WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

AI Fitness Trainer: REAL-TIME EXERCISE POSE DETECTION USING OPENCV,MEDIAPIPE AND STREAMLIT

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ABSTRACT :

This paper presents the development of an AI-powered fitness trainer that leverages real-time computer vision to analyze posture, track exercise reps, and provide intelligent feedback. Built using Python, OpenCV, and MediaPipe, this Streamlit-based web application ensures correct exercise form and minimizes injury risks by detecting incorrect postures. The system also integrates a nutrition tracker and AI chatbot for holistic fitness monitoring. Designed for fitness enthusiasts of all levels, this solution enhances home workouts by combining user-friendly design with cutting-edge AI, aiming to democratize fitness training and improve accessibility.

Keywords: AI Fitness Trainer, Pose Estimation, Computer Vision, MediaPipe, OpenCV, Streamlit, Real-Time Feedback, Rep Counting

1. Introduction

The global shift towards digital fitness has seen a rise in demand for intelligent workout solutions that help users maintain proper exercise form. In traditional settings, a fitness trainer guides and corrects form, ensuring effectiveness and preventing injuries. However, during home workouts, this guidance is often missing. AI Fitness Trainer aims to fill this gap using computer vision technologies. This system uses a standard webcam and advanced algorithms to analyze body posture, count repetitions, and offer real-time feedback, bringing the personal trainer experience into users' homes.

2. Literature Review

Several existing research works have focused on human pose estimation and workout posture correction using AI techniques:

1. Pose Trainer by Steven Chen and Richard R. Yang provides real-time feedback to users by detecting exercise postures using pose estimation frameworks like OpenPose or MediaPipe. It helps reduce injury risks but may face limitations in device performance and personalization.

2. The survey by Lijuan Zhou et al. presents a comprehensive overview of deep learning methods for pose estimation, tracking, and action recognition. Though insightful, the work is broad and lacks implementation-specific analysis.

3. Paritosh Parmar et al. proposed a domain knowledge-informed self-supervised model to assess workout form. Their system integrates motion patterns and self-supervised learning for enhanced robustness, but it requires complex computational resources and expert input for validation.

3. Methodology

The AI Fitness Trainer is built as a web application using Streamlit. It uses a webcam for capturing real-time video, MediaPipe for pose estimation, and OpenCV for frame analysis. Key modules include:

- User Interface: Built using Streamlit for simplicity and responsiveness.
- Real-Time Tracking: MediaPipe analyzes skeletal keypoints.
- Rep Counting: Exercise-specific logic counts accurate repetitions.
- AI Chatbot: OpenAI-powered chatbot (FitBot) answers fitness-related questions.
- Nutrition Tracker: Users can log daily meals and monitor nutrition.
- Motivational Tools: Built-in music and podcast playlists to enhance engagement.

4. Implementation

The development followed the Software Development Life Cycle (SDLC) using the Iterative Model. Key steps included:

- Requirement Gathering: Identified needs such as posture analysis, rep counting, and feedback.
- Design: Structured architecture using Python, Streamlit, OpenCV, and MediaPipe.
- Iterative Development: Six iterations refined features like UI, rep counting, nutrition logging, chatbot integration, and performance optimization.
- Testing: Over 20 functional tests ensured real-time accuracy, responsiveness, privacy, and usability.

5. Results and Discussion

The AI Fitness Trainer successfully provided real-time posture correction and rep counting. Testing across multiple browsers, devices, and lighting conditions showed high reliability. The system responded well to incorrect postures, offering accurate feedback. User engagement improved through motivational content and intuitive navigation. Future enhancements such as AR and wearables are expected to elevate personalization and training insights.

6. Features and Applications

The AI Fitness Trainer includes a wide range of features that make it a comprehensive workout companion:

- Real-time posture correction using computer vision
- Automated repetition counting for multiple exercises
- AI chatbot for fitness-related advice and user interaction
- Built-in nutrition tracker for dietary logging and feedback
- Workout music and podcasts for motivation
- Secure processing of camera data to maintain privacy
- Compatibility across devices and browsers

Applications:

- Home-based fitness training
- Gym training assistance without a physical trainer
- Remote fitness coaching platforms
- Integration with e-commerce and fitness gear recommendations
- Potential use in physiotherapy and rehabilitation exercises

7. Future Scope

Future developments of the AI Fitness Trainer aim to enhance its functionality and usability further:

- Integration with wearable fitness trackers for advanced analytics
- Augmented reality (AR) based guidance overlays for real-time visualization
- Gamification features including badges, challenges, and community workouts
- Support for multiple languages and regional workout styles
- Personalized workout plans using AI-driven performance analysis
- AI-powered meal suggestions and nutritional analysis
- Virtual community integration for shared goals and encouragement

Acknowledgements

We extend our heartfelt thanks to our project guide, Er. Poonam Pawar, for her guidance and support throughout the project. We are also grateful to the Head of Department, Mr. Vijay Patil, and our Principal, Dr. Ashish Ukidve, for their continuous encouragement. Special thanks to all our faculty members and teammates for their contributions.

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