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AsanaAI: A Real-Time Human Pose Estimation and Gamified Learning System for Personalized Yoga Coaching

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ABSTRACT: This paper presents AsanaAI, an AI-powered web and mobile platform designed to deliver personalized yoga training through real-time posture assessment and adaptive learning. Traditional self-guided yoga resources provide static, non-interactive instruction that fails to correct improper alignment, often leading to reduced effectiveness or injury risk. AsanaAI addresses this limitation by integrating Mediapipe, which extracts 33 skeletal keypoints and computes joint angles and deviation thresholds to generate accurate pose scores and instant corrective feedback. The platform features a dual-interface architecture, enabling learners to receive automated guidance while certified instructors monitor performance trends, assign customized practice modules, and provide analytics-driven mentorship. To improve long term adherence, AsanaAI incorporates gamification mechanisms such as experience points (XP), levels, badges, streaks, and community leaderboards. A four-week pilot study with 50 learners and 5 instructors demonstrated a 22% improvement in pose accuracy, increased session completion, and 76% retention, significantly outperforming conventional self-learning methods. These findings highlight the potential of combining real-time pose estimation, structured pedagogy, and gamified engagement to create an effective digital yoga training ecosystem. AsanaAI offers a scalable mHealth solution bridging automated posture correction with human-centered instruction for accessible and reliable yoga practice.

KEYWORDS: Human Pose Estimation; Gamified Learning; Personalized Yoga Training; Artificial Intelligence; mHealth Applications.

I. INTRODUCTION

Yoga is widely practiced for its physical and mental health benefits, yet beginners and self-guided learners often struggle with correct posture alignment, which is essential for safe and effective practice [1], [2]. Most existing digital yoga tools rely on pre-recorded or static content and lack the ability to detect posture errors or provide corrective feedback, causing users to repeat incorrect movements and experience limited progress [3], [4]. Studies in motor learning show that real time feedback significantly improves skill acquisition, particularly for users without access to professional guidance [5].

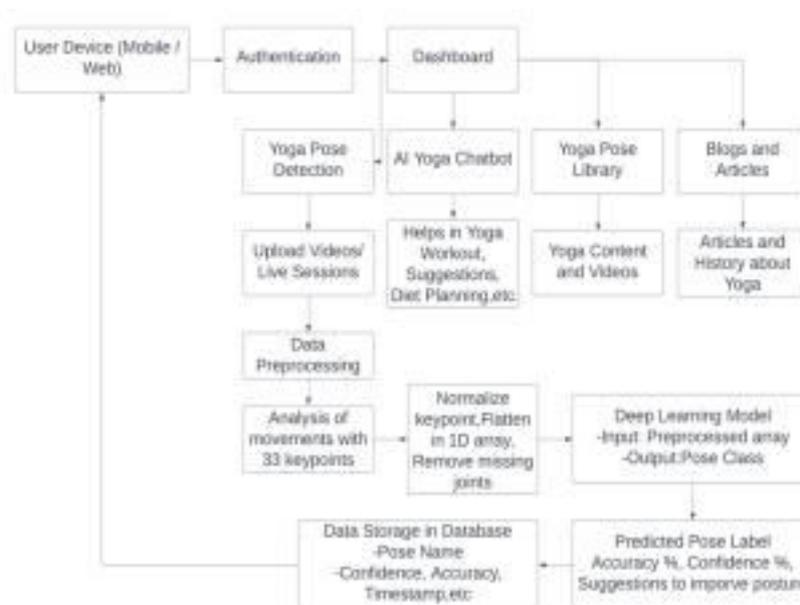
Advances in computer vision and AI have enabled accurate pose estimation on consumer devices using lightweight models such as MoveNet [6]. In parallel, research on gamified learning indicates that reward-based mechanisms can improve motivation, consistency, and long-term engagement in digital wellness applications [7]. However, current yoga platforms rarely combine real-time AI feedback, personalized learning pathways, and instructor involvement within a single system [3].

To address this gap, this paper presents AsanaAI, an AI-enabled web and mobile platform that delivers personalized yoga training through real-time posture analysis and gamified engagement. The system uses Google MoveNet to extract skeletal keypoints and evaluate pose accuracy, while a dual-interface design supports both learners and certified instructors for performance tracking and guided mentorship. Gamification features such as XP, streaks, and leaderboards encourage consistent practice. A four-week pilot study with 50 learners and 5 instructors showed a 22% improvement in pose accuracy and a 76% user retention rate. Overall, AsanaAI integrates AI-driven posture correction with gamified learning and instructor support, offering a scalable and effective mHealth solution for accessible yoga practice.

II. SYSTEM MODEL AND ASSUMPTIONS

AsanaAI is designed as a web and mobile-based AI-assisted yoga training platform that delivers real-time posture analysis and personalized feedback using consumer-grade devices. As shown in Fig. 1, the system follows an end-to-end processing workflow starting from user interaction to AI-driven pose evaluation and feedback delivery. Users access the platform through mobile or web devices and authenticate to interact with various system modules, including live yoga sessions, video uploads, pose libraries, and AI-based assistance.

Yoga sessions are captured either as real-time video streams or uploaded recordings. The system assumes adequate lighting conditions, stable camera positioning, and visibility of major body joints for reliable pose estimation. Captured frames are processed using a pose detection module that extracts 33 skeletal keypoints for each frame. These keypoints undergo preprocessing steps such as normalization, flattening into a one-dimensional feature array, and handling of missing joints to ensure consistency across users and devices..



The preprocessed pose features are passed to deep learning models responsible for pose classification, accuracy estimation, and confidence scoring. The system outputs predicted pose labels, posture accuracy percentages, confidence values, and corrective suggestions. These results are stored in the database along with session metadata such as pose name and timestamps. Learners and instructors access this information through dedicated dashboards, where progress visualization, performance analytics, and feedback summaries are presented. The model assumes role-based access, reliable backend connectivity, and secure data handling to support scalable and real-time yoga training.

III. EFFICIENT COMMUNICATION

Efficient communication in AsanaAI is achieved through a streamlined data pipeline connecting pose capture, analysis, and feedback delivery. Video frames captured during a session are processed to extract skeletal keypoints, which are then transmitted as compact feature representations rather than raw video data. This reduces bandwidth usage and improves real-time responsiveness.

Backend services handle parallel execution of pose classification, accuracy scoring, and corrective feedback models, enabling timely feedback to users. Session summaries, posture scores, and gamification updates are synchronized with user dashboards to ensure consistent progress tracking. This design supports low-latency interaction, scalable analytics, and smooth coordination between learners and instructors during training sessions.

IV. SECURITY

AsanaAI is designed to ensure secure handling of user data through controlled access and role-based permissions across the training workflow. Learners and instructors interact through authenticated dashboards, where access to posture analytics, session summaries, and long-term progress records is restricted to authorized users only. Instructor access is limited to assigned learners, ensuring privacy-preserving mentorship and preventing unauthorized data exposure.

Pose data collected from live sessions or uploaded videos is processed through secure on-device and backend pipelines. To reduce privacy risks, raw video streams are not retained; instead, only skeletal keypoints, posture scores, and joint deviation metrics are stored for analysis and feedback generation. Session records, analytics results, and gamification data—such as XP, streaks, and achievement logs—are securely maintained to prevent unauthorized modification or misuse.

The system also ensures integrity in feedback delivery and progress tracking. Backend services manage model outputs, leaderboard updates, and performance summaries in a controlled manner, ensuring consistency across learner and instructor views. Together, these mechanisms protect user privacy, preserve data integrity, and support trustworthy AI assisted yoga training.

V. RESULT AND DISCUSSION

The performance of AsanaAI was evaluated using publicly available pose estimation datasets and a custom yoga dataset collected during a four-week pilot study involving 50 learners and 5 instructors. The evaluation focused on pose classification accuracy, posture alignment scoring, corrective feedback quality, and overall user engagement. Experimental results demonstrate that integrating angular features with deep learning significantly improves pose understanding and feedback reliability.

[1] A. Pose Classification Performance Table I presents the comparison of pose classification models used in AsanaAI. The hybrid DNN with angular features achieved the highest accuracy, indicating improved discrimination between visually similar yoga poses.

Table I. Pose Classification Performance

Model	Accuracy	Precision	Recall
MLP	0.8421	0.8354	0.8298
CNN	0.9035	0.8981	0.9012
DNN	0.9214	0.9180	0.9201
Hybrid DNN + Angle Features	0.9478	0.9432	0.9456

[2] B. Posture Alignment Scoring Performance

Posture quality estimation was evaluated using multiple regression models. As shown in Table II, the proposed DNN + PCA model achieved the highest alignment accuracy, confirming its ability to capture subtle biomechanical deviations.

Table II. Pose Alignment Scoring Performance

Model	Accuracy
Linear Regression	0.6214
FNN	0.7810

DNN	0.8127
Proposed DNN + PCA	0.8543

[3] C. Corrective Feedback and User Engagement

The effectiveness of joint-level corrective feedback was measured using regression-based models. Table III shows that the DNN with angular inputs outperformed baseline approaches. Additionally, the pilot study revealed strong improvements in learning outcomes and engagement.

Table III. Corrective Feedback & User Engagement Results

Corrective Feedback Model (DNN + Angles) R ² Score	0.5641
Improvement in Pose Accuracy	22%
Metric	Result
User Retention Rate	76%
Pilot Study Duration	4 weeks
Participants	50 learners, 5 instructors

[4] D. Discussion

The results confirm that AsanaAI effectively enhances yoga training through accurate pose recognition, reliable posture scoring, and actionable feedback. The integration of angular features with deep learning improves model performance, while gamification elements contribute to sustained user engagement. Compared to traditional self-guided yoga methods, AsanaAI provides structured learning, objective assessment, and instructor-supported analytics, making it a scalable and effective solution for personalized digital wellness.

VI. CONCLUSION

AsanaAI illustrates the effectiveness of AI-driven systems in enhancing yoga posture training through real-time pose analysis and intelligent feedback. By leveraging deep learning-based pose estimation and biomechanical alignment scoring, the platform delivers personalized guidance that improves accuracy and consistency beyond conventional self-guided practice. The unified integration of posture assessment, instructor-led analytics, and progress visualization addresses common limitations faced by independent learners, including the absence of corrective supervision and sustained engagement. Gamification mechanisms further support user motivation and regular practice. The resulting gains in pose accuracy and retention underscore the role of AI in digital wellness, establishing AsanaAI as a scalable mHealth solution, with future developments focused on advanced 3D modeling, sequence-level analysis, and wearable sensor integration.

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