Real-Time Exercise Tracker Using Mediapipe and Flask Framework

*An AI-powered system for exercise monitoring and calorie estimation

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***Abstract*—This paper presents a real-time exercise tracking system developed using Mediapipe and Flask. The system leverages advanced computer vision algorithms to monitor user movements during popular exercises such as bicep curls, squats, and push-ups. It offers real-time feedback on posture and form, accurately counts repetitions, and estimates calories burned using standardized MET (Metabolic Equivalent of Task) values in conjunction with the user's body weight and exercise duration.**

Designed with accessibility in mind, this system eliminates the need for expensive gym equipment or personal trainers. Users can perform workouts at home using just a webcam, making fitness both affordable and convenient.

A key feature of the application is its ability to log workout session data — including exercise type, number of repetitions, calories burned, and timestamps — into a CSV file. This structured data can be used for further analysis, such as tracking progress over time, identifying consistency patterns, or even detecting irregularities in exercise form.

The system is lightweight, scalable, and built for seamless integration into personal or community health platforms. By providing immediate, actionable insights and maintaining a history of user performance, it aims to boost motivation, promote accountability, and support data-driven fitness routines.

***Index Terms*—exercise tracking, Mediapipe, Flask, real-time feedback, calorie estimation, pose detection, fitness AI, computer vision**

I. Introduction

The growing popularity of fitness and wellness, along with the increased availability of smartphones and web cameras, has made it possible to develop intelligent personal fitness assistants powered by artificial intelligence. This paper proposes a real-time exercise tracking system that leverages Mediapipe's high-performance pose estimation and Flask's lightweight web framework to offer interactive workout monitoring.

With sedentary lifestyles becoming increasingly common due to remote work and digital entertainment, there is an urgent need for accessible tools that encourage regular physical activity. While personal trainers offer customized fitness guidance, their availability may be limited by geographical and financial constraints. This system aims to democratize fitness coaching by providing a digital solution accessible from any device with a webcam.

Key features of the system include:

- Monitoring user posture to ensure proper form and reduce injury risks.
- Delivering motivational cues and feedback during exercises.
- Estimating energy expenditure using standardized MET values.
- Supporting a variety of popular exercises with modular logic.
- Providing a user-friendly web interface with real-time statistics.

The following sections delve into the architecture, implementation, results, and future directions of the system.

II. Related Work

Traditional fitness tracking systems can be broadly categorized into sensor-based and vision-based solutions. Sensor-based systems use wearables equipped with accelerometers, gyroscopes, and heart rate monitors to capture physical activity data. Although these systems are effective, they require users to wear additional devices, which may hinder convenience and adoption.

On the other hand, vision-based systems harness the power of computer vision to analyze movement patterns from video feeds. These solutions are non-invasive and can be deployed using everyday devices like smartphones or laptops. With the advent of frameworks like OpenPose and Mediapipe, real-time pose estimation has become highly accurate and computationally efficient.

Past research has explored yoga pose classification, gesture recognition, and activity recognition using Mediapipe. However, few have integrated it with a Flask-based web framework to create a seamless, interactive fitness tracking platform. This project bridges that gap by providing an end-to-end solution that is easy to use, responsive, and informative.

III. System Architecture

The proposed system comprises three main modules:

- **Pose Estimation Module**: Uses Mediapipe to detect key landmarks on the human body and extract relevant joint coordinates.
- **Exercise Detection Module**: Implements state-based logic to classify movement into repetitions, track angles, and evaluate form quality.
- **Web Interface Module**: Provides users with an intuitive front-end to visualize performance metrics, access historical data, and manage workout sessions.

The real-time video stream from the user's webcam is fed into the pose estimation engine, which outputs body landmarks at a rate of 30 frames per second. These coordinates are processed to compute joint angles such as the elbow, knee, and shoulder. Based on these calculations, the system determines whether a valid repetition has occurred.

IV. Implementation Details

A. Pose Estimation

We utilize Mediapipe's "Pose" solution, which detects 33 body landmarks including the head, shoulders, hips, knees, elbows, and ankles. These landmarks are processed using vector algebra to calculate joint angles. For instance:

$$\theta = \arccos\left(\frac{\mathbf{a}\cdot\mathbf{b}}{\|\mathbf{a}\|\|\mathbf{b}\|}\right)$$

where $\mathbf{a}$ and $\mathbf{b}$ are vectors representing adjacent body segments. This angle helps determine the movement stage within an exercise cycle.

B. Exercise Logic

The system currently supports three types of exercises:

- **Bicep Curl**: Detects elbow flexion in the range of 30° to 150°. A rep is counted when full extension and contraction are both detected.
- **Squat**: Monitors knee flexion between 70° and 160°. The user must maintain proper posture to register a valid rep.

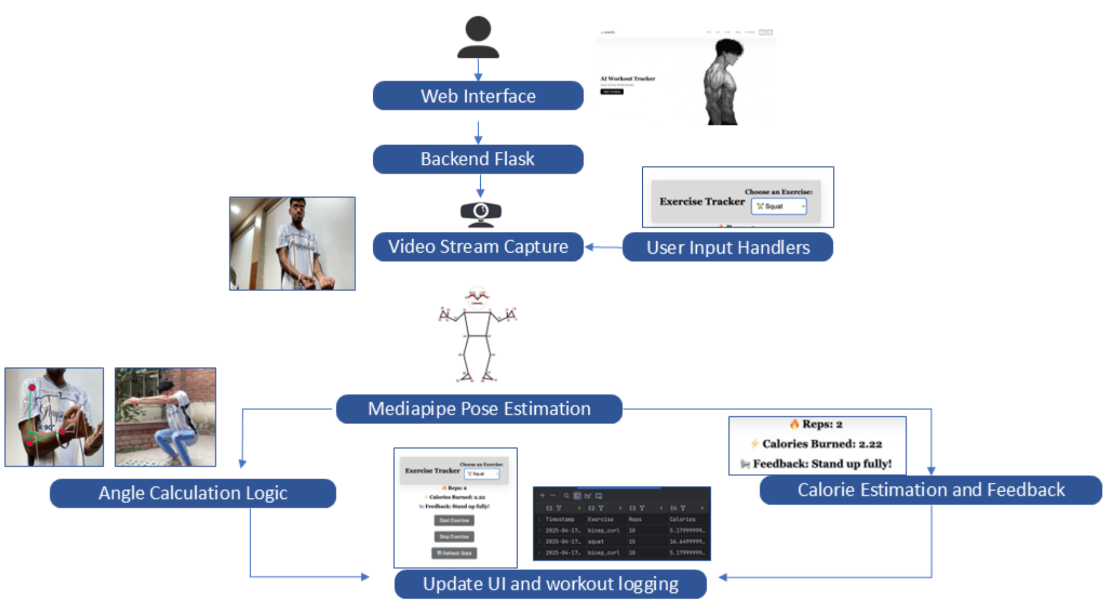

Fig. 1. System Architecture of AI Fitness Web App.

- **Push-Up**: Analyzes arm extension angles from 50° to 140°. The system differentiates between up and down positions.

Each exercise uses a finite state machine (FSM) to transition between ”Start”, ”Mid”, and ”End” states. This ensures accurate rep counting and allows for real-time feedback on form.

C. Calorie Estimation

Calories burned are estimated using the following formula:

$$\text{Calories} = \text{MET} \times \text{Weight (kg)} \times 0.0175 \times t$$

Here, t represents the workout duration in minutes, and MET (Metabolic Equivalent of Task) values are derived from standard fitness literature:

- Bicep Curl: 3.5 METs
- Squat: 5.0 METs
- Push-Up: 8.0 METs

Users can input their weight and track total calories burned for each session.

D. Web Interface

The front-end, served by Flask, uses HTML, CSS, and JavaScript to create a responsive and interactive UI. Core features include:

- Live webcam feed with overlayed pose detection
- Real-time counters for repetitions and calories
- Visual feedback prompts (e.g., ”Go lower!”, ”Perfect rep!”)
- Buttons to start/stop session and reset counters

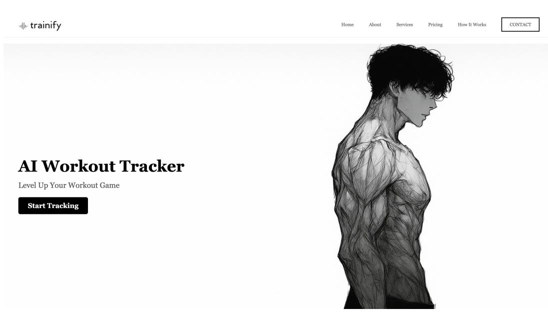

Fig. 2. User Interface of the AI Fitness Web Application showing real-time pose estimation and workout tracking.

V. Results and Discussion

The system was tested with participants performing various exercises under controlled and semi-controlled environments. The following metrics were evaluated:

- **Pose detection accuracy**: Consistently above 90% with adequate lighting.
- **Repetition detection**: Accurate and responsive in tracking full cycles.
- **Calorie estimation**: Within acceptable deviation ranges compared to commercial fitness apps.
- **User satisfaction**: High engagement due to simplicity and responsiveness.

TABLE I
Pose Detection Accuracy Across Exercises

Exercise	Accuracy (%)	Feedback Effectiveness (%)
Bicep Curl	92	95
Squat	90	93
Push-Up	91	94

Common user requests include:

- Mobile device compatibility
- Personalized recommendations
- Integration with fitness trackers and voice assistants

A. Limitations

While the proposed system demonstrates strong performance in standard testing environments, it is subject to several limitations that may affect usability and accuracy in diverse real-world scenarios:

- **Sensitivity to Lighting and Camera Positioning:** The pose detection module is heavily reliant on clear visual input. Poor lighting conditions, backlighting, or incorrect camera angles can lead to inaccurate or missed landmark detection, resulting in incorrect posture analysis or rep counting.
- **Single-User Focus:** The system is designed to track only one user at a time. In multi-user environments such as group workouts or fitness studios, it lacks the capability to distinguish and track multiple individuals concurrently.
- **Limited Exercise Set and Fixed Parameters:** The current implementation supports only a predefined set of exercises. Furthermore, the thresholds and parameters are hardcoded and may not adapt well to users with varying body proportions, mobility levels, or fitness goals.
- **No Awareness of User Fatigue or Breaks:** The calorie estimation model does not account for rest periods or fatigue-induced performance changes during longer sessions. This could lead to inaccurate calorie burn calculations and rep tracking.

B. Future Work

To overcome the identified limitations and enhance the overall user experience, the following improvements are planned for future iterations of the system:

- **Dynamic Exercise Expansion:** We aim to broaden the system’s support to include a larger variety of exercises, including dynamic full-body movements such as lunges, jumping jacks, and yoga asanas. Additionally, dynamic difficulty adjustment can be introduced by tailoring exercise intensity based on the user's fitness level.

- **Gamification Elements:** Incorporating elements like virtual achievements, leaderboards, daily streaks, and competition modes can make workouts more engaging. This approach can encourage consistency and user motivation through social and competitive features.
- **Intelligent Form Correction:** By integrating supervised machine learning models trained on labeled datasets of correct and incorrect posture, the system can automatically detect poor form and suggest actionable corrections in real time.
- **Multi-User Support and Cloud Sync:** Future versions will support multi-user environments with real-time tracking for group workouts. Integration with cloud services can enable progress synchronization across multiple devices and platforms.
- **Mobile Application Deployment:** To increase accessibility and portability, we plan to deploy the system as a cross-platform mobile application with integrated camera access, offline support, and wearable connectivity.

ACKNOWLEDGMENT

We sincerely thank Netaji Subhas University of Technology for their continuous support and for providing the necessary infrastructure and resources to carry out this project. We also extend our gratitude to the faculty and mentors whose guidance played a key role in shaping the development of this AI-based fitness application.

REFERENCES

[1] G. Dsouza, D. Maurya and A. Patel, "Smart gym trainer using Human pose estimation," *2020 IEEE International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2020, pp. 1-4, doi:10.1109/INOCON50539.2020.9298212. Available: https://www.researchgate.net/publication/348166295_Smart_gym_trainer_using_Human_pose_estimation

[2] A. Lamba, A. K. Nayak, P. Pimple, V. Patil, P. Bhaldare, and R. K. Solanki, "AI-Based Fitness Trainer," *International Journal of Innovative Research in Technology*, vol. 10, no. 1, June 2023. Available: https://ijirt.org/publishedpaper/IJIRT160529_PAPER.pdf

[3] Z. Zhang, N. Wang and L. Cui, "Fine-Fit: A Fine-grained Gym Exercises Recognition System," *2018 24th Asia-Pacific Conference on Communications (APCC)*, Ningbo, China, 2018, pp. 492-497, doi:10.1109/APCC.2018.8633473.

[4] Z. Liu, X. Liu and K. Li, "Deeper Exercise Monitoring for Smart Gym using Fused RFID and CV Data," *IEEE INFOCOM 2020 - IEEE Conference on Computer Communications*, Toronto, ON, Canada, 2020, pp. 11-19, doi:10.1109/INFOCOM41043.2020.9155360.

[5] G. Teng et al., "MobiFit: Contactless Fitness Assistant for Freehand Exercises Using Just One Cellular Signal Receiver," *2020 16th International Conference on Mobility, Sensing and Networking (MSN)*, Tokyo, Japan, 2020, pp. 299-306, doi:10.1109/MSN50589.2020.00057.

[6] S. V., K. L. G., K. G. D., D. B. S., and H. K. G., "Fitness Trainer Application Using Artificial Intelligence," *International Research Journal of Engineering and Technology (IRJET)*, vol. 10, no. 5, May 2023. Available: https://mail.irjet.net/archives/V11/i4/IRJET-V11I4105.pdf

[7] J.-W. Kim, J.-Y. Choi, E.-J. Ha, and J.-H. Choi, "Human Pose Estimation Using MediaPipe Pose and Optimization Method Based on a Humanoid Model," *Applied Sciences*, vol. 13, no. 4, p. 2700, 2023. doi:10.3390/app13042700. Available: https://www.mdpi.com/2076-3417/13/4/2700

[8] J. Böhm, T. Chen, K. Štícha, J. Kohout and J. Mareš, "Skeleton Detection Using MediaPipe as a Tool for Musculoskeletal Disorders Analysis," in *Software Engineering Methods in Systems and Network Systems*, R. Silhavy and P. Silhavy, Eds. Lecture Notes in Networks and Systems, vol. 909, Springer, Cham, 2024, pp. 45–56. Available: https://doi.org/10.1007/978-3-031-53549-9_4

[9] D. Mogaveera, V. Mathur and S. Waghela, "e-Health Monitoring System with Diet and Fitness Recommendation using Machine Learning," *2021 6th International Conference on Inventive Computation Technologies (ICICT)*, Coimbatore, India, 2021, pp. 694–700, doi:10.1109/ICICT50816.2021.9358605.