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Classification of Physical Activities using Machine Learning

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Abstract

Human activity analysis is helpful across numerous sectors. With our quick-paced schedules these days, many choose to be physically active at home but feel the need for a coach to evaluate their activity form. Yoga focuses on maintaining firm postures and relaxing muscles. Asana is defined by Patanjali as "a steady and comfortable state." The movements are calm and controlled, and the breathing is in rhythm. The emphasis during regular exercise is on movement and muscle stimulation. This study proposes a fresh technique to classify the physical activity as yoga and exercise. This study lays the groundwork for such a system by examining different machine learning for efficiently categorizing yoga and non-yoga poses. The project also goes through the keypoint detection approach and the several machine learning models used for posture classification. Our very own dataset containing images of various physical activities is collected for this system. The study also explores the keypoint detection method and several machine learning models used for physical activity classification. The results are encouraging; with 99.4% accuracy achieved using the K-Nearest Neighbor Classifier.

Keywords: *Yoga Pose Classification, Exercise, Machine Learning, TensorFlow MoveNet*

1. Introduction

Yoga and exercise are common ways to remain in shape in modern culture, but the two have a lot of variations in terms of goal and the specific advantages. The ultimate goal of exercise is to boost overall physical fitness and health by engaging in aerobic activity that raises the heart rate. Exercise can help you shed weight by strengthening your muscles and cardiovascular system. Strength, agility, coordination, and feasible movement skills can all be enhanced by yoga. Additionally, yoga is unmatched as a mind/body method in its capacity to reduce stress, help patients cope with medical treatments, find meaning in daily life, and establish healthier connections with their bodies. Yoga is an excellent way to improve and normalize troubled breathing patterns. Exercise focuses solely on physical training while ignoring breathing and mindfulness. Yoga postures are sitting, sleeping, and standing activities that emphasize inhalation and exhalation while remaining attentive to both the body (posture) and the breaths (Pranayama). Asana promotes inner consciousness, develops intuition, and prepares for meditation and Samadhi, whereas exercise does not allow for meditation. Warming up the body with exercise usually focuses on a certain portion of the body. However, Asana acts to soothe the body and involves the entire body. Asana attempts to alleviate stress and pain in the body. Asana can be practiced by everyone, regardless of gender or age. However, exercise has its limitations.

This paper is structured as follows: The image dataset is first collected and merged, then preprocessed and augmented for improved outcomes. Second, for keypoint extraction, the pre-trained TensorFlow MoveNet applies, and parameters are refined for improved accuracy. Finally, the classification performance of the models was validated and compared.

2. Related Work

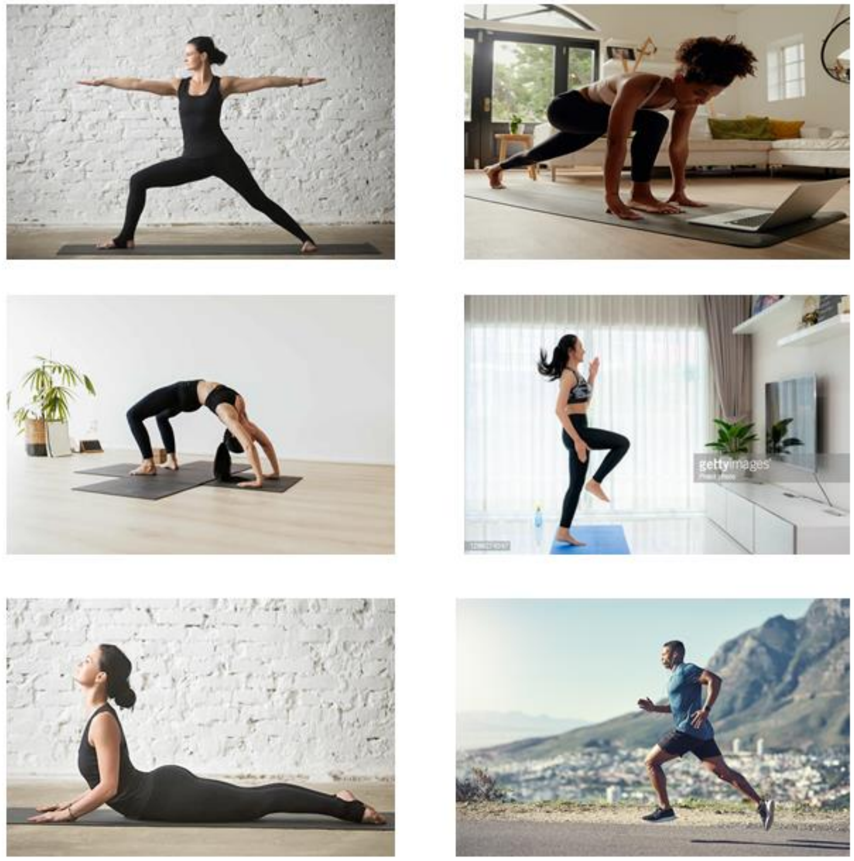
Several studies are done on human pose estimation, yoga pose recognition and effects of exercise. *Ashraf, F.B. et al. (2023)* [1] used Deep Learning (DL) and Neural Network (NN) for yoga pose classification. Two types of convolutions used then concatenated, 94.91% accuracy is achieved. *Dong, B. et al. (2023)* [2] stated that the most effective exercise methods for cancer-related fatigue were combined aerobic and resistance training, yoga, and regular physical activity. *Jose, J., et al. (2021)* [8] classified 10 classes of yoga poses attained from video and images using Convolution Neural Network of Deep Learning method. He attained 85% accuracy. *Kothari S. (2020)* [11] described a computational method for categorizing Yoga poses from images that use deep learning, specifically CNN. For creating the classification model, they used a dataset of 1000 photos divided into six classes. For this work, around 85% accuracy was reached. In 2019Deep learning algorithms were used by Yadav, S.K. et al. [12] to detect the yoga posture. They developed their own dataset and achieved 99% accuracy. This wasn't, however, a cost-effective option because it needed a lot of gear.

3. Proposed Methodology

This study assessed the performance of four classifiers for grouping physical activity into yoga and exercise. The author chose a pre-trained model for keypoint extraction for this purpose. This model was trained on a preprocessed image dataset designed solely by the author of the paper. For training, testing, and validation, this preprocessed dataset is partitioned into 8:1:1. And the evaluation findings are represented graphically. This planned system functioned like this:

3.1 Data Preparation

74 photos were collected from Google images to help train the model. The image dataset is divided into two classes: Yoga and Exercise, with 34 and 40 photos in each. Yoga represents all of the pictures of various yoga asanas, whereas exercise represents non-yoga images such as aerobics, cardio, jogging, and so on. Figure 1 shows an example image from the used image collection, while Table 1(a) describes the dataset in detail.



(a) (b)

Figure 1: Sample of image dataset (a) Yoga (b) Exercise

3.2 Data Preprocessing

The data must be close in order to render them more compatible for subsequent phases. We are transferring the data via various pre-processing processes throughout the pre-processing stage. Because the data is gathered from several sources, the dimensions will vary. The data of various dimensions are scaled in the initial step of preprocessing, checking for any faulty images and reducing distortion. In the following stage, we will use an *Exploratory Data Analysis* (EDA) to help us study the full dataset and identify its essential elements. The purpose of the third and final phase, *Image Augmentation*, is to expand the size and variety of the training set, which can help strengthen the model's performance by lowering over fitting as well as improving its capacity to generalize to new, previously unknown data. As we can see in Table 1 (b), number of images is increased after augmentation. Figure 2 shows the number of images in training, testing and validation folders.

Table 1: Number of images in dataset for physical activities,
(a) Number of raw images (b) Number of images after augmentation

(a)

Physical Activity	No. of images
Yoga	34
Exercise	40
Total	**74**

(b)

Physical Activity	No. of images
Yoga	1551
Exercise	1781
Total	**3332**

```
Training folder :
Number of Exercise images : 1424
Number of Yoga images : 1240
Total Number of Images : 2664


Testing folder :
Number of Exercise images : 179
Number of Yoga images : 156
Total Number of Images : 335


Validation folder :
Number of Exercise images : 178
Number of Yoga images : 155
Total Number of Images : 333
```

Figure 2: Training, Testing and Validation folders after Image Augmentation

3.3 *Generation of Key points*

TensorFlow MoveNet, extracts the keypoints from the image. The MoveNet model quickly and accurately identifies 17 essential body regions. Lines between two keypoints are given colours, magenta, cyan and yellow are used. Figure 3 showing the keypoint extraction, Figure 4 represents the image of an exercise with the keypoints marked on it.

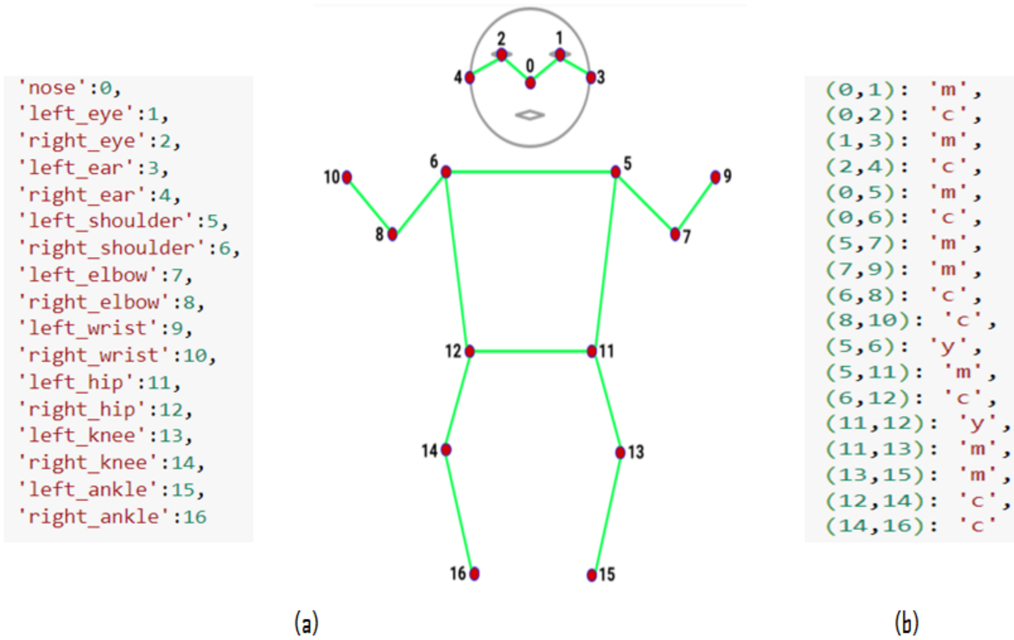


Figure 3: Key Points of TensorFlow MoveNet (a)keypoints on human body (b)colours used on the lines between the points

Figure 4: Key Points of TensorFlow MoveNet on exercise image

3.4 Creation of New Data

Creating key points for training/testing/validation sets and saving them as three distinct csv files.

```
df.head()
```

	category	image_name	keypoint	nose_y	nose_x	nose_score	left_eye_y	left_eye_x	left_eye_score	right_eye_y	...	left_knee_score
0	Exercise	aug_0_6849.jpeg	[[0.34061167, 0.29703584, 0.6436267], [0.32302...	0.340612	0.297036	0.643627	0.323023	0.324190	0.878526	0.318769	...	0.53961
1	Exercise	aug_0_5581.jpeg	[[0.17880945, 0.45322412, 0.70374095], [0.1667...	0.178809	0.453224	0.703741	0.166715	0.470518	0.397246	0.166767	...	0.36080
2	Exercise	aug_0_8408.jpeg	[[0.15303794, 0.4662413, 0.794726], [0.1344707...	0.153038	0.466241	0.794726	0.134471	0.498713	0.814805	0.132167	...	0.90258
3	Exercise	aug_0_4003.jpeg	[[0.47101983, 0.25218523, 0.5621491], [0.47073...	0.471020	0.252185	0.562149	0.470732	0.238195	0.621565	0.484789	...	0.51243
4	Exercise	aug_0_1246.jpeg	[[0.32937345, 0.7696711, 0.42876154], [0.31838...	0.329373	0.769671	0.428762	0.318387	0.793629	0.763022	0.314270	...	0.458047

5 rows × 54 columns

Figure 5: New generated dataset of training set

3.5 Classification using Machine Learning

In Supervised machine learning, when classifying further observations into various classes or groups, a programme first learns from a provided collection of observations.

Scikit-Learn, a Python toolkit, are used to implement four different classification algorithms: K-Nearest Neighbor (KNN), Multilayer Perceptron (MLP), Decision Tree, and Support Vector Machine (SVM).

a) The distance between some test data and the known values of some training data is calculated by the **K-Nearest Neighbour Classifier**. The class is picked because it is the collection of classes having the closest training and testing locations.
b) A **Decision Tree Classifier** segments a dataset into ever-smaller pieces using various criteria. Data continuously splits as per certain criteria.
c) **Support Vector Machines Classifier** separates the data into two classes by mapping the data points to a high-dimensional space followed by locating the best hyperplane.
d) A Neural Network is linked to a **multi-layer Perceptron classifier**. MLPClassifier performs classification using an underlying Neural Network.

4. Results and Discussion

On 3332 images, Scikit-Learn, a Python toolkit, is used. The classification into Yoga asana and Exercise is used to get the final prediction. The complete dataset is used to construct training, testing, and validation sets.

Classifier Accuracy

Accuracy measurement is the basic performance calculator. Table 2 shows the accuracy for training, testing and validation dataset for all the four classifiers. Graphical representation of comparison is shown in figure 6.

Table 2: Comparison of accuracy of all 4 classifiers

Model	Train	Test	Val
K-Nearest Neighbor Classifier	0.9936	0.994	0.997
Multi-Layer Perceptron Classifier	0.9876	0.9821	0.991
Decision Tree Classifier	1	0.9672	0.997
Support Vector Classifier	0.997	1	0.997

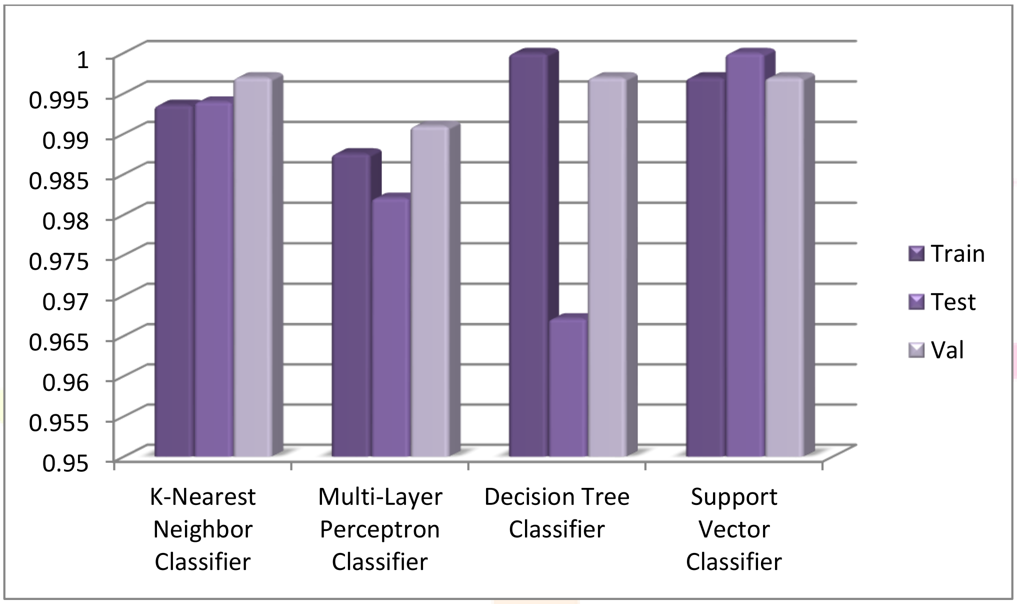


Figure 6: Graphical representation of classifier accuracy

5. Conclusion and Future Work

Regular exercise is one of the most vital things you must do for your health. Everyone can benefit from physical activity; be of any age group. Currently, various researches are done on yoga poses and exercises separately. We came up with the idea of classification of both of them thus worked on the dataset created by our own; because the dataset was small image augmentation was used. Machine learning classifiers performed and the results were great. Support Vector Classifier provided 100% accuracy, which is quite close to the accuracy of KNN Classifier i.e. 99.6%.

In future, large dataset can be taken for classification. More physical activities can be added in the dataset and be classified further, such as, aerobics, swimming, gym exercises, etc. Video analysis or video still can also be taken, larger dataset of images, live tutor can also be used to examine the activities correctly.

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