Review on Yoga Pose Detection and Feedback System

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Abstract*—In an era where health and fitness are becoming increasingly important, personalized tools for self-improvement are essential. This research presents the design and implementation of a real-time Yoga Pose Detection and Feedback System aimed at assisting usersin accurately performing yoga postures. The system integrates several key features: real-time yoga pose detection using image processing techniques, feedback generation based on body posture deviations, and a user-friendly interface for pose selection. The pose detection system leverages machine learning algorithms and OpenPose for key-point extraction, while feedback is provided through voice commands and visual cues. The app ensures proper form and posture, improving user experience by making at-home yoga practice more effective. This paper delves into the system's architecture, challenges encountered, and the overall impact on modern fitness routines.

Keywords: Yoga Pose Estimation, Computer Vision, OpenPose, Machine Learning

I. INTRODUCTION

In order to reap the full benefitsof yoga, a centuries-old practice that improves mental, physical, and spiritual well-being, specific body postures are necessary. However, practitioners run the risk of striking the wrong poses without the right guidance, which could result in injuries or hinder progress. Traditionally, yoga is taught in person by instructors who provide real-time feedback to correct postures and ensure the proper alignment of the body.With the rise of at-home fitness and remote wellness practices, there's a growing demand for automated tools that can replicate this guidance, allowing users toperform yoga poses safely and accurately without requiring a human instructor.

This paper presents a Yoga Pose Detection and Feedback System, which employs advanced image processing and machine learning techniques to provide real-time feedback to users, helping them improve their form and posture during yoga sessions. The system is designed to assess the user's body posture using key-point extraction models such as OpenPose, which detects important points on the body (like shoulders, elbows, and knees) and evaluates their alignment against ideal poses. By analyzing these key-points through a classification algorithm, the system can determine whether the user's posture aligns with the ideal form and offer actionable recommendations for improvement, such as straightening the back or adjusting arm positions.

The app features an interactive interface that allows users to select from a variety of yoga poses and receive continuous feedback during their practice. Real-time posture correction is provided through voice commands and visual cues, helping users make on-the-spot adjustments. Whether the user is a beginner learning basic poses or an experienced practitioner seeking to refine their technique, the app caters to all skill levels. This combination of machine learning and pose analysis technology ensures a productive and seamless yoga experience that promotes physical safety and well-being. Furthermore, the system's feedback loop creates an interactive and engaging experience that motivates users to maintain proper form throughout their sessions, ultimately leading to better yoga practice and improved health outcomes.

II. LITERATURE REVIEW

In order to achieve precise posture alignment and lower the risk of injury, effective feedback is vital in yoga practice. Real-time pose correction, which is crucial in yoga because of the accuracy of alignment needed, is frequently absent from traditional fitness applications. Instantaneous corrective feedback has been shown to improve learning and prevent injuries in users [1]. This need is met by recent developments such as OpenPose, which provides real-time body key-point detection and is appropriate for correcting yoga posture, with studies reporting accuracy rates of around 86.2% in applications requiring ergonomic analysis and feedback [5]. OpenPose detects key points from live video feeds, providing users with immediate feedback and enabling them to instantly correct their posture. Meanwhile, by identifying minute details in body alignment and posture, neural network models like YoNet further maximize feedback accuracy [3]. Voice-guided instructions help users maintain their focus on the pose instead of the

screen, according to research on the role of visual and auditory feedback. Like a virtual yoga instructor, this allows for minimal distraction and increases engagement.

Visual aids that help maintain proper alignment and improve user understanding include color-coded skeletons that show correct and incorrect postures, which have been shown to improve user accuracy by up to 15% in some applications [4]. Deep learning models that combine CNN and OpenPose are particularly useful for real-time pose correction because they accurately identify body key points, reaching accuracies over 91% in postural correction tasks. Research indicates that when it comes to assessing and giving precise feedback on postural deviations, deep learning performs better than more conventional techniques like logistic regression [2]. OpenPose's effectiveness in identifying and resolving postural misalignments has been demonstrated by ergonomic research, which has important ramifications for yoga practice as well as more general fitness applications [5]. Real-time correction systems with feedback loops compare user postures to the recommended yoga poses and recommend adjustments as necessary. It has been demonstrated that these ongoing feedback systems greatly enhance yoga practitioners' learning outcomes [6],[8]. Research on human pose estimation demonstrates the value of several sophisticated models, such as CNN and LSTM, which improve classification and correction accuracy for yoga poses, reaching upwards of 90% in certain implementations [7],[10].Furthermore, various deep learning-based techniques have demonstrated encouraging outcomes in correctly classifying and giving users constructive criticism on their poses, with accuracy rates around 88% or higher, providing crucial assistance for self-learning and enhancing posture accuracy during live yoga practice [1],[9].

III. METHODOLOGY

3.1 System Architecture:

The diagram presents the framework of the Yoga Pose Detection and Feedback System, designed to aid users in real-time correction of their yoga postures through desktop software. The subsequent section offers an in-depth analysis of the operational mechanisms of this architecture. The framework of the Yoga Pose Detection and Feedback System is comprised of multiple critical elements that collaboratively function to deliver precise evaluations of yoga postures. The clients denote distinct users who engage with the desktop application via their personal devices. Each client participates in the system by choosing a specific yoga pose and activating the desktop camera to facilitate real-time input.

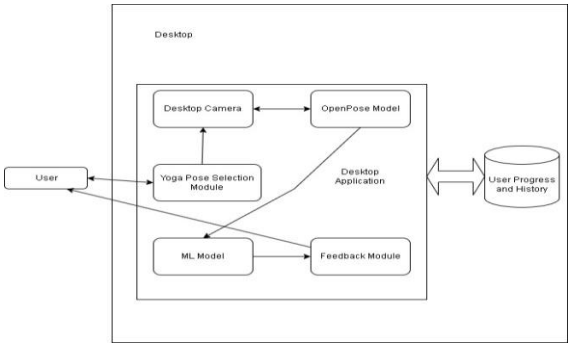

Fig 1: High-level System Architecture

Upon the selection of a pose, the Yoga Pose Selection Module engages with the camera to obtain a continuous stream of the user's movements. This camera feed undergoes processing and is transmitted to OpenPose, a library dedicated to real-time human pose estimation, which identifies key body points by evaluating the user's posture in every frame.

The OpenPose Module is responsible for extracting key points, which are subsequently transmitted to the Deep Learning Model. This model, which has been trained to recognize variations in body pose and posture, analyzes the key-point data and contrasts it with an optimal yoga pose stored in the database. The Deep Learning model evaluates the precision of the user's pose and determines specific areas that may require adjustment.

Upon analyzing the key points, the output produced by the deep learning model is transmitted to the Feedback Module. This module is responsible for delivering both visual and auditory feedback to the user, offering immediate recommendations for pose correction. For instance, it may advise modifications such as "align your back" or "raise your arms" in response to the discrepancies identified by the system.

The Feedback Module communicates corrective instructions to the user via the interface, providing ongoing support during the yoga session. This immediate feedback mechanism enables users to sustain correct posture and alignment, thereby minimizing the likelihood of injury during yoga practice.

The system is also capable of retaining session data,

including user progress, pose accuracy, and any corrections made, within a local database for subsequent reference and performance evaluation. This enduring data retention enables users to monitor their development over time and modify their practice as needed.

3.2 Process Flow:

1. Users initiate the application and select a yoga pose from the Yoga Pose Selection Module. This choice marks the commencement of the yoga session, prompting the system to prepare for the monitoring and assessment of the user's posture.
2. The desktop camera is engaged to record the user's movements, and the real-time video streamis transmitted to the OpenPose Module for additional analysis.
3. The OpenPose Module utilizes the live camera feed to identify and extract the key points of the user's body in real time. These key points correspond to essential joints and angles that are vital for evaluating posture.
4. The salient features obtained from OpenPose are subsequently transmitted to the Deep Learning Model, which has undergone training to accurately identify proper yoga postures and detect any deviations. This model evaluates the user's pose in relation to the optimal pose.
5. The analysis conducted by the Feedback Module results in the formulation of corrective directives, including suggestions like "elevate your arms" or "realign your spine." These directives are presented visually on the application interface and communicated audibly through the system.
6. The individual modifies their posture based on thefeedback obtained. This procedure is reiterated at consistent intervals, with the camera persistently recording new frames, while the system delivers revised feedback.
7. Upon the completion of the yoga session or the closure of the application, the system retains session data locally, encompassing metrics such as pose accuracy, adjustments implemented, and progress tracked over time. This information is accessible to the user for the purposes of self- evaluation and enhancement.

3.3 Implementation

3.3.1 Designing the Environment for Yoga Pose Detection The main aim of developing the yoga pose detection environment is to establish a real-time desktop application that assists users in enhancing their yoga postures. The project scope was delineated to accommodate individuals of varying skill levels, offering guided yoga sessions along with feedback for posture correction. A strong emphasis was placed on usability and user experience to ensure that the system remains intuitive and user-friendly. Notable features include the capability to select specific yoga poses and receive feedback regarding their accuracy. To facilitate this, OpenPose was chosen for body key-point detection, while a Deep Learning (DL) model was employed to analyze the user's posture based on the identified key-points. The application incorporates libraries that enable real-time key-point extraction, angle computations, and suggestions for posture correction. Designing the Environment for Yoga Pose Detection The main aim of developing the yoga pose detection environment is to establish a real-time desktop application that assists users in enhancing their yoga postures. The project scope was delineated to accommodate individuals of varying skill levels, offering guided yoga sessions along with feedback for posture correction. A strong emphasis was placed on usability and user experience to ensure that the system remains intuitive and user-friendly. Notable features include the capability to select specific yoga poses and receive feedback regarding their accuracy. To facilitate this, OpenPose was chosen for body key-point detection, while a Deep Learning (DL) model was employed to analyze the user's posture based on the identified key-points. The application incorporates libraries that enable real-time key-point extraction, angle computations, and suggestions for posture correction.

3.3.2 The initial phase of the project involved configuring the development environment within Visual Studio Code (VS Code). The project was systematically organized into separate directories dedicated to the user interface, data processing, and model integration. Key libraries were installed, including OpenPose for key-point detection and either TensorFlow or PyTorch to facilitate the execution of the machine learning model that assesses posture accuracy.

For the database configuration, MongoDB was chosen to manage user profiles, session histories, and feedback results. Connections were established between the back-end server, utilizing Mongoose for MongoDB, and the application, enabling the system to effectively save and retrieve user session data and historical feedback, thereby facilitating progress tracking.

3.3.3 Yoga Pose Detection Implementation

The pose detection system was developed using a Deep Learning model, with OpenPose utilized to capture key body points from the user's live camera feed. These points are then sent to the Deep Learning model, which evaluates the user's posture against a reference pose template. The system determines the angular discrepancies between the user's pose and the ideal one, providing real-time feedback for improvement.

The feedback is delivered through both visual and auditory cues. Users can view their posture alongside the ideal pose in the app's interface, and they receive immediate corrections, such as "straighten your back" or "raise your arms higher," based on the calculated angle differences.

3.3.4 User Interaction and Experience

The user interface (UI) aims to create a straightforward and engaging experience. Users can choose from a selection of yoga poses while viewing their live camera feed alongside a perfect reference pose. The system evaluates each body part gradually, highlighting areas requiring correction and displaying the extent of deviation in real time.

Immediate feedback enables users to adjust their poses promptly. Additionally, audio cues improve the experience, offering vocal guidance for alignment adjustments throughout the pose.

3.3.5 User Data Management via Database Integration

A MongoDB database was established to manage user information, such as profiles, yoga session histories, and feedback results. This system enables users to monitor their progress over time. The database schema contains fields for session timestamps, pose accuracy metrics, and feedback specifics.

Users can access and visualize this data within the application, allowing them to examine past sessions and track improvements in their posture. This integration guarantees a smooth user experience, with every session recorded and stored for future reference.

IV. RESULT

The Yoga Pose Detection and Feedback System was created in response to the increasing need for accessible and immediate posture correction during yoga sessions. This desktop application allows users to engage in yoga poses while receiving guided feedback, thereby enhancing the accuracy of their postures through prompt corrections. By utilizing OpenPose for key-point extraction and a deep learning model for posture assessment, the platform delivers real-time, interactive support suitable for practitioners of varying skill levels. The system is designed with a user-friendly interface that enables individuals to choose specific yoga poses and observe their camera feed alongside an ideal reference pose. It evaluates key points from the user's live video, compares them to a standard model, and provides both visual and auditory feedback for necessary posture adjustments. This functionality facilitates smooth and effective corrections for each yoga pose, allowing users to execute exercises accurately without the assistance of a human instructor. Continuous key-point analysis underpins real-time posture evaluation, with feedback generated at regular intervals to help users maintain proper alignment. The feedback mechanism is highly responsive, enhancing the overall user experience by offering immediate and actionable recommendations. User data, including session history and posture development, is securely stored in MongoDB, enabling users to monitor their progress over time. By promoting self-directed yoga practice with real-time feedback, the platform enriches the learning experience, making it more accessible and tailored to individual needs. The seamless integration of deep learning and computer vision technologies provides a practical solution for users aiming to enhance their yoga practice in a comfortable environment. This system not only improves pose accuracy but also encourages healthier yoga habits for practitioners at all levels.

V. CONCLUSION

The Yoga Pose Detection and Feedback System leverages advanced technologies to create a real-time yoga practice environment. Using OpenPose for key-point detection and a deep learning model for pose evaluation, it provides immediate posture correction and feedback, helping users improve their yoga performance. Its user-friendly interface, along with visual and auditory guidance, accommodates all skill levels. Designed for use anywhere, the system offers a personalized yoga experience without the need for in-person instructors. By tracking session data and user progress, it fosters ongoing improvements in posture and practice. The real-time feedback feature enables quick adjustments, promoting a healthier yoga routine. In summary, this system is a valuable tool for modern yoga enthusiasts, enhancing posture accuracy and overall wellness while paving the way for future AI-driven fitness innovations.

VI. REFERENCES

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