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Real-Time Yoga Posture Detection and Correction System

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ABSTRACT

Ensuring proper posture during yoga sessions is essential for maximizing benefits and preventing injuries. However, many users, especially beginners, often perform poses incorrectly because they lack guidance. This paper presents a system that detects and corrects yoga postures in real time using the YOLOv8 object detection algorithm. The system captures live video and assesses the practitioner's body movements, comparing them to a predefined set of standard yoga positions to identify any differences. When a variation is found, the system provides immediate feedback, helping the user make necessary adjustments to their posture. Additionally, the system tracks performance over time, enabling users to monitor their progress and receive personalized suggestions for improvement. The results show that the proposed system accurately identifies deviations.

1. INTRODUCTION

Yoga plays a crucial role in maintaining physical and mental well-being. Many individuals practice yoga regularly to stay fit and reduce stress. However, beginners often perform yoga poses incorrectly due to a lack of proper guidance. Improper alignment can reduce the effectiveness of yoga and may even lead to injuries. With the advancement of technology, computer vision techniques are being applied across various domains. These techniques can also be used to improve yoga practice. By using pose detection methods, body movements can be analysed to determine whether a posture is correct.

This paper presents a real-time yoga posture detection and correction system. The system uses a camera to capture the user's

movements and evaluates body posture through pose detection techniques. It compares the user's pose with standard yoga postures and provides immediate feedback for correction. The main objective of this system is to help users practice yoga correctly without the need for a trainer, making it especially useful for beginners practicing at home.

Yoga is a potent method to improve physical and mental health. People come to classes not only to relax and relieve stress but also to learn how to properly perform yoga poses. Human trainers can provide personalized, specific directions on how to do a yoga pose correctly. However, technology is much more capable than what was used to the past. A lot of research has been conducted in the field of intelligent human motion analysis and many good ideas designed to help people are now being proposal.

Among many other possibilities, there are also intelligent ways to help improve yoga practice. Based on hardware solutions it can become somewhat difficult to have the use of a decent product. For example, there are already some projects which using wearable sensors can analyze, collect and even give useful feedback based on the accurate motion data. However, the sensors are expensive and not less convenient, and their use is most effective when motion data is captured with several sensors separately. Camera-based computer vision is often used to solve similar problems like decoding the joint's movement and determining the correctness of posture.

As the number of users is constantly increasing all over the world, developers are always looking for a better solution to meet their needs. One way is to solve the current yoga practice problem by creating a real-time analysis of posture performance. A hardware application assisting with yoga poses that includes real-time posture detection and correction. It allows for immediate feedback on current poses, so the user can train himself and do yoga at home, instead of going to classes every day. Some disadvantages are a complex setup that needs to be done on the computer and the solution is not user-friendly. While it's on the other side simple to set up, efficient and provides a real-time solution, the design would take a lot of time, and users would still need software on their computer. So even considering the hardware downsides, an optimal solution providing accessibility and effectiveness is a camera-based solution that requires no additional hardware.

2. PROBLEM STATEMENT

Yoga is an age-old discipline followed for enhancing physical fitness and mental well-being. However, while performing the yoga poses, the beginners tend to perform them incorrectly, which leads to their ineffectivene increases the risk of injuries. The reason for them performing the poses inappropriately can be due to lack of proper guidance and supervision from an expert. The traditional approach for learning yoga is through professional trainers or following recorded videos, which lacks the real-time feedback and the personalized correction of mistakes by the trainer. Thus, as a result, the user is left unaware of the mistakes they are performing, even after the training. Moreover, accessing a professional trainer may not be possible for all users due to high fees, time constraints, and unavailability. There is a need for a simple, cost effective, and easy-to-use home based system which does not require any additional equipment but accurately detects the incorrect yoga postures and provides the user with an immediate feedback to ensure safe and effective execution of the yoga practice.

3. PROPOSED SYSTEM ARCHITECTURE

The proposed system takes a camera-based approach and attempts to identify and rectify yoga postures in real time. It captures live video input of the user as they perform yoga poses, breaks the video into frames, identifies key points in each frame (shoulders, elbows, hips, knees, etc.), connects them into a skeletal representation of the user, compares that to a library of standard yoga poses, identifies discrepancies, and provides feedback on what the error in posture is and how to fix it.

A. Input Module

The input module gets video from a webcam or camera. It does this in time. The video stream goes into the system so it can be looked at closely. The input module makes sure the video is quality and that the frames are captured properly. This helps the system detect posture accurately.

B. Pose Detection Module

This module uses Media Pipe and OpenCV libraries to find the points of the human body. It looks at things like shoulders, elbows, knees and hips. The system goes through each frame of the video. It figures out where the body joints are using methods to guess the pose. The module is really good at detecting body key points, like shoulders, elbows, knees and hips using media Pipe and OpenCV libraries.

C. Pose Comparison Module

In this part the body posture that is detected is compared to the yoga poses that are already stored in the system. The system does this by calculating the angles, between the joints and checking if the position is right. If the users body posture is not

like the correct pose it is marked as not correct. The system is checking the yoga poses to see if the user is doing them right. The detected body posture is compared to the yoga poses.

D. Feedback Module

The feedback module gives the user ideas on what to do away. It shows messages like "Straighten your back" or "Raise your arms" to help the user correct their posture. The feedback module shows these messages on the screen really fast so the user can improve their posture with the feedback module. The user sees the messages, from the feedback module. Can fix their pose

4. SYSTEM DESIGN AND METHODOLOGY

A system is proposed that operates as a real-time yoga posture detection and correction system with a camera-based setup. The proposed system has several modules: input module, processing module, pose detection module, comparison module, and feedback module. The input module captures live video using a webcam or mobile camera, which is then divided into frames for detailed analysis by the processing module. The pose detection module identifies key body points such as shoulders, elbows, hips, and knees from each frame and uses these points to form a skeletal structure of the user's posture. The comparison module compares the detected posture with standard yoga poses stored in the system, and the feedback module provides real-time guidance to the user through text, visual signals, or audio instructions. Finally, the system can include a storage module to record results.

A. Video Capture and Pre-processing

The process begins when the user starts the system using a webcam. The camera takes video frames. These frames are then made to look better so the system works well. This means the system makes the frames smaller and changes how bright and dark they are. This helps the system find things correctly even when the light is different.

B. Pose Detection

The pose detection module uses media Pipe to find the parts of our body like shoulders, elbows, hips and knees. It looks at each frame to get the coordinates of these joints. This helps us see how the user is standing or sitting at that moment. The pose detection module is really good, at figuring out the user's posture in time using media Pipe.

C. Pose Comparison and Analysis

In this step we compare the detected body points with correct yoga poses that are already defined. The system calculates the angles between joints. It checks if the posture matches the standard pose. If there is any deviation, from the correct pose the system identifies it as a posture. The yoga poses are checked for alignment. The detected body key points are compared with the yoga poses.

D. Feedback and Output

The system gives you feedback away based on what it finds. It shows you things like "Straighten your back" or "Lift your arm higher" to help you do it correctly. This way you can fix your posture on the spot. Do yoga better. The yoga system is really helpful because it gives you this feedback in time which is great for yoga. The system is, about helping you with your yoga posture.

[Camera Input]

↓

[Video Capture]

↓

[Frame Extraction]

↓

[Pose Detection]

↓

[Skeleton Formation]

↓

[Pose Comparison]

↓

[Error Detection]

↓

[Feedback Output]

(Text / Audio / Visual)

↓

[User + Data Storage]

5. IMPLEMENTATION

A camera-based setup is used to implement the proposed system for real-time yoga posture detection and correction. Live video input of the user performing yoga poses captured through a webcam is processed in real-time by dividing the video stream into frames, analysing each frame to detect key body points (such as shoulders, elbows, hips, and knees), connecting these points to create a skeletal representation of the user, comparing the detected posture with predefined standard yoga poses stored in the system (based on joint

angles and relative positions of body parts), and providing real-time feedback in the form of visual cues to correct incorrect posture.

Tools and Technologies Used

- Programming Language: Python
- Libraries: OpenCV, MediaPipe
- Hardware: Webcam / Laptop
- Platform: Windows Operating System

A. Technology Stack

The system is made using Python. We use OpenCV to capture video and process images and media Pipe to detect poses in time. The user interface is pretty simple. Made with basic frameworks. The system works on a computer that has a webcam. To build the system we use tools, like Jupyter Notebook or VS Code.

B. Pose Dataset and Reference Models

The system has a set of yoga poses that are used as reference models. These yoga poses are the ones that people do all the time like Tad asana and Tree Pose and Warrior Pose. Each yoga pose is made up of the points, on your body and the angles of your joints. The system uses these reference yoga poses to check how well you are doing the yoga poses and to see if you are doing them correctly.

C. Pose Detection and Processing

The media Pipe model is used to find the body landmarks in time. It finds the points like the shoulders, the elbows, the hips and the knees. The media Pipe model looks at each frame of the video. Figures out the angles, between the joints to see how the user is standing or sitting. The media Pipe model uses these values to compare with the reference poses of the media Pipe model.

D. Feedback and System Execution

The system gives you feedback away based on how you are sitting or standing. If your posture is not good it tells you what to do, like "Adjust your arm position" or "Keep your back straight." The system is always on. Gives you new feedback the moment you move. This helps people fix their posture when they are doing yoga. The yoga posture is very important. The system helps with that by giving you constant feedback on your yoga posture.

RESULTS AND DISCUSSION

A proposed system for real-time yoga posture detection and correction was successfully implemented and tested using a webcam-based setup, which accurately detected body key points and generated a skeletal structure for various yoga poses, correctly identified whether the user's posture was accurate or not when compared with predefined standard poses, and provided immediate feedback to help users adjust their alignment in real time, enhancing the overall effectiveness of the yoga practice. The system operated efficiently in normal lighting conditions and processed video frames in real time with minimal delay, although the accuracy of posture detection was found to be contingent upon camera angle, lighting conditions, and user positioning. The results suggest that the system is effective in supporting users, particularly beginners, in executing yoga poses properly.

CONCLUSION

In this paper, a real-time yoga posture detection and correction system was proposed based on camera-based approach, which captures user movements to detect body posture using pose detection techniques, compares the user's posture with the standard yoga poses, and provides immediate feedback for correcting mistakes. The results indicate that the system is capable of detecting incorrect postures and helping users to correct their practice, particularly for beginners who lack professional trainers, and it is simple, cost-effective, and easy to implement in a home environment. While the system works well under normal conditions, some limitations such as dependence on lighting and camera positioning still exist. However, the proposed system offers a practical solution to safe and effective yoga practice. The system can be further improved in the future by increasing accuracy, supporting more complex yogasanas, etc.

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