

CSE-344 Course Project

Yoga Pose Classification using features extracted from
keypoint detection

Team

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Problem Statement

Goal : **Classification** and **Grading** of **yoga poses** using Computer Vision and Machine Learning techniques

Input : Poses from Yoga-82 dataset (**19k images** and **82 poses**)

Output : Given an input image, **classify** the yoga pose and assign a **score** based on the pose similarity

[Yoga82 paper](#)

Methodology



Data Extraction

Load Yoga-82 dataset
and remove corrupted
images

Keypoint Extraction

Extract 33 keypoints
for the human body
using Mediapipe

Feature Engineering

Design explainable
features from keypoints
using 3D angles and
geometric properties

ML Models

Training ML models on
raw and custom
features and
comparing the results

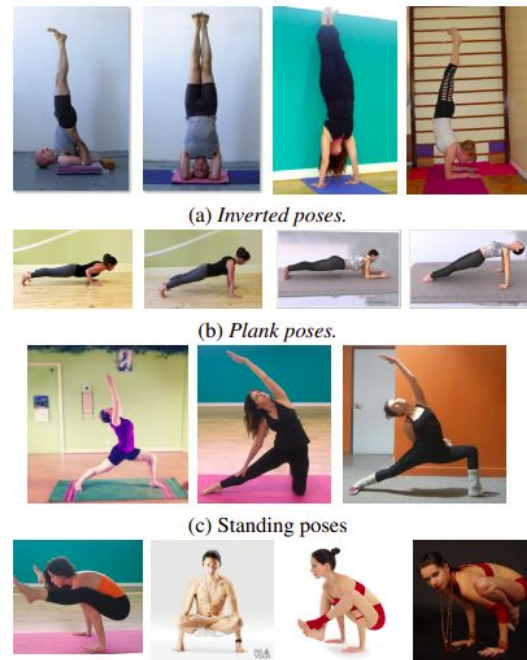
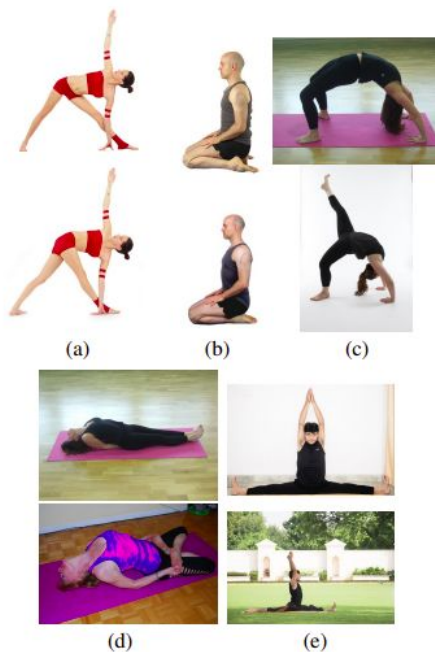
Pose Evaluation

For each pose, compare
feature-wise similarity
and suggest correction
areas

Yoga-82 dataset

- 15516 data points
- 75:25 train-test split
- 82 different poses

Note: corrupted files were removed

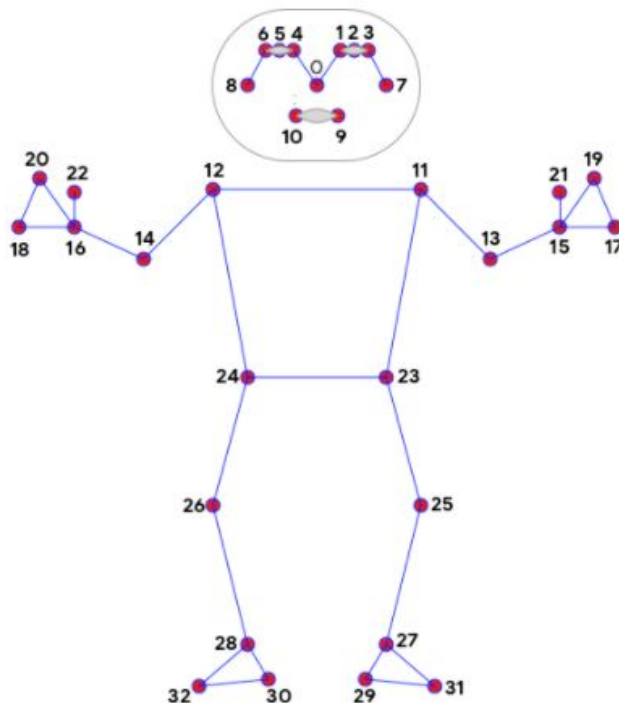


Keypoint Extraction using Mediapipe

For each keypoint -

- x coordinate
- y coordinate
- z coordinate
- visibility ratio

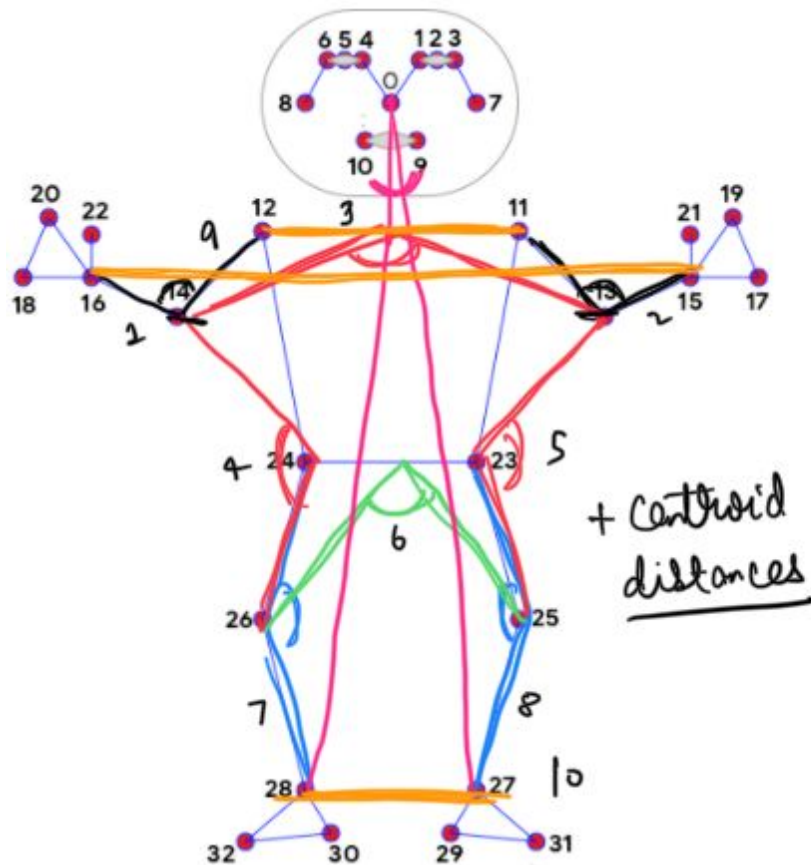
Note: cartoon images did not yield any keypoints hence discarded.



- | | |
|--------------------|----------------------|
| 0. nose | 17. left_pinky |
| 1. left_eye_inner | 18. right_pinky |
| 2. left_eye | 19. left_index |
| 3. left_eye_outer | 20. right_index |
| 4. right_eye_inner | 21. left_thumb |
| 5. right_eye | 22. right_thumb |
| 6. right_eye_outer | 23. left_hip |
| 7. left_ear | 24. right_hip |
| 8. right_ear | 25. left_knee |
| 9. mouth_left | 26. right_knee |
| 10. mouth_right | 27. left_ankle |
| 11. left_shoulder | 28. right_ankle |
| 12. right_shoulder | 29. left_heel |
| 13. left_elbow | 30. right_heel |
| 14. right_elbow | 31. left_foot_index |
| 15. left_wrist | 32. right_foot_index |
| 16. right_wrist | |

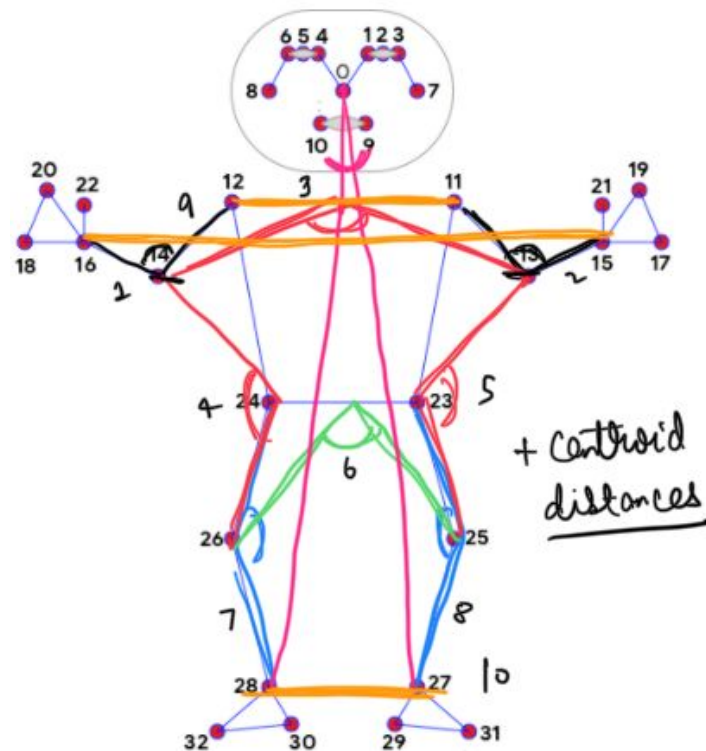
Feature Engineering

Elbow to Elbow Angle	Max Foot Angle
Max Hand Angle	Min Foot Angle
Min Hand Angle	Nose to Heel Angle
Knee to Knee Angle	Feet to Shoulder Ratio
Max Elbow to Knee Angle	Hand to Shoulder Ratio
Min Elbow to Knee Angle	Centroid Distances



U/LBS : body straightness, EKC: elbow-knee coord, L/UBSp: body spread, BB: body balance, Sagittal plane - Symmetry

Elbow to Elbow Angle - UBS	Max Foot Angle LBS
Max Hand Angle UBS	Min Foot Angle LBS
Min Hand Angle UBS	Nose to Heel Angle
Knee to Knee Angle LBS	Feet to Shoulder Ratio LBSp
Max Elbow to Knee Angle EKC	Hand to Shoulder Ratio UBSp
Min Elbow to Knee Angle EKC	Centroid Distances BB



Pose Evaluation

- Similarity calculated for each feature -

$$\text{sim}(x,y) = 1 - |x-y| / |x+y|$$

x and y are features(can either be angle or distance) values.

- Mean feature values calculated for each pose using training set
- Feature-wise similarity between mean features (true features) and predicted features is calculated and the three most dissimilar features are reported for correction

Pose Evaluation Image



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Top 3 keypoints to be corrected :

min_elbow_to_knee_angle : 0.5888787152505317

max_elbow_to_knee_angle : 0.8788583822873939

min_foot_angle : 0.891508322306959

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Experimental Results

Metric	Feature Type	COSINE SIMILARITY	GAUSSIAN NAIVE BAYES	RANDOM FOREST	XGBOOST	KNN CLASSIFIER
Accuracy	Raw Mediapipe Features (132)	0.2843	0.2904	0.7743	0.7654	0.7465
	Custom Geometric Features (25)	0.3786	0.883	0.9296	0.91253	0.7056
F1 Score	Raw Mediapipe Features (132)	0.2943	0.2671	0.7680	0.7609	0.7425
	Custom Geometric Features (25)	0.3786	0.8840	0.9292	0.9122	0.7005

Benchmark : Yoga-82 DenseNet-201 based best model has **F1** of **85.1**

Conclusion and Contributions

- In this project we introduced **features** for yoga poses with the following characteristics -
 - Better Explainability
 - Improved Performance
 - Lesser in Number (from 132 to 25)
 - robust to “lateral inversion” and shift invariant
- Introduced method for pose correction

Keypoints detected through Mediapipe



References

[Human Activity Recognition Using Pose Estimation and Machine Learning](#)

[Yoga-82: A New Dataset for Fine-grained Classification of Human Poses](#)

[Yoga pose detection and classification using machine learning techniques](#)

[Yog-guru: Real-time yoga pose correction system using deep learning methods](#)

[Real-time Yoga recognition using deep learning](#)

[Detection of Gait Abnormalities caused by Neurological Disorders](#)