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Yoga Pose Tracking Application

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ABSTRACT:

Yoga pose detection and correction involve using computer vision techniques to identify body postures and assess their accuracy in real time. By leveraging deep learning models for real time like "MobileNet V3 small" for feature extraction and keypoint detection frameworks such as "MediaPipe", systems can detect landmarks on the human body to analyze poses. These systems are trained on large datasets of labeled yoga poses to recognize and classify various postures. The correction aspect compares detected poses against ideal postures, offering feedback for alignment and improvement. This technology has applications in virtual yoga classes, fitness apps, and personalized training, promoting safe and effective practice

Keywords - Computer Vision, Deep Learning, Mediapipe, PoseEstimation, Image Classification, MobileNet V3 small, Feature Extraction.

1. INTRODUCTION:

In recent years, the integration of deep learning and computer vision has revolutionized various domains, including fitness and health monitoring. Yoga is a practice that relies heavily on correct posture and alignment to ensure its physical and mental benefits while reducing the risk of injury. Traditionally, yoga instructors guide practitioners to achieve and maintain the correct form during various poses(asanas). However, with the increasing popularity of remote learning and fitness applications, the need for automated systems that can detect and correct yoga poses has emerged. These systems leverage computer vision and deep learning techniques to analyze body movements and provide real-time feedback. By detecting key body landmarks, they can identify the user's pose and compare it to an ideal reference, offering suggestions for improvement. Such systems are beneficial in virtual yoga classes, fitness apps, and rehabilitation programs, providing users with guidance and personalized corrections, enhancing the overall safety and effectiveness of their practice. As a result, pose detection and correction technologies are gaining attention as valuable tools in modern fitness and wellness applications.

2. LITERATURE REVIEW:

1. Deepak Mane et al. (2023): A customized SVM classifier is proposed for yoga pose classification. Utilizes Radial Basis Function (RBF) kernel for non-linear relationships. Joint angles are calculated from keypointusing trigonometry. Data is normalized to zero mean and unit variance. Dataset is split into training and testing sets (80:20 ratio). Real-time feedback is provided through a graphical user interface.

2. Arun Kumar, Sibi Chakkaravarthy Sethuraman et al. (2023): The methodology involves yoga posture classification using keypoint detection. It utilizes machine learning and deep learning techniques. The process includes feature extraction from images and videos. A multiclass SVM is employed for classification tasks. Real-time detection is achieved using advanced sensors and algorithms.

3.S.C.Sethi et al. (2023): A hybrid deep learning model is proposed for yoga pose detection. The model uses OpenPose for keypoint extraction from images. LSTM analyzes feature changes across frames for pose accuracy. Real-time feedback is provided when poses deviate from correct form. The system aims to support self-mastery in yoga practice.

4. Priyanka Verma et al. (2023): A literature search was conducted using specific key terms.Key terms included "Artificial Intelligence" and "Yoga Posture." The search covered studies from 2019 to 2023.Databases used included Google Scholar and PubMed. Nine articles were identified; eight were examined closely**.**

5.Abhishek Sharma et al. (2023): The tf-pose algorithm extracts coordinates for posture evaluation. Joint angles and distances are calculated for posture correction.A skeleton of the palm is created for mudra detection.Angles from joints are used as features for classification. Data is split 80:20 for training and testing datasets. XGBoost with RandomSearch CV achieves the highest accuracy**.**

6.Ranjana Jadhav et al. (2023): The methodology includes data collection, joint estimation, and pose correction. A dataset of 2500 images of seven yoga poses was used. Images were resized to 300 x 300 pixels for processing. A deep neural network estimates joint positions using MoveNet model.

The model processes RGB images or video streams for joint estimation. Confidence scores are calculated using mean squared error (MSE). Feedback is provided in real-time for pose correction. The system evaluates robustness under varying conditions and angles. Hyperparameters are optimized for improved model performance. User- friendly interface allows video uploads for posture critique.

7.Vivek Thoutam et al(2022): Deep learning-based yoga pose estimation methodology is proposed. Method consists of feature extraction, classification, and feedback generation. Videos or images are input for key point extraction. Angles between joints are calculated for classification. Feedback is generated based on angle differences. yoga poses are classified: Cobra, Tree, Mountain, Lotus, Triangle, Corpse.

8.Yash Shah et al. (2021): A large dataset of 5500 yoga pose images was created. TF-pose estimation algorithm was utilized for skeleton creation. Joint angles were extracted as features for classification. Six machine learning models were tested for pose classification. 80% of the dataset was used for training. 20% of the dataset was used for testing. Random Forest Classifier achieved 99.04% accuracy.

9.Shubham Garg et al. (2019): The model classifies yoga poses into five categories. Skeletonization is performed using the MediaPipe library. Various deep learning models are compared with and without skeletonization. The dataset consists of 1551 yoga pose images. The proposed model uses a convolutional neural network architecture. Media Pipe detects human skeletal key points for pose classification. The model achieves low latency for real-time applications.

10. Arun Kumar et al. (2022): The methodology involves autonomous prediction of yogic postures. It consists of four phases: data collection, pre-processing, feature extraction, classification. Distinct classes of yogic postures are collected in the first phase. Images are resized and normalized during pre-processing. Pretrained CNN models extract features from the yoga images. Machine learning classifiers classify the extracted features. Six pre- trained CNN architectures are utilized for feature extraction.

11.Santosh Kumar et al.(2019): Data collection from real-time and recorded videos. OpenPose identifies joint locations using keypoint detection. CNN extracts patterns from detected keypoints. LSTM analyzes temporal changes in keypoints over time. Framewise prediction and polling approach on 45 frames. Time-distributed CNN detects patterns in single frames. LSTM memorizes patterns from recent frames. System eliminates need for handcrafted features.

12. Fazil Rishan et al. (2020): The system identifies user poses in real-time. It uses mobile camera for capturing user movements. Pose estimation employs OpenPose to identify 25 keypoints. A Deep Learning model analyzes user poses using CNN and LSTM. Feedback on posture accuracy is provided to users. TensorFlow Lite and PoseNet visualize posture correctness on Android. The system supports multiple user levels: Beginner, Intermediate, Expert.

13.Chhaihuoy Long et al.(2020): Development of a yoga posture coaching system proposed. Utilized an interactive display for real-time feedback. Collected 14 yoga postures using an RGB camera. Eight participants performed each posture ten times. Applied data augmentation to prevent overfitting. Employed six transfer learning models for classification tasks. Selected TL- MobileNet-DA model based on evaluation metrics. Achieved overall accuracy of 98.43% with the model. Provided instructional feedback for incorrect postures using joint angles. Developed system interface using Python and Tkinter.

14.D Mohan Kishore et al. (2023): Dataset of 6000 images was obtained and divided. Images classified for 5 Yoga poses and labeled. Pre-trained deep learning model used with specific parameters. Mediapipe extracted key points from images for analysis. Test images captured and inputted to the model. Key points provided a skeletal view of the pose. Angles between key points calculated for posture correction. Dataset included various Yoga poses performed by participants.

15.Mukund Nale et al. (2023): Live camera input captures video stream for analysis.Preprocessing enhances video quality and usability. Relevant features extracted from human body keypoints. Classification uses logistic regression for yoga pose identification.

3. METHODOLOGY:

1. Input Layer:

The project begins by capturing input data in two primary formats:

a) **Live Video Stream:** Utilize a camera (USB/Webcam or mobile device) to capture real-time video streams of users performing yoga poses.

b) **Image Uploads:** Allow users to upload static images of yoga poses for analysis. These input methods provide flexibility, enabling the system to cater to both live and static pose evaluations.

2. Pose Detection Module:

This module is responsible for identifying and extracting human body landmarks from the input data.

a) **MediaPipe Pose Estimation:** Leverage Google's MediaPipe Pose library to detect and extract 33 key landmarks corresponding to major body joints. Ensure robust detection in both real-time video streams and uploaded images.

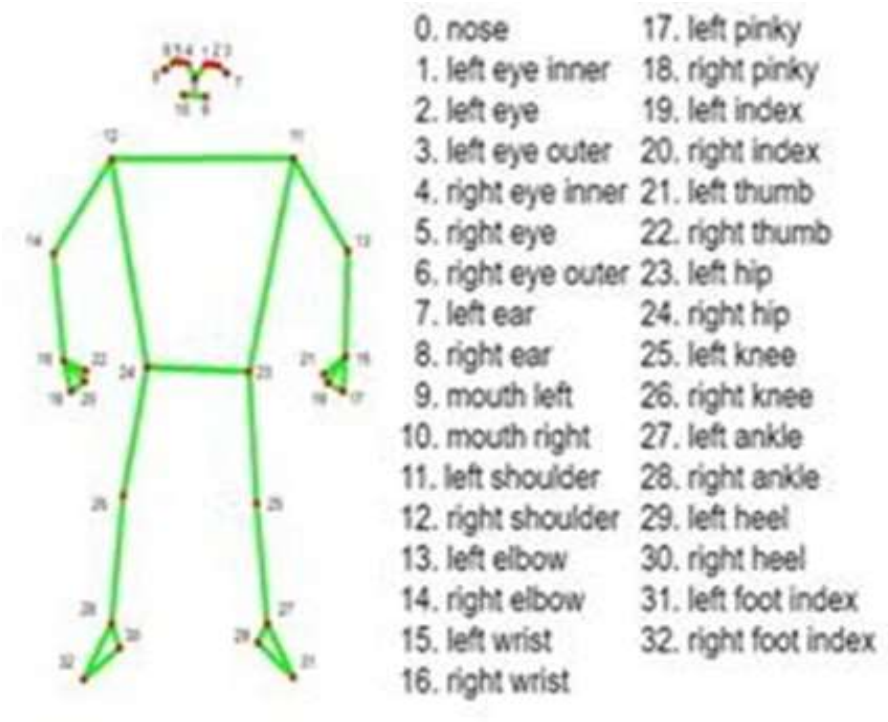

Figure1: Human body coordinates detected using MediaPipe.

3. Preprocessing Layer:

To ensure consistency and accuracy, the input data undergoes preprocessing steps:

a) **Normalization:** Normalize keypoint coordinates to ensure uniformity across poses, regardless of the individual's height, camera angle, or distance.

b) **Data Augmentation:**Apply transformations such as rotation, scaling, and translation to static images, enhancing the diversity of the training dataset.

c) **Additional Data Collection:** Expand the dataset by including variations of poses (e.g., different angles, execution styles, and user body types) to improve model robustness and generalization.

5. Feature Extraction Module:

This module focuses on extracting high- level features from the input data:

a) MobileNet V3 Small: Use MobileNet V3 Small, a lightweight and efficient convolutional neural network, for feature extraction.Fine-tune the pre-trained model using a specific yoga pose dataset to achieve higher accuracy and relevance to the project's objectives.

5. Classification Layer:

The extracted features are classified into predefined yoga poses:

a) **Pose Classification:** Implement a classification algorithm to identify poses from a dataset comprising 8 distinct yoga poses. Ensure high accuracy in pose recognition by using state-of-the-art supervised learning techniques.

6. Correction Module:

This module compares detected poses with optimal pose templates and provides actionable feedback:

a) **Landmark Comparison:** Measure the deviations in joint angles and positions by comparing the user's detected landmarks to predefined optimal positions.

b) **Error Analysis:** Calculate angular and positional discrepancies to identify incorrect alignments in the user's pose.

c) **Feedback Generation:** Generate corrective feedback in real time, offering precise instructions (e.g., "Your back is bent; try straightening it").

7. Feedback Display:

The final step involves presenting the feedback to users in a clear and actionable manner:

a) **Visual Feedback:** Overlay detected landmarks on the input image or video, highlighting deviations and corrections visually.

b) **Textual Feedback:** Provide easy-to- understand textual instructions for pose correction.

c) **Continuous Monitoring:** For live video streams, update the feedback dynamically as the user adjusts their pose.

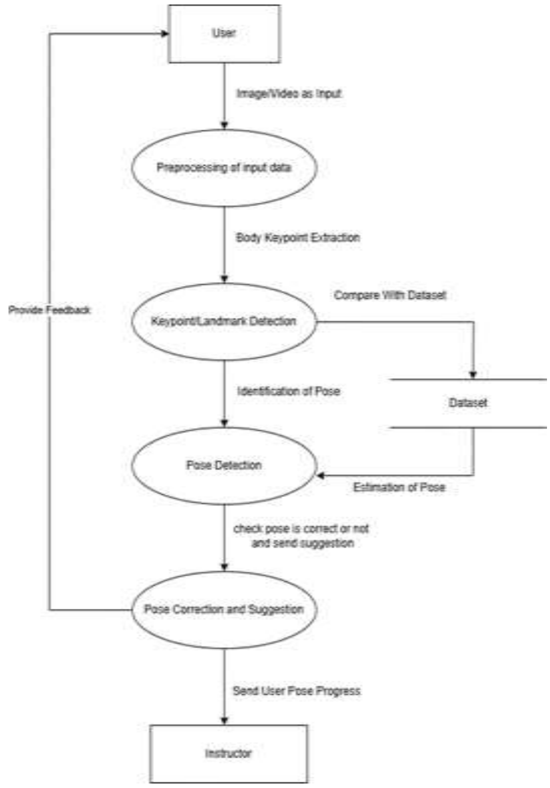

Figure 2. System Workflow

4. EVALUATION MECHANISM:

a) **Accuracy:** The accuracy metric quantifies the proportion of accurate predictions made by a model, relative to the total number of predictions made by the model.

b) **Precision:** Precision is a metric that determines the proportion of correctly classified positive instances (yoga poses) tothe total number of instances predicted as positive by the model.

c) **Recall:** The recall metric measures the fraction of accurately classified positive instances (yoga poses) relative to the total number of actual positive instances present in the testing set.

d) **F1 score:** The F1 score metric computes the harmonic mean of precision and recall, thereby providing a single combined measure of the model's accuracy and completeness in correctly identifying both positive and negative instances (yoga poses) in the testing set.

5. CONCLUSTION:

The yoga pose detection and correction system follows a step-by-step process aimed at detecting and analyzing human body posture in real-time. The system begins by capturing input through a webcam, where it checks for the presence of a human body. Upon detecting a human body, the system extracts skeletal coordinates, which are displayed visually on the interface as a skeleton overlay. These coordinates are used to calculate key joint angles, which are then compared to the ideal angles for the correct yoga pose.

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