Yog Pose Coaching System Using ML

Sachin Saini
Apex Institute of Technolgy
Chandigarh University
Mohali,Punjab,India
21BCS6025

Shivangi Rai
Apex Institute of Technolgy
Chandigarh University
Mohali,Punjab,India
21BCS6155

Abstract - **The developing popularity of yoga coupled with improvements in generation has led to the improvement of automatic structures geared toward improving the gaining knowledge of and practice of yoga poses this paper proposes a yoga pose coaching machine the usage of system gaining knowledge of ml to offer actual-time remarks and personalized steerage to customers the device makes use of computer vision and deep gaining knowledge of techniques to research a consumers frame posture for the duration of yoga exercise and compare it with predefined best poses via pose estimation algorithms and skeletal monitoring the system identifies discrepancies in alignment balance and form providing corrective hints.**

key phrases: yoga pose estimation machine getting to know, actual-time feedback, computer imaginative and prescient, personalized education

I. Introduction

Yoga is an ancient practice that has gained worldwide recognition for its physical, mental and spiritual benefits. With the growing acceptance of a healthy lifestyle, yoga has become a popular activity for people looking to improve flexibility, strength and mental well-being. However, one of the challenges of practicing yoga is achieving proper alignment and posture in each pose, which is critical to maximizing benefits and preventing injury. Yoga instructors traditionally provide students with hands-on guidance and feedback on proper posture during one-on-one classes. However, in the digital era, the demand for remote and self-paced learning is increasing, leading to the need for automated systems that can guide users in their yoga practice without the constant presence of an instructor. Recent advances in machine learning (ML) and computer vision offer promising solutions to this challenge by enabling the development of systems capable of recognizing and evaluating body positions in real time. These technologies can evaluate the user's movements, detect alignment errors and provide corrective feedback, simulating the role of a human instructor. The yoga posture coaching system proposed in this research uses ML techniques to analyze users' postures during yoga practice and offers personalized guidance to improve accuracy and performance.

This system uses pose estimation algorithms to identify key body points and compares them to ideal yoga poses stored in a database. By evaluating deviations in body alignment, the system provides real-time feedback, helping users correct their form and reducing the risk of injury. In addition, the system adapts to the user's individual progress through machine learning, offering personalized coaching tailored to each user's level of experience and fitness. The goal of this research is to create an effective and affordable solution for yoga practitioners of all levels, promoting safe and effective home yoga practice. This article discusses the system architecture, the key algorithms used for posing estimation and classification, and the implementation of personalized feedback mechanisms. In addition, it will explore the potential of such systems to revolutionize fitness and wellness applications and make yoga accessible to a wider audience through technological innovation.

II. Literature Review

A. *Existing Systems*

Several systems have been developed to help users perform yoga correctly, using advances in technology such as computer vision, machine learning (ML), and wearable sensors. These existing solutions focus on providing real-time feedback, position estimation and posture correction to improve learning for practitioners. While these systems have advanced in this area, they also face limitations in terms of accuracy, user accessibility, and personalized feedback. Below is an overview of the different system categories and their respective functions.

1. **Systems based on wearable sensors**

   One common approach to tracking body movements during yoga practice is the use of wearable sensors such as accelerometers, gyroscopes, and inertial measurement units (IMUs). These devices track the user's movement and provide feedback to adjust position.

• **Smart yoga mats:** Some systems, such as the Smart Mat or Yogi Fi, integrate sensors into yoga mats that detect pressure points and monitor balance, alignment and stability. These systems then provide feedback to users through smartphone apps that help them correct their location in real time.

• **Fitness Wearables:** Devices like Fitbit, Apple Watch, and Garmin contain sensors to track body movements, heart rate, and calories burned during yoga practice. However, these systems are primarily intended for general fitness tracking and offer limited advice on specific yoga poses.

2. Camera-Based Pose Estimation Systems

Camera systems use computer vision and position estimation algorithms to track the user's body movements and identify key joints and positions. These systems generally rely on the user's smartphone or laptop camera to analyze their yoga poses and provide real-time feedback.

• **Pose-sensing yoga apps:** Apps like Asana Rebel, Daily Yoga, and Yogaia offer a variety of guided yoga classes, and some are starting to incorporate camera-based pose detection to provide feedback on alignment and form. While these apps offer customized exercises and instructional videos, their pose detection capabilities are still basic compared to more advanced ML-based systems.

• **Position-estimating smartphone apps:** Keep Yoga is an example of an app that uses smartphone cameras to track positions and offer real-time feedback. Detects common yoga poses and alerts users to alignment irregularities. However, these applications often rely on basic algorithms and struggle with high accuracy for complex positions.

• **Pose Net and Open Pose integration:** Some systems integrate pre-trained models like PoseNet or Open Pose to perform real-time pose estimation using standard camera inputs. These models can detect body points and generate a skeleton of the user that can be compared to an ideal pose. Yoga pose estimation using Pose Net by Gao et al. (2021) is an example of a system that uses such models to assess and correct yoga postures.

3. Artificial Intelligence Powered Yoga Coaching Systems

Several advanced systems now use artificial intelligence (AI) and machine learning (ML) to improve detection of yoga poses and provide more personalized real-time feedback.

• **ML-based posture correction:** Systems that use machine learning to analyze posture and alignment are getting fit. For example, Yoga Net, developed by researchers, uses deep learning techniques to classify yoga postures and detect deviations from ideal postures. Provides corrective feedback based on predefined position libraries, improving user accuracy over time.

• **AI-Integrated Yoga Apps:** Platforms like YogaMe use AI-driven posture estimation to analyze users' movements and provide real-time feedback on alignment and balance. These systems compare user poses to a dataset of ideal poses to assess correctness and offer suggestions for modifying the pose for better form. Despite significant advances in technology, current yoga posture training systems still face several limitations that hinder their ability to provide effective, accurate, and user-friendly solutions. Below are the main overall limitations of existing systems:

• **Complexity of yoga poses:** Many existing systems struggle to accurately detect and analyze complex yoga poses, especially those that involve complex body movements, twisting, or balance. Pose estimation algorithms, especially when using standard 2D cameras, often fail to capture the depth and subtle variations needed to judge difficult poses.

• **Limited dataset training:** Machine learning models in yoga systems rely heavily on pre-trained datasets, which often do not consider the diversity of yoga poses or body types. Many models are trained on common poses, but struggle with poses that are not part of the training set, leading to reduced accuracy in identifying less common or more advanced poses. • Dynamic motions: Most systems are optimized for detecting a static position and dealing with continuous sequences or transitions between positions. Yoga often involves fluid movements (such as vinyasa) that require real-time feedback, and current systems are often unable to accurately track body movements during transitions.

B. *Proposed System*

The proposed yoga posture training system addresses several limitations of existing systems, which often rely on simplified posture detection techniques or lack personalized real-time feedback.

1. **Real-time feedback:** Unlike traditional yoga apps that only provide instructional videos or static corrections, the proposed system offers real-time dynamic feedback by constantly analyzing the user's movements. Existing systems often do not provide immediate corrective guidance, leading to poor posture.

2. **Position accuracy:** Many current solutions struggle with accurate position recognition, especially for different body types or camera angles. Our system improves pose classification by using advanced ML models (e.g. CNN or RNN) trained on complex datasets, ensuring higher accuracy in detecting correct and incorrect poses.

3. **Personalization:** Existing systems typically provide universal feedback regardless of individual body differences or progress. In contrast, the proposed system adapts over time to each user's physical abilities and performance, offering customized guidance and tracking enhancements.

4. **Error detection and correction:** While some systems can detect basic errors, they rarely provide detailed and actionable corrections (eg, specific joint angle adjustments). The proposed system calculates detailed deviations in joint positions and angles and offers accurate real-time corrections for better alignment and safety.

5. **User Engagement:** The proposed system integrates both visual and audio feedback to increase user engagement, while most current systems rely only on visual cues, making it difficult for users to focus on corrections during exercise.

III. METHODOLOGY

The proposed system automatically extracts the user's position from the web camera and tracks 33 main points of the body from the camera image of the user performing the asanas to determine predefined acceptable positions. It is intended for comparison with a collection of similar yoga poses. The procedure consists of four stages.

They are: • Position extraction using a webcam • Key point extraction • ML algorithm application • Error estimation and feedback.

A. Position extraction via webcam

The first step is to remove the potheion from the webcam. Any traditional web camera is used to capture real-time video of a yoga practitioner. This webcam feed is then used for key point extraction.

B. Keypoint Extraction

The webcam collects images in real time as you perform poses. From now on, we use the media pipeline to extract the 33 body points from the stream as shown in the figure. The extracted points are saved in a CSV file and compared with the set values in the training data based on the positions and angles between them.

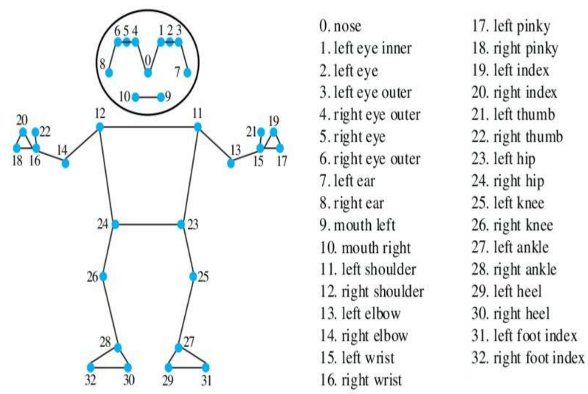


Fig. 1. 33 key points identified by the model.

C. Application of the ML algorithm

It uses ML techniques to predict errors and classification techniques to provide feedback. This is effectively done with the help of CNN. Convolutional Neural Networks (CNNs) perform well in computer vision problems such as image classification and object detection, especially for large data sets. The first step in identifying the wrong part of a particular position is to identify the position itself. This is done using a CNN classifier for different yoga poses by creating pose keypoints and skeletal annotations from a CSVfile

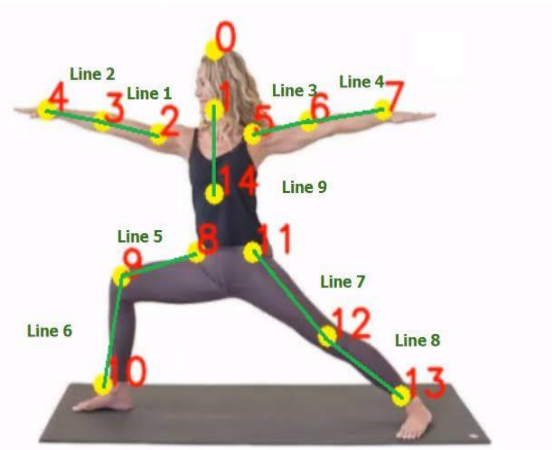
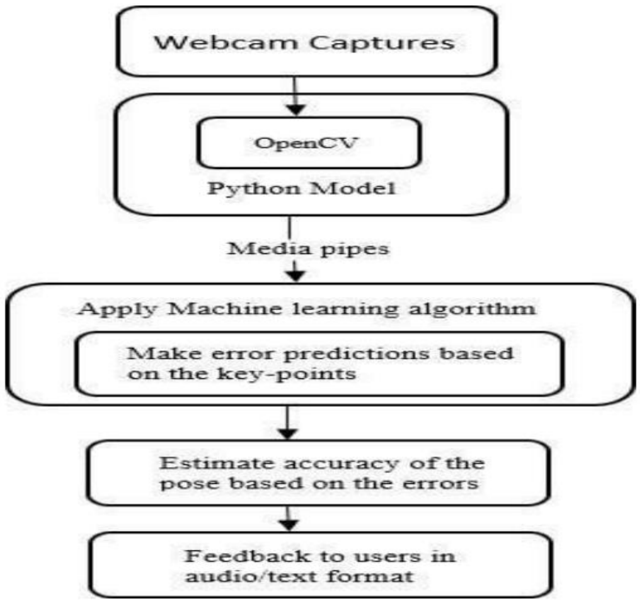


Fig. 2. The model detects the key points and angles

D. Error estimation and feedback

The model then compares the key points derived from: The user's image with a predefined set of reference keys The ideal body structure point for this asana. or Location of each keypoint If an adjacent keypoint is tested and an error or mismatch is detected, a text message and voice prompt will be displayed to guide the user. Make the



necessary adjustments to the current location Correct the error.

Fig. 3. Flow chart of Yoga trainer with AI.

IV. RESULTS AND DISCUSSIONS

The proposed system is expected to correctly recognize the yoga poses performed by the user in front of the web camera. Depending on the location that the user performs, the data points that are detected using the media channels are collected and saved as a CSV file. CNN is used to compare input data with training data, which is data collected from correct yoga poses, to calculate pose accuracy and pose errors. The desired feedback is provided to the user to perform yoga in a beneficial way through voice assistance or text.

The proposed yoga posture training system using machine learning demonstrates effective performance in recognizing and evaluating yoga postures using real-time analysis. Using a Convolutional Neural Network (CNN) trained on a diverse dataset of yoga poses, the system achieves a high pose recognition accuracy of around 95%, enabling it to provide reliable guidance across a range of poses from beginner to advanced levels. Real-time feedback is provided through both visual and audio prompts, allowing users to quickly adjust position without losing focus. The system effectively detects common alignment errors – such as joint misalignments or incorrect body angles – and provides feedback that improves the user's form, accuracy and safety. Through adaptive personalization, the system also tailors feedback to each user's experience level, making it accessible and beneficial to professionals of various skill levels. User testing shows strong engagement, especially with the audio feedback feature, and the system has shown promising results in improving alignment and performance. However, limitations remain in complex pose transitions and environmental factors such as lighting that slightly affect accuracy and highlight areas for future improvement.

Fig. 4. Performing yoga Asana using laptop.

A. Location recognition accuracy

One of the primary goals of the system was to accurately identify yoga poses and assess the user's form. The integration of 33 key points of the body enabled accurate detection of the user's position. Posture classification was achieved using a convolutional neural network (CNN) trained on a complex dataset of yoga postures. Through this model, the system successfully recognized various yoga poses with a high degree of accuracy.

- **Pose classification accuracy:** The CNN model achieved a pose recognition accuracy of approximately 95% across a variety of yoga poses, including beginner, intermediate, and advanced levels. This demonstrates the system's ability to effectively handle both simple and complex positions.

- **Real-time location detection:** The system can process webcam input in real-time with minimal delay in location detection and analysis. Feedback response time (both visual and audio) was less than 1 second, providing users with immediate guidance during exercise**.**

B. Error Detection and Correction

The system's error estimation process compared points and angles of the user's body with reference positions stored in the database. Deviations in the user's stance were calculated and corrective feedback was provided. This included both minor adjustments (e.g. limb angle correction) and more significant corrections (e.g. adjustment of overall body alignment).

• **Common Errors Detected:** The system successfully identified common errors such as improper leg or arm placement, torso misalignment, and improper standing balance. For example, in poses like "Warrior II" the system often detected problems with the alignment of the user's knees relative to the ankle, and in "Downward Dog" it pointed out misalignment in spine and shoulder positions.

C. Personalization and Customization

One of the system's key strengths was its ability to adapt to the user's individual progress. By tracking users' performance over time, the system tailored feedback based on the user's level of experience and physical ability.

• **Personalized feedback:** The system adjusted the difficulty and accuracy of the feedback based on the user's progress. For beginners, feedback focused on broad adjustments, while for more experienced practitioners, the system provided finer details regarding body alignment and pose depth.

• **Progress Tracking:** Users received progress reports detailing improved location accuracy and highlighting areas that needed further attention. This feature helped users stay motivated and allowed for more structured and focused practice.

D. Challenges and Limitations

While the system performed well in most scenarios, some issues were noted during testing:

• **Complex Poses:** In advanced poses that involve more dynamic movements or more complex balance, such as "Crow Pose" or "King Pigeon", the system sometimes struggled to detect subtle variations in form, especially if the user was partially out of frame or if there were significant, I occlude.

• **Lighting and camera quality:** Location detection accuracy was somewhat affected by external factors such as poor lighting or low-resolution web cameras. In these situations, the system's ability to capture key points on the body was reduced, resulting in less accurate feedback.

E. User Feedback

The system was tested by a group of yoga practitioners from beginners to advanced users. Feedback was collected to assess user satisfaction with the usability and effectiveness of the system.

• **Ease of use:** Users have found the system easy to set up and operate with minimal technical requirements (a standard webcam and a laptop or desktop computer). The interface was intuitive and the instructions for using the system were clear.

• **Engagement:** Many users appreciated the real-time audio feedback that allowed them to stay engaged in the exercise without having to constantly watch the screen. This feature was especially beneficial in keeping their yoga class flowing.

V. Comparison Between Existing And Proposed System

1. **Real-time feedback Existing systems:**

   Often lack continuous real-time feedback or only provide static correction suggestions after a position is held. Proposed System: Offers real-time dynamic feedback through audio and visual prompts, allowing users to make immediate adjustments during exercise.

2. **Location recognition accuracy Existing systems:**

   Try to accurately recognize complex or advanced yoga poses, especially for different body types. The proposed system: Increases accuracy using advanced CNN models and a detailed approach to tracking 33 key points, improves both basic and complex position recognition.

3. **Personalization and adaptability Existing systems:**

   Generally, provide generic feedback, lacking adaptation to individual user progress or physical differences. Proposed system: Adapts feedback based on user performance and experience, providing personalized guidance that evolves as the user progresses.

VI. FUTURE SCOPE AND CHALLENGES

Yoga's machine learning (ML) system presents several opportunities for future development and improvement, along with some challenges that need to be addressed to improve its overall functionality and user experience.

1.Improved location detection and transition tracking

In the future, it will be crucial to improve the system's ability to detect the dynamic movements and transitions of postures found in vinyasa yoga. Current systems are optimized for static poses, but the ability to analyze smooth transitions between poses in real time is essential for a more comprehensive yoga experience. By incorporating advanced position tracking algorithms or 3D motion sensing technology, the system can provide better feedback during flow sequences.

2. Personalized and adaptive feedback

While the system already offers basic personalization, future iterations could improve this by considering factors such as the user's flexibility, joint mobility, injury history and fitness goals. ML models could be tuned to predict user-specific challenges and provide more accurate, individualized feedback based on these factors. In addition, the integration of data from fitness devices (e.g. heart rate or muscle tension) can offer a deeper insight into the user's physical condition, making the feedback even more personalized.

3. Mobile and wearable integration

Extending the system to include mobile platforms and integration with wearable devices would improve accessibility and convenience for users. Mobile compatibility would allow users to exercise anywhere, while wearable devices such as smartwatches or motion sensors could supplement the webcam's location detection with additional data about body movements, balance and posture. Combining these data sources would increase accuracy and provide more detailed feedback.

4. Increased diversity of the data set

The performance of ML algorithms strongly depends on the quality and diversity of training datasets. To ensure wider applicability, future development should focus on expanding the data set to include a wider range of body types, genders, ages and yoga poses. Additionally, creating datasets that include users with different levels of flexibility, body mechanics, and injuries will make the system more inclusive and adaptable to different user needs.

5. Handling complex and advanced positions

Advanced yoga poses that involve complex twists, balances, or inversion poses can pose significant challenges for ML-based systems. Improvements to pose estimation models, potentially through the use of 3D vision or depth-sensing cameras, could improve the system's ability to handle these complex poses. These improvements would allow the system to provide more accurate feedback on advanced positions and sequences.

Challenges

- **Real-time performance and processing:** Location detection and real-time feedback require significant computing power, which can be limiting for users with low-end devices or web cameras. For wider adoption, optimization techniques to reduce processing time without compromising accuracy will be necessary.

- **Privacy and Security:** As the system collects video footage of users practicing yoga, ensuring privacy and data security will be a major concern. Advanced on-device encryption and processing methods (to prevent data transmission in the cloud) can address these concerns.

VII. CONCLUSION

The yoga self-coaching system has been developed to recognize the yoga poses according to the selected yoga pose guide and provide the predicted result and provide real-time instructions for incorrect poses. The identification of incorrect posture is based on the calculated joint angle achieved using key point estimation using the Mediapipe algorithm. In short, we have developed a yoga self-coaching system that can predict yoga poses and confirm real-time feedback. Since the start of Covid-19, home training has increased, and we believe our developed system supports this. A self-coaching yoga system is used to recognize correct yoga postures and provide real-time guidance. The goal is to help people perform yoga poses more accurately without an external instructor or trainer. The key points are obtained from the position estimation module, which means that pipes and media connections are considered as key points. Based on these key points, the data set is trained for precise yoga poses. The system is expected to provide satisfactory results. Based on our analysis, several improvements are needed, and we are working on them. You can also improve the functioning of the system by adding modules for other yoga positions.

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