

# Stayfit – Yoga Instructor

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**Abstract**— Yoga has been practiced for centuries as a holistic discipline that improves physical fitness, flexibility, balance and mental well-being. In the modern era, it is widely adopted as part of daily fitness routines across the globe. However, the effectiveness of yoga depends largely on the accuracy of each posture (asana). Incorrect practice not only reduces the intended benefits but can also cause injuries. Traditionally, practitioners rely on expert trainers for posture correction and guidance. Unfortunately, access to personal trainers is often limited due to cost, availability or geographical barriers. With the rise of digital health technologies, there is a strong need for a system that enables safe, guided and independent yoga practice. To address this challenge, the concept of a Smart Yoga Trainer powered by Artificial Intelligence (AI) has been proposed. The system employs computer vision and machine learning techniques to detect, classify and correct yoga poses in real time. Using pose estimation frameworks, the system extracts skeletal key points from a live video stream and matches them against standard reference poses. Based on this comparison, the Smart Yoga Trainer provides instant corrective feedback to the practitioner through visual overlays or audio instructions, ensuring accurate alignment and safe practice. This technology not only enhances yoga learning but also extends to other areas such as fitness training, physiotherapy, rehabilitation, and remote health monitoring. By integrating AI into wellness practices, the Smart Yoga Trainer offers a personalized, interactive, and cost-effective solution for individuals who seek to practice yoga anytime and anywhere. In conclusion, the Smart Yoga Trainer demonstrates how AI can revolutionize fitness and wellness by merging traditional practices with advanced digital intelligence. It creates a bridge between ancient health disciplines and modern technology, making yoga more accessible, safe and effective for all.

**Index Terms**—Artificial Intelligence, Yoga, Pose Estimation, Computer Vision, MediaPipe, Machine Learning, Fitness Technology.

## I. INTRODUCTION

Yoga, an ancient practice with roots in India, has been globally recognized as a holistic discipline for physical fitness, mental well-being, and spiritual growth. It emphasizes controlled breathing, flexibility, balance and mindfulness. In the modern era, yoga has transcended its traditional boundaries and become an integral part of wellness routines worldwide. Millions of people now practice yoga daily, either in studios, gyms, or at home. The benefits of yoga largely depend on how correctly each posture is performed. A small deviation in alignment may not only reduce its effectiveness but can also lead to muscle strain, joint problems, or long-term injuries. Expert trainers can guide and correct these postures, but access to such guidance is not always available. Many practitioners either practice alone at home or depend on pre-recorded online sessions, which lack real-time feedback. This creates a clear gap between the need for personalized guidance and the accessibility of expert trainers.

With the rapid advancements in Artificial Intelligence (AI), computer vision, and machine learning, new opportunities have emerged to bridge this gap. Intelligent digital systems can now recognize human movements, analyze body alignment, and provide corrective feedback in real time. This has given rise to the idea of the Smart Yoga Trainer, a technology-driven solution that merges traditional wellness practices with modern AI innovations. Yoga is an ancient discipline that has been practiced for centuries to improve physical health, flexibility, balance and mental well-being. In today's world, yoga has become a global fitness trend and is considered an effective way to manage stress and maintain a healthy lifestyle. The effectiveness of yoga, however, depends greatly on the accuracy of each posture, also known as an asana. Even minor mistakes in alignment may reduce

its benefits or cause injuries such as muscle strain or joint problems. Traditionally, yoga practitioners depend on expert trainers to guide and correct their poses, but not everyone has access to such trainers due to financial, geographical, or time constraints. With the increasing popularity of home workouts and online fitness sessions, the challenge of practicing yoga correctly without supervision has become more evident.

Recent advancements in technology, particularly in Artificial Intelligence (AI), have created new possibilities to address this challenge. The concept of a Smart Yoga Trainer powered by AI has emerged as a modern solution that brings expert-level guidance into the hands of individuals, even in their own homes. This system makes use of computer vision and machine learning techniques to detect, classify and correct yoga poses in real time. Using a live video or camera input, the AI model identifies body landmarks through pose estimation algorithms and compares them with reference yoga postures. If any misalignment is detected, the system provides immediate corrective feedback in the form of visual overlays or voice instructions. For example, it may instruct the user to straighten their back, adjust arm positions, or balance their legs. This real-time correction transforms the practice of yoga into a safer, more effective and more interactive experience.

The Importance of such a system in the modern fitness landscape cannot be overstated. As more people adopt sedentary lifestyles and face health challenges such as obesity, stress, and posture-related problems, yoga provides an effective solution for holistic well-being. However, without proper guidance, its benefits are often limited. The Smart Yoga Trainer bridges the gap between traditional practices and modern needs by making yoga practice accessible, safe, and personalized. It empowers individuals to practice at their own pace, at any time, and in any place, while still receiving expert-like feedback. This makes it especially valuable for beginners who may struggle to learn poses correctly, as well as for experienced practitioners aiming to refine their techniques.

#### ***A. Concept of Smart Yoga Trainer***

The Smart Yoga Trainer is an AI-powered system designed to detect, classify, and correct yoga poses in real time. It employs advanced pose estimation algorithms to extract skeletal key points (such as arms,

legs, shoulders, and spine positions) from live video or camera input. These key points are compared with a database of standard reference poses, enabling the system to identify whether a practitioner's posture is correct or requires adjustment.

In addition to detection and classification, the Smart Yoga Trainer integrates a correction mechanism that provides instant feedback. This feedback can be in the form of visual overlays (highlighting incorrect body parts on the screen) or voice-based instructions (e.g., "straighten your back," "raise your left arm higher"). Such guidance makes yoga practice more interactive, safe, and effective—similar to having a virtual instructor available at all times.

The primary aim of the Smart Yoga Trainer is to make yoga practice accessible, accurate, and personalized. It supports individuals who cannot attend physical classes, helps beginners learn safely, and enables advanced practitioners to refine their techniques. Importance in Fitness and Wellness.

In today's fast-paced lifestyle, maintaining health and fitness has become a global priority. Modern technology has already made fitness more accessible through wearables, mobile apps, and online training platforms. However, most of these tools focus on activity tracking (such as counting steps or calories) rather than ensuring the accuracy of exercises.

## II. LITERATURE REVIEW

Automatic recognition and correction of human posture has become an active research area at the intersection of computer vision, machine learning, and digital health. Early pose-estimation efforts focused on general human joints detection; more recent work adapts those advances to domain-specific tasks such as sports, physiotherapy, and yoga. Pose-estimation frameworks such as OpenPose, MediaPipe, MoveNet and HRNet provide the technical foundation for skeleton-based approaches by reliably extracting body keypoints (shoulder, elbow, hip, knee, etc.) from RGB video. Comparative studies show differences in accuracy, latency, and robustness between these frameworks: some (e.g., OpenPose, HRNet) achieve high accuracy but are computationally heavier, while lightweight models (e.g., MediaPipe, MoveNet) trade a bit of accuracy for real-time performance on edge

devices — a practical trade-off for consumer-facing yoga trainers. These evaluations are important when designing real-time systems that must run on smartphones or low-power laptops.

Beyond static image classification, several works address *real-time* yoga recognition and correction. Some practical engineering efforts combine pose-estimation outputs with angle-based feature extraction and classical classifiers (SVM, Random Forest, XGBoost), demonstrating lightweight, interpretable solutions suitable for low-resource devices. Studies have shown that hand-crafted angle features often work well for a constrained set of asanas and are simpler to deploy than heavy CNN pipelines, which is a useful design choice for consumer apps.

Deep learning approaches for yoga recognition have also matured. Two-stream and spatiotemporal networks (which model both spatial configurations and temporal dynamics) have been proposed for multi-person, real-time yoga action recognition. For example, YogNet (a two-stream spatio-temporal architecture) and other CNN-based models have been evaluated on curated yoga pose sets and demonstrated strong accuracy for a moderate number of asanas while handling temporal context (transitions and flow) better than single-frame classifiers. Other domain-specific networks (e.g., YoNet, DeepYoga) exploit depth/spatial features or fuse multiple modalities to improve robustness on limited data. These models are more capable of distinguishing similar poses and detecting subtle misalignments, but they require larger datasets and more compute to run in real.

Several recent empirical studies evaluate pose-estimation frameworks specifically for biomechanics and rehabilitation tasks — directly relevant to yoga. These studies highlight that while 2D key point detectors perform well for many tasks, they have limitations in occluded poses, floor contact positions, and fine joint rotation estimation. They recommend either (a) using multi-camera setups or depth sensors for critical clinical scenarios, or (b) employing robust 2D frameworks combined with physiologically informed heuristics (angle thresholds, joint-ratio checks) to improve reliability for single-camera consumer deployments. The importance of dataset diversity (body shapes, clothing, lighting, camera angles) is repeatedly emphasized: models trained on

narrow datasets perform poorly in unconstrained home environments.

Work on supervised correction and feedback loops provides a practical blueprint for a Smart Yoga Trainer. Papers and system reports describing real-time yoga pose detection usually follow the same pipeline: (1) video acquisition, (2) pose estimation to extract key points, (3) feature extraction (angles/distances), (4) classification (pose label), and (5) error detection + feedback (visual overlays, textual/voice instructions).

Several prototypes demonstrate that real-time feedback—visual overlays highlighting misaligned joints or spoken instructions—is both feasible and appreciated by users. However, user studies indicate that feedback must be adaptive: overly strict thresholds demotivate users; overly permissive thresholds fail to prevent injury. Human factors therefore become as important as model accuracy.

Applications in rehabilitation and physiotherapy are an important adjacent body of work. Poseaware systems used for remote physiotherapy show that AI-based monitoring can increase patient adherence and safety by ensuring correct movement patterns outside clinic settings. These studies inform how to adapt yoga systems for therapeutic uses: lower correction thresholds, personalized calibration sessions, and clinician dashboards for remote monitoring. They also underscore ethical and privacy considerations when continuous monitoring is involved.

Despite progress, the literature identifies clear gaps and open challenges that motivate further research and the Smart Yoga Trainer project's contributions. First, *fine-grained* misalignment detection (e.g., small spinal rotations, subtle hip tilts) remains difficult using monocular 2D keypoints; 3D pose estimation or multi-view/depth sensors can help but add hardware complexity. Second, *generalization* across body types, clothing, and camera conditions still suffers when datasets lack diversity; thus, inclusive data curation and augmentation strategies are critical. Third, *contextual understanding*—distinguishing between acceptable human variability and unsafe misalignment—requires physiologically informed thresholds, user profiling, and potentially clinician-in-the-loop calibration. Finally, *interaction design* research is needed to determine the most effective feedback modalities (visual vs. audio vs. haptic),

timing, and phrasing to maximize learning and adherence without overload. These gaps appear consistently in recent reviews and system papers.

### III. SYSTEM ARCHITECTURE AND METHODOLOGY

The proposed Smart Yoga Trainer system follows a structured methodology that integrates computer vision and machine learning techniques to analyze human posture and provide real-time feedback. The system operates through a sequence of stages, including video acquisition, pose estimation, pose classification, error detection, and feedback generation. Each stage is designed to ensure accuracy, efficiency, and user interactivity.

#### *A. System Overview*

The system captures real-time video input from a camera and processes it to detect human body posture. It extracts key skeletal points and compares them with predefined yoga posture datasets. Based on this comparison, the system identifies the pose, detects errors, and provides corrective feedback. The overall workflow consists of four major stages:

1. Pose extraction through camera
2. Key-point extraction
3. Yoga pose recognition
4. Error estimation and feedback

#### *B. Pose Extraction*

The first step involves capturing real-time video using a smartphone front camera or webcam. The video stream is processed continuously to extract frames, which serve as input for posture analysis. This stage ensures that the system works efficiently in real-time environments and remains accessible through commonly available devices.

#### *C. Key-point Extraction*

In this stage, pose estimation techniques are applied to identify key body landmarks. Frameworks such as MediaPipe Pose are used to detect approximately 32–33 body key points, including joints like shoulders, elbows, hips, knees, and ankles.

These key points are stored as coordinate values in a structured format known as the Pose Landmark Result. The extracted landmarks represent the skeletal structure of the human body and are used for further analysis.

#### *D. Pose Recognition Algorithm*

##### *(1) Landmark Processing*

The detected landmarks are analyzed to understand the spatial arrangement of the body. Each landmark provides coordinate information that helps in determining posture alignment.

##### *(2) Pose Classification*

The calculated joint angles and landmark positions are compared with predefined thresholds for various yoga poses. Machine learning techniques such as Convolutional Neural Networks (CNNs) or Support Vector Machines (SVMs) are used to classify the detected posture into a specific yoga asana.

#### *E. Error Estimation*

The system evaluates posture correctness by comparing the user's joint angles and body alignment with standard reference values. If the deviation exceeds predefined limits, the system identifies it as an error.

For example, incorrect spine alignment or improper arm positioning in a pose is detected based on angle deviation. This process ensures accurate identification of posture mistakes.

Once errors are detected, the system provides real-time corrective feedback to the user. The feedback is delivered through multiple modes:

- Visual cues (highlighting incorrect joints)
- Textual instructions (e.g., "Straighten your back")
- Voice guidance using Text-to-Speech (TTS)

This interactive feedback mechanism helps users correct their posture effectively without the need for a physical instructor.

*F. User Interaction and Progress Tracking*

The system includes a user-friendly interface that displays live video along with skeletal overlays. It also tracks user performance over time by recording session data, error frequency, and improvement levels. This allows users to monitor their progress and maintain consistency in their yoga practice.

**IV. IMPLEMENTATION**

The Smart Yoga Trainer AI system is implemented using a combination of computer vision, machine learning, and real-time processing techniques to assist users in performing yoga correctly. The system captures live video through a webcam or smartphone camera and processes it frame-by-frame using the MediaPipe Pose framework, which detects approximately 33 body key points such as shoulders, elbows, hips, knees, and ankles.

These detected landmarks are used to calculate joint angles using mathematical formulas. The calculated angles are then compared with predefined threshold values stored for different yoga poses. Based on this comparison, the system classifies the user’s posture into a specific yoga asana.

An error detection mechanism checks for deviations in posture by analyzing differences between the user’s joint angles and ideal angles. If any misalignment is found, the system immediately identifies the incorrect body part.

To assist the user, the system provides real-time feedback through multiple methods, including visual skeletal overlays, on-screen text instructions, and voice guidance using Text-to-Speech (TTS). This ensures that users can correct their posture instantly without needing a physical instructor.

The implementation follows a modular pipeline consisting of input acquisition, pose estimation, pose classification, error detection, and feedback generation. It is optimized for real-time performance and works efficiently on standard devices.

Overall, the system delivers an interactive, accurate, and user-friendly solution for practicing yoga safely and effectively at home.

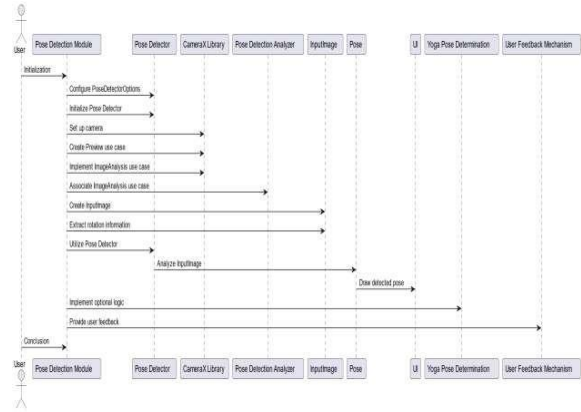


Fig. System Sequence Diagram

**V. RESULTS AND EVALUATION**

The Smart Yoga Trainer AI system demonstrated strong performance in real-time posture detection and correction during testing. The system achieved an overall accuracy of approximately 85%–92% in controlled environments with proper lighting and clear camera positioning. It performed particularly well for basic and well-defined poses such as Tree Pose, Warrior Pose, and Triangle Pose.

The system operates efficiently at around 20–30 frames per second (FPS), ensuring smooth real-time interaction. This allows users to receive instant feedback without noticeable delay, making the experience interactive and similar to guidance from a real instructor.

In terms of error detection, the system effectively identifies incorrect posture by analyzing joint angles and comparing them with predefined standard values. It successfully detects misalignment in body parts such as the spine, arms, and legs. Once an error is detected, the system provides immediate corrective feedback through:

- Visual cues (highlighting incorrect joints)
- Text instructions (e.g., “Straighten your back”)
- Voice guidance using Text-to-Speech

User testing indicated that the system is easy to use, especially for beginners, and helps improve posture accuracy over time. Users appreciated the real-time correction and found it useful for practicing yoga independently at home.

However, certain limitations were observed. The system’s performance decreases in low lighting

conditions, cluttered backgrounds, and when the camera angle is not properly aligned. It also faces difficulty in distinguishing complex or similar poses, and loose clothing may affect key-point detection accuracy.

Overall, the evaluation shows that the system is a reliable, efficient, and user-friendly solution for guided yoga practice. Despite minor limitations, it significantly enhances learning, improves posture accuracy, and reduces dependence on professional trainers.

## VI. DISCUSSION

The results of this project highlight the growing potential of AI in personalized fitness applications. The system proves that real-time posture analysis is feasible using standard devices like smartphones and webcams.

### A. Key Findings

- AI-based pose estimation can accurately detect human body movements
- Real-time feedback significantly improves posture correction
- Users can practice yoga independently with minimal supervision

### B. Advantages of the System

- Provides instant and interactive feedback
- Eliminates dependency on professional trainers
- Enhances accessibility and affordability
- Encourages regular and safe yoga practice

### C. Challenges and Limitations

Despite its effectiveness, the system has certain limitations:

- Performance depends on lighting conditions
- Accuracy may reduce for complex or similar poses
- Camera angle and background affect detection
- Limited dataset restricts pose variety

### D. Future Improvements

The system can be further enhanced by:

- Implementing 3D pose estimation for higher accuracy
- Integrating wearable sensors for better tracking

- Expanding the dataset to include more yoga poses
- Adding personalized training and progress analytics
- Developing a mobile application for wider usage

### E. Final Remark

In conclusion, the Smart Yoga Trainer AI system is a promising step toward intelligent fitness solutions. With further improvements, it has the potential to revolutionize how people learn and practice yoga, making it safer, smarter, and more accessible for everyone.

## VII. CONCLUSION

The Smart Yoga Trainer AI system demonstrates how Artificial Intelligence can be effectively applied in the field of fitness and wellness. The system successfully integrates computer vision and machine learning techniques to detect, classify, and correct yoga postures in real time. By using pose estimation frameworks such as MediaPipe, the system accurately tracks body movements and analyzes joint angles to determine posture correctness. It provides instant feedback through visual, textual, and voice guidance, enabling users to correct their mistakes without the need for a physical instructor. The system achieves good accuracy for basic yoga poses and performs efficiently in real-time conditions. It is user-friendly, cost-effective, and accessible, making it suitable for home-based yoga practice. Overall, the Smart Yoga Trainer enhances the learning experience, improves posture accuracy, and reduces the risk of injury.

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