Detection and Correction of Yoga Poses

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Abstract

Yoga is a highly beneficial physical activity with promising applications in personal healthcare. Multiple studies have demonstrated that yoga can serve as a physical treatment for various health issues, such as cancer, musculoskeletal disorders, depression, Parkinson's disease, and respiratory and heart diseases, among others. Proper body alignment is critical in yoga, requiring effort on the muscles, ligaments, and joints to achieve the optimal posture. Postural-based yoga can improve flexibility, energy, and brain activity, and reduce stress, blood pressure, and back pain. During yogic asanas, proper body alignment is crucial to avoid strain on the joints, ligaments, and backbone, particularly during forward or backward bending asanas such as uttanasana, kurmasana, ustrasana, and dhanurasana. To ensure correct poses while performing different asanas, it is essential to monitor body posture alignment. Advancements in computer vision algorithms and sensors have made it possible to predict yoga posture and automatically analyse movement. Therefore, practitioners can now leverage technology to enhance their yoga practice and achieve better results. This paper proposes a method to analyse the yoga postures performed by the user and correct them in real time.

Keywords: Random Forest Classifier, Open Pose, Yoga Posture Recognition, Optimal Posture, Machine Learning

Introduction

Yoga is a safe and effective kind of exercise that may boost physical activity, especially strength, flexibility, and balance, while also increasing physical and emotional well-being. It is a total-body workout that develops both the mind and the body by using deep breathing, meditation, and relaxation. Yoga is especially good for people who suffer from high blood pressure, heart difficulties, discomfort, or stress, since regular practice can help to ease these symptoms. As a result, Yoga has grown in popularity in recent years all around the world. Nonetheless, joining Yoga courses might be difficult for many people owing to a variety of issues. In Myanmar, for example, elderly find it difficult to attend yoga lessons owing to inefficient public transit systems.

Motivation

The creation of a system capable of detecting and correcting yoga poses is critical for boosting safety and reducing accidents during yoga practice. Real-time input on posture and alignment can help practitioners avoid injury and preserve appropriate technique. This is especially critical for new practitioners who may lack the requisite skills to effectively perform poses. Yoga's full advantages, such as increased flexibility, strength, and mental clarity, need proper posture and technique. Practitioners may improve their performance and get the advantages of their practice by providing feedback on posture and alignment. Furthermore, a system that recognizes and corrects yoga postures can make yoga more accessible to people who do not have access to a yoga studio or instructor, especially those who reside in distant or rural locations. Individuals who practice yoga in the comfort of their own homes while receiving real-time feedback can reap the advantages of yoga without having to visit a class.

Objectives

The present endeavour endeavours to construct a sophisticated machine learning model that can identify the precise yoga posture performed by an individual through computer vision techniques, followed by offering suggestions to the user to enhance their posture, without requiring any direct human supervision. The proposed system operates by capturing a sequence of images of the individual while performing yoga asanas, analysing the captured images using advanced algorithms to gauge the accuracy of the posture, and subsequently providing intuitive feedback to the user to refine their yoga practice.

Literature Survey

The literature review encompasses a comprehensive spectrum of methodologies and technologies designed to address the challenging task of accurately classifying and monitoring yoga poses. In their study, Agrawal et al. [1] introduced a novel machine learning technique that harnessed the power of the tf-pose-estimation algorithm to generate intricate skeleton models of yoga poses. Their approach involved capturing a photograph of a yoga pose with a camera, which was then used to produce a detailed skeleton model. Crucially, they extracted essential features such as joint angles from these models and employed them as input for a machine learning model. The training and evaluation process utilized a dataset consisting of ten different yoga poses, with each class containing between 400 to 900 images. The dataset was divided into 80% for training and 20% for testing, and the model's performance was assessed using six different machine learning models. The result was an impressive overall accuracy rate of 94.28%, demonstrating the model's ability to classify yoga poses accurately. Notably, the Random Forest classifier excelled among the models, achieving an extraordinary 99.04% accuracy. The authors postulated that their technique had practical implications in various domains, including yoga training and the monitoring of correct pose alignment.

Meanwhile, Navaneeth and Dileep [2] presented a unique approach focusing on the Suryanamaskar yoga style, which comprises twelve distinct steps. Their primary objective was to employ video monitoring as a means of tracking body movements and postures during yoga practice. They recorded videos from a side view using a single camera, specifically choosing the left side. To capture practitioners' poses, they developed a 3D kinematic pose estimation model using a bottom-up approach. This involved constructing the complete body position from various identified body parts. To identify these body parts, they employed a deep learning-based posture estimation algorithm, which was used to recognize body parts from input images or video frames. Subsequently, inverse kinematics was applied to these identified body parts to generate a 3D posture. Their proposed algorithm then compared the angles obtained from the vectors with the data from the testing set and the training set, which had been recorded using the same methodology and stored in a database.

Another innovative perspective was presented by Kotak et al. [3], who introduced a method for classifying yoga poses by combining Media Pipe and an angle heuristic approach. They employed the Blaze Pose model, which provided more comprehensive key point information compared to traditional methods, to obtain thirty-three body key points. These key points were then analysed using the Media Pipe library. To calculate body posture, an angle heuristic technique was used, determining the angle between two key points. The input data consisted of fifty samples, each containing fifty images, categorized into standing and sitting asanas, with 5 and 4 classes, respectively. The technique calculated the angle specific to each pose by computing the mean average from five test images. The combination of advanced technology and sophisticated algorithms in this approach allowed for the accurate classification of yoga poses. The Blaze Pose model and the Media Pipe library offered a higher level of detailed information, facilitating the identification of various key points. The application of the angle heuristic approach to determine the angle between these key points resulted in precise posture classification. The real-time capabilities of this technique made it particularly valuable for yoga practitioners seeking to monitor their poses without requiring the expertise of an instructor.

Lastly, Devi et al. [4] explored a sensor-based posture detection system that utilized sensors such as accelerometers, gyroscopes, and magnetometers to detect a person's posture in real time. Their system offered two posture detection approaches: a rule-based method and a machine learning-based approach. The latter proved to be more accurate and reliable than the former. While the technology was adaptable and non-invasive, with potential applications in healthcare, sports, and ergonomics, it also presented certain challenges. These included cost considerations, complexity in recognizing specific postures, and potential privacy concerns. Therefore, before widespread deployment, careful assessment of these obstacles and limitations was essential. Overall, this system represented a viable option for improving posture and promoting healthy behaviours across various sectors.

Problem Statement

The main objective of this paper is to execute an easy and efficient method of doing yoga wherever and whenever. Post-Covid outbreak exercising in your own space and with the equipment available lead to many people turning to yoga for an all-around body workout. However, practicing yoga incorrectly poses a higher risk of injuries. To ensure a safe and correct method, we developed an application that helps in real-time yoga pose detection and correction with the help of simple devices available at home. The focus was on making it user-friendly and simple to understand for all age groups and easily accessible. The challenges faced were collecting a dataset of the poses performed by a professional and comparing the results to a user. Large sets of images were scanned and used to identify the various yoga poses and then saved for future reference. Suitable hardware and software were required to form a collection for the detection and correction of the performed yoga pose.

Project Requirement Specifications

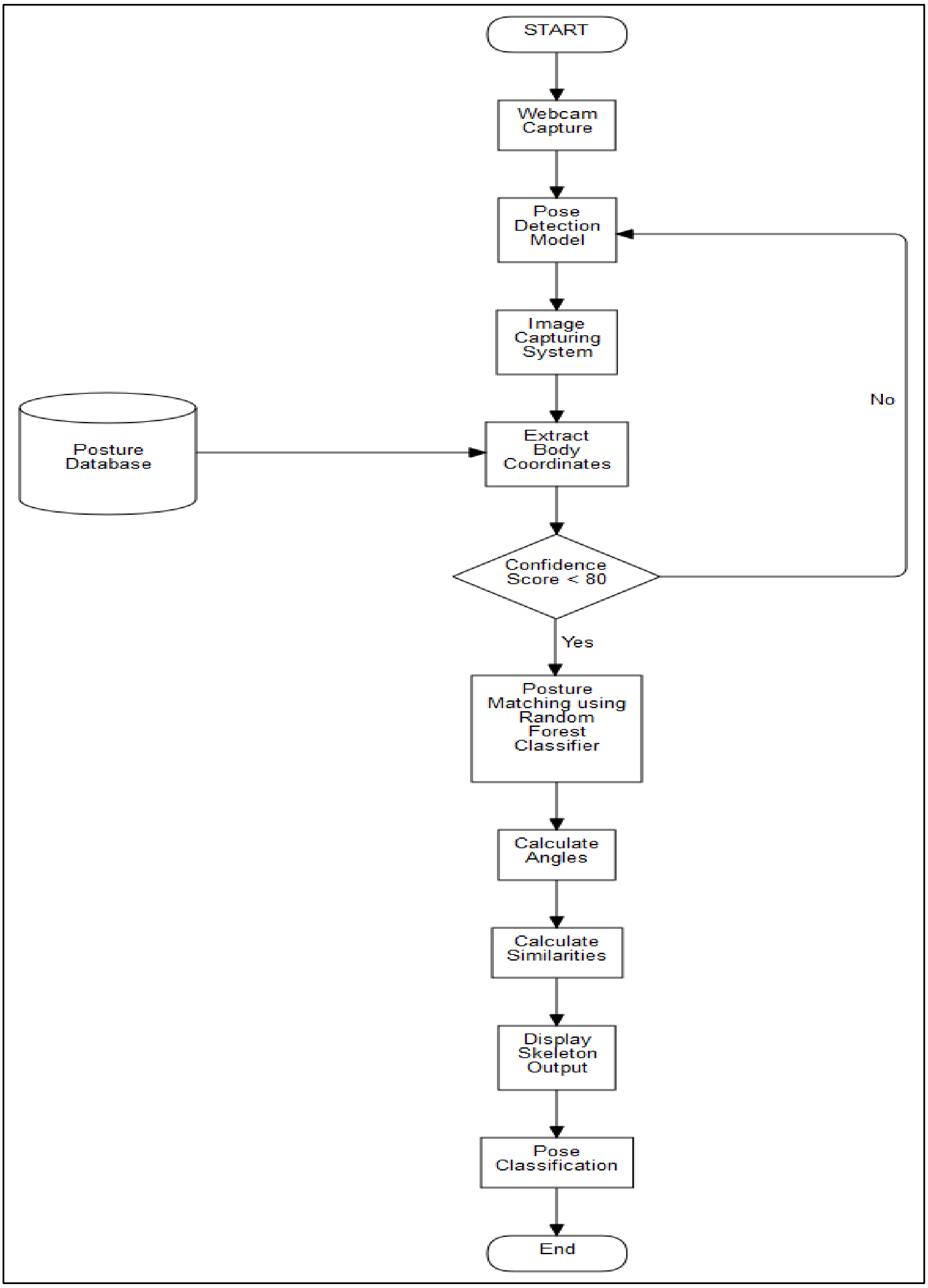
Random Forest Classifier (RFC) is a common machine learning technique that reduces sensitivity to training data and prevents overfitting by using bootstrapping and random feature selection. The method chooses a portion of training data, creates decision trees for each subset, chooses just a subset of features, and uses majority voting to make the final prediction. Random feature selection decreases the correlation between the trees, preventing them from sharing decision nodes and performing similarly, which would raise the variance of the model.

The Random Forest Classifier method is dubbed random because it employs two random processes to improve its performance: bootstrapping and random feature selection. A collection of yoga positions is included in our dataset. These files will require instruction. To adapt and train data, third-party Python modules such as Open Pose for collaborative feature extraction, Keras, Tensor flow, and NumPy will be used. Keras will be used to create our model architecture and train this vast quantity of data. High-end GPUs capable of training 14k instances per second, will be required to learn these huge dataset samples. It can also work in milliseconds on a batch of 128 or 256 photos. However, the power usage is for such a machine. As a result, installing and training datasets on cloud-based platforms such as Google Cloud is optimum and efficient.

Proposed System Architecture and Diagram

The flow diagram below clearly displays the system design and functioning. The camera captures your yoga positions in real time and sends the necessary data to the image-capturing system, which maps the body joints to the available dataset for comparison. The system then extracts the body coordinates and presents a marked picture. The system begins matching the real-time posture to the dataset in the database with the help of the Random Forest Classifier Algorithm. This database contains models of postures executed successfully and badly, indicating where the user is going wrong. When the comparison is finished and the result reveals an 80% confidence level, the system computes the angles and similarities and presents a skeleton graph. This output is then used to precisely identify and detect the yoga stance done by the user, as well as whether it is accomplished correctly.

Figure 1: Control Flow of the Proposed System



Project Plan

The system's primary objective is to assist yoga practitioners in improving their poses by providing real-time feedback and guidance. To achieve this, the project plan outlines a series of key steps and activities. Firstly, the requirements gathering phase will be conducted to identify the hardware and software requirements for the system. This includes determining the necessary datasets of yoga poses performed by professionals and any external dependencies or third-party tools required for the project. The dataset

collection and preparation phase will involve collecting a diverse range of yoga poses, cleaning and labelling the images, and splitting the dataset into training and testing sets. The subsequent phase focuses on model development, where a suitable machine learning algorithm, such as the Random Forest Classifier, will be implemented. The algorithm will be trained using the prepared dataset, and efforts will be made to optimize the model parameters and ensure its robustness through cross-validation techniques. The system implementation phase will involve developing the software components for real-time pose detection and correction. The trained model will be integrated into the system, and user interfaces will be designed to provide intuitive and user-friendly interactions. Rigorous testing and validation will be conducted to ensure the system's functionality and accuracy.
Additionally, the project plan emphasizes the importance of documenting the entire development process. This includes preparing detailed documentation, such as user manuals, and writing a comprehensive project report that summarizes the development process and presents the achieved results. The documentation will be supplemented with relevant diagrams, flowcharts, and code snippets, as necessary. Finally, the deployment and maintenance phase will focus on deploying the system in a suitable environment and monitoring its performance. Any maintenance or support requirements will be addressed, and future enhancements or updates will be considered to ensure the system's longevity and adaptability. By following this project plan, we aim to deliver a robust and user-friendly yoga pose detection and correction system that effectively assists yoga practitioners in refining their poses and improving their overall practice.

High Level Design

Figure 1. Use Case Diagram for the Proposed System

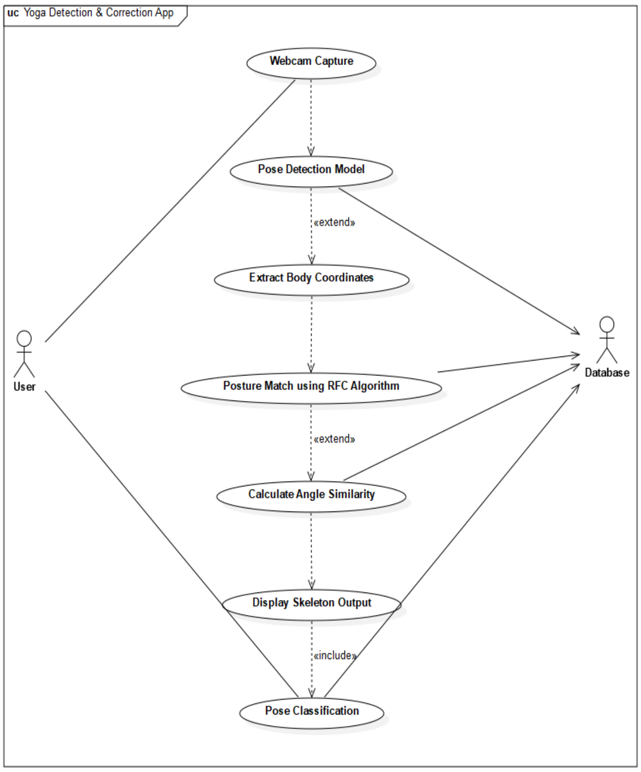


Figure 2. shows how the user of the proposed system will interact with it. Firstly, the user will stand in front of the webcam and do an asana. The pose detection model will try to estimate what yoga asana that

user is trying to perform and cross check with the database of the all the yoga poses. Then the system will extract the body joint co-ordinates and feed it into the function to calculate the angle similarities between the yoga pose being performed by the user and the pose that the model has estimated. After calculating the similarities, a 'colour gradient' video will be shown on the screen to the user, using which they can see which parts of their body are not in position with the correct yoga pose.

Conclusion

We are glad to offer our suggested system for identifying various yoga asanas and providing users with remedial visual cues. We opted to use the Random Forest Classifier because of its high accuracy to achieve this goal. We are optimistic that our model will be able to recognize yoga postures performed by users with an estimated accuracy of 98% or higher. Our ambitions include improving the capability of our system to accommodate numerous users in the same scenario at the same time. Furthermore, we want to improve the input technique by including a 3D motion- sensing device. This innovative technology will allow our system to assess the user's position more precisely, especially in low-light conditions. We are certain that with these upgrades, our system will give consumers an ideal and highly customized yoga experience.

Acknowledgement

We wish to extend our heartfelt thanks to Professor Pragya Sinha for her invaluable guidance, unwavering support, and mentorship throughout the research process for our paper, "Detection and Correction of Yoga Poses." Her expertise in computer vision and her dedication to our academic growth have been pivotal in shaping this research endeavour. We also extend our appreciation to the Computer Engineering faculty for fostering an environment of academic excellence, which contributed to the success of this project.

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