe BlazePose model to detect human skeletal landmarks from a webcam stream and applies joint-angle calculations to assess posture accuracy across common exercises such as squats, lunges, push-ups, and bicep curls. A rule-based decision mechanism is employed to verify posture correctness and count valid repetitions only when movements meet predefined thresholds. Immediate on-screen feedback assists users in adjusting their form during the workout rather than after completion. Exercise performance data is stored using MongoDB, and a React-based dashboard enables users to review their progress over time. Experimental evaluation shows that the system performs reliably across different body types and indoor conditions. The approach demonstrates that computer-vision-based posture monitoring can provide affordable and effective guidance for home fitness without requiring wearable sensors or external supervision.

Key Words: Virtual personal trainer, Pose estimation, MediaPipe, OpenCV.js, Socket.IO, JSON Web Tokens (JWT), RESTful API

1. INTRODUCTION

The increasing dependence on home workout routines has shifted responsibility for movement accuracy from fitness trainers to individuals. Although fitness videos and mobile training applications provide guidance, they do not evaluate whether the user performs movements with the correct posture. Suboptimal form, knee valgus, hip drop, and partial range of motion are frequently observed errors that compromise training outcomes. Advances in computer vision now make it possible to extract skeletal kinematics using only a webcam. MediaPipe BlazePose enables detection of 33 anatomical landmarks on the human body, and can serve as the foundation for real-time motion evaluation. This work develops a posture-aware workout assistant that delivers live correction, repetition validation and performance analytics directly through a web browser.

2. SYSTEM OVERVIEW

2.1 Problem Context

Existing fitness applications largely focus on repetition counting, timers and demonstration videos but cannot monitor technique. Incorrect posture repeated across sessions reinforces improper motor patterns rather than improving fitness. A system capable of analysing movement precision in real time can act as a virtual trainer for home users.

2.2 System Architecture

The proposed platform integrates pose estimation and web technologies within a modular MERN stack. React manages webcam streaming and user interaction. BlazePose extracts skeletal landmarks, OpenCV.js computes angular metrics, and a rule-based inference engine validates posture. Workout metrics are stored in MongoDB using a Node.js and Express backend.

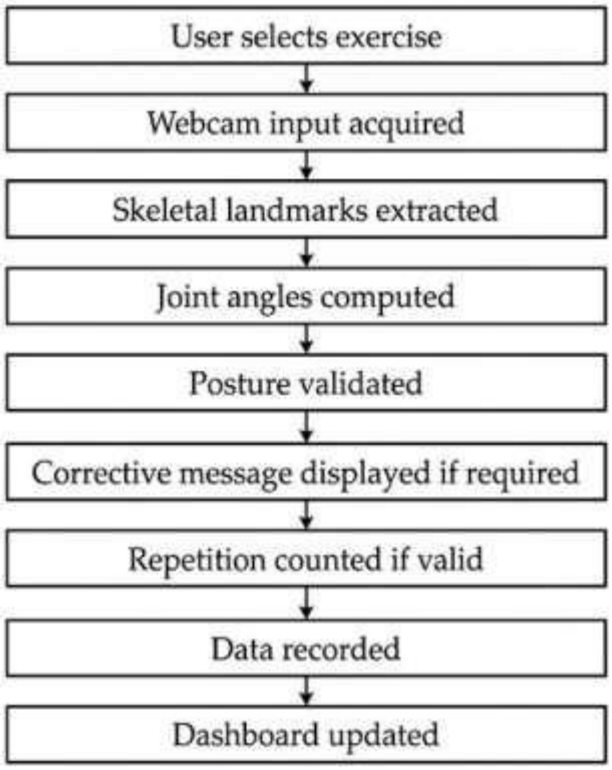

Fig.2.1 System Architecture

2.3 Core Components

- Webcam Capture Module: Captures user motion through browser.
- Pose Landmark Detector: BlazePose infers joint coordinates in real time.
- Angle Processing Engine: Computes joint angles using trigonometry.
- Posture Evaluation Module: Validates movement based on predefined thresholds.
- Repetition Validator: Increments only if posture passes all checkpoints.
- Analytics Dashboard: Visualises long-term workout history.

2.4 Operational Workflow

The operational workflow of the system begins when the user selects an exercise from the application interface. Once selected, the webcam activates and captures live video, from which skeletal landmarks are detected using MediaPipe BlazePose. These landmarks are then processed to calculate joint angles in real time. Based on these angles, the rule-based validation engine determines whether the user is maintaining correct posture. If the posture is incorrect, a corrective message is displayed to guide improvement. When the posture meets defined thresholds, a valid repetition is registered, stored in the database, and reflected in the user's performance dashboard.

2.5 Functional Capabilities

The system provides stability detection, posture-oriented rep counting, timing control, voice/text feedback and continuous monitoring to discourage injury-prone technique.

Functional Capability	Description
Stability detection	Detects loss of balance or improper alignment during exercise.
Posture-oriented rep counting	Counts repetitions only when the user's posture is correct.
Timing control	Ensures controlled movement tempo during each stage of an exercise.
Voice/text feedback	Provides live corrective cues during the workout.
Continuous monitoring	Tracks the user's posture throughout the entire workout to discourage injury-prone technique.

2.6 Performance Evaluation

Tests across indoor lighting variations and different body shapes showed that the model sustained stable inference. The rule engine successfully filtered incomplete or unsafe movement patterns and maintained low latency during live feedback.

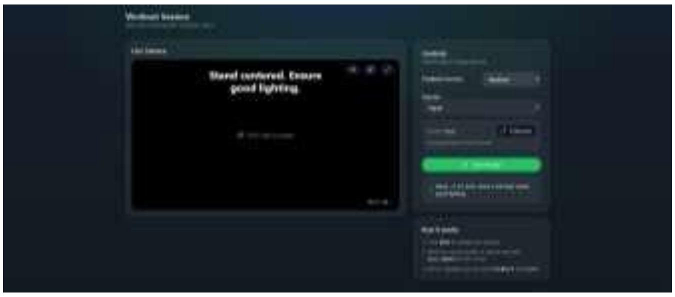

Fig.2.2 Performance Evaluation

Fig. 2.3 Calorie Counter

2.7 User Experience Summary

Participants reported that live feedback reduced uncertainty, provided confidence, and prevented habitual errors. New users felt more comfortable attempting compound exercises independently, and experienced users valued progress tracking.

Fig. 2.4 User Profile Setup UI

Fig.2.5 Diet Log UI

2.8 Limitations

Occasional landmark drift occurred during poor lighting or loose clothing. Only a defined set of exercises is currently supported. Personalisation and adaptive scoring remain future enhancements. In addition, the accuracy of joint-angle estimation can vary based on camera distance and body orientation, which may reduce feedback precision for users who move outside the optimal frame. The system also relies on a stable internet connection for smooth dashboard updates, though pose detection itself runs locally. Furthermore, the current rule-based posture evaluation cannot fully account for individual biomechanical differences such as flexibility, injury history, or body proportions. Incorporating machine learning–based adaptive calibration may address these limitations in future versions.

2.9 Comparative Context

Compared with repetition-only fitness apps and wearable-based trainers, this system provides posture validation without hardware cost and visual tracking without manual supervision. Compared with repetition-only fitness apps and wearable-based trainers, this system provides posture validation without hardware cost and visual tracking without manual supervision. Traditional workout applications typically focus on counting repetitions or guiding users through prerecorded videos without verifying whether movements are performed safely or with proper alignment. Wearable-based systems can deliver accurate motion data but require devices that many users may not have access to and often involve calibration or subscription costs. In contrast, the proposed system uses only a webcam and a browser to evaluate posture, making it more accessible and cost-effective. The real-time feedback loop also gives users a level of guidance that is closer to a human trainer, improving both safety and workout quality.

3. CONCLUSION

The study demonstrates that a browser-based posture evaluation system powered by MediaPipe BlazePose and the MERN stack can provide safe and effective home workout guidance. The platform improves form accuracy through real-time feedback, encourages structured progression and reduces reliance on personal trainers and wearable sensors. Future work includes developing personalised workout recommendations, automated exercise type recognition and full mobile deployment.

Moreover, the results highlight that users were able to understand and correct their posture more confidently when feedback was delivered immediately during the exercise rather than after the session. The system's lightweight implementation also means that users do not require specialised hardware, making it accessible to anyone with a standard laptop or webcam. Feedback collected during testing suggests that users found the dashboard visualisations helpful for tracking improvements over time and staying motivated to exercise regularly. Expanding the system to support multiple difficulty levels and adaptive exercise plans could further enhance user engagement and make the platform suitable for both beginners and experienced fitness enthusiasts.

4. FUTURE SCOPE

The system can be enhanced further by incorporating AI-driven adaptive scoring that personalizes posture evaluation based on each user's flexibility, body proportions, and fitness level. Automatic exercise classification using deep learning would eliminate the need for manual exercise selection and support more seamless workout sessions. Additional features such as voice-based guidance, multi-language support, and gamified challenges can improve long-term engagement. A mobile version with offline pose detection would make the platform more accessible, especially for users without laptops. Integration with smart wearables and physiotherapy datasets also presents opportunities to expand the system for injury rehabilitation and professional athletic training.

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