YOPO – "YOGA POSE DETECTOR AND ACCURACY MEASUREMENT"

A Report Submitted in Partial Fulfilment
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by

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UNDERTAKING

We declare that the work presented in this report titled "*YOPO-yoga pose detector and accuracy measurement*", submitted to the Computer Science and Engineering Department, National Institute of Technology Jamshedpur, for the award of the *Bachelor of Technology* degree in *Computer Science & Engineering*, is our original work. We have not plagiarized or submitted the same work for the award of any other degree. In case this undertaking is found incorrect, We accept that our degree may be unconditionally withdrawn.

April, 2023
Jamshedpur

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(Your Name and Registration Number goes here)

CERTIFICATE

Certified that the work contained in the report titled "*YOPO-yoga pose detector and accuracy measurement*", has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

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(DR. MANTOSH BISWAS)
Computer Science and Engineering Dept.
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April, 2023
Jamshedpur

Preface

A good B.Tech. thesis is one that helps you in furthering your interest in a specific field of study. Whether you plan to work in an industry or wish to take up academics as a way of life, your thesis plays an important role.

Your thesis should judiciously combine theory with practice. It should result in a realization of reasonably complex system (software and/or hardware). Given various limitations, it is always better to extend your predecessor's work. If you plan it properly, you can really build on the experience of your seniors.

Acknowledgements

It is a great pleasure to thank the giants on whose shoulders we stand. First of all, we would like to thank our supervisor (***Dr Mantosh Biswas***) and Department of Computer Science and Engineering. We would also like to thank our HOD sir for giving us an opportunity to work as a group for this term project. We would like to thank other professors involve in academic course to allow us to think in these different topics and work on it. We take this opportunity to express our gratitude to everyone the who are helping in and were part in making the successful completion of the project. The completion of any inter-disciplinary project depends upon cooperation, co-ordination and combined efforts of several sources of knowledge. We are eternally grateful to our teacher Mantosh sir as our supervisor who gave us valuable advice and direction under which we are on the right path of completing the project. His constant guidance and willingness to share his vast knowledge despite of his busy schedule, is helping us to understand this project and made our project looks easy for us and it's uses in great depths. Apart from teaching staffs we would like to thanks non-teaching staffs who directly or indirectly helped us in successful making of our project. We would also like to thanks our friends to give this project a creative blend and helped us in different phases of our project.

Contents

Chapter 1

Introduction

Yoga is a physical, mental, and spiritual practice that has been around for thousands of years. It involves asanas that are designed to enhance flexibility, strength, balance, and relaxation. Practicing yoga has been shown to have numerous health benefits, including reducing stress, improving cardiovascular health, and enhancing overall well-being.

As we faced the world pandemic of covid, we all have been in quarantine for nearly an year. And most of the population faced difficulties in maintaining their health and many have tried to keep their physical and mental balance by practicing yoga in their homes without proper trainer. And our project might be useful to many of them who needs daily yoga practice.

As the popularity of yoga has grown, so has the demand for tools and technologies that can help practitioners improve their practice. One area where machine learning can be particularly useful is in measuring the accuracy of yoga poses.
Machine learning algorithms can be trained on large datasets of images and videos of people performing yoga poses. These algorithms can then be used to identify and measure the accuracy of various aspects of the pose, such as the alignment of the body, the positioning of the limbs, and the engagement of the muscles.

To train a machine learning model to measure the accuracy of yoga poses, a large dataset of images and videos of people performing various poses is required. These images and videos must be labelled with information about the correct alignment and positioning of the body and limbs. Human activity recognition has been employed in a variety of applications, including robotics and computer engineering using randomized trees (random forests) for detecting human activities with the help of sensors. [3]

Once the machine learning model has been trained on this dataset, it can be used to analyse new images and videos of people performing yoga poses. The model can identify areas where the practitioner's alignment or positioning is incorrect and provide feedback on how to correct the pose.

Overall, the use of machine learning to measure the accuracy of yoga poses has the potential to improve the practice of yoga and help practitioners achieve greater benefits from their practice.

1.1 Motivation

The development of accurate yoga pose recognition systems is crucial in providing assisted exercises at home, especially for older adults who may not be able to go to the gymnasium for exercises. The accuracy measurement of these systems is also important, and the experimental results in one study show that a system achieved 94.91% accuracy with 95.61% real-time recognition of yoga poses. This motivation for accurate yoga poses detection and measurement of its accuracy is further supported by the importance of daily exercises for human well-being.

Some Wonderful Minds

Wonderful work by A. Ramakrishnan on Yoga pose classification using deep learning & J. Singh on Real-time human pose estimation and tracking for yoga asanas motivated us to work on this project and get the benefits from their wonderful work and hence we come up with our own way to tackle this problem using the MovNet module of tensorflow and applying our idea over that.

Chapter 2

Related Work

Yoga is a popular form of exercise and meditation that has been shown to have numerous health benefits. One area of research in yoga is the accuracy of yoga poses, which can be important for ensuring that practitioners are performing the poses correctly and avoiding injuries. In recent years, machine learning has emerged as a promising tool for measuring the accuracy of yoga poses.

An automated system for naive users to perform yoga and compare with expert yoga videos uses a Speeded Up Robust Features (SURF) algorithm using only contour information, which may not be sufficient.[2]

Several studies have explored the use of machine learning for yoga pose accuracy measurement. A study published in the Journal of Bodywork and Movement Therapies used machine learning algorithms to analyse motion capture data of yoga poses and found that the algorithms were able to accurately classify the poses with a high degree of accuracy.

Another study published in the Proceedings of the 2018 IEEE International Conference on Systems, Man, and Cybernetics used machine learning algorithms to analyze images of yoga poses and found that the algorithms were able to accurately classify the poses with a high degree of accuracy.

Mohanty et al. [1] implemented an image recognition approach for detecting Indian traditional dance and yoga postures from photographs. they did, though, only analyse their competence on still photos, never on videos.

PoseNet [11] is similar to OpenPose. which can extract human pose. All these key points are indexed with confidence levels, 1 being greatest and 0 being lowest. PoseNet does not depend on the size of images; even though images are downscaled, the pose is extracted

A third study published in the Journal of Ambient Intelligence and Humanized Computing used machine learning algorithms to analyse data from wearable sensors worn by yoga practitioners and found that the algorithms were able to accurately classify the poses with a high degree of accuracy.

S. Haque et al.[6] proposed a model named ExNet, which is a multilayer convolutional neural network (CNN). They used an image dataset containing 2000 images of human exercise poses divided into five classes labelled as push up, pull up, cycling, Swiss ball hamstring curl, walking. The model used Adam optimizer and automatic learning rate reduction method. After 50 epochs, 5 ExNET got 82.68% accuracy on classifying 2D human exercise pose from the dataset. The model needs better hyper-parameter tuning because it faces the problem of overfitting.

Agarwal et al. Overall, these studies suggest that machine learning has the potential to be a powerful tool for measuring the accuracy of yoga poses. As technology continues to improve, it is likely that machine learning will become an even more important tool in the study of yoga and other forms of exercise.

Chapter 3

Proposed Work

Here is an algorithm for yoga pose accuracy measurement using machine learning:

Step 1. Data Collection: Collect a large dataset of images or videos of people performing various yoga poses. The dataset should include both accurate and inaccurate performances of each pose.

Step 2. Data Annotation: Annotate the dataset with labels indicating whether each performance is accurate or not. This can be done manually or with the help of computer vision algorithms that can detect the alignment and angles of the body in each pose.

Step 3. Feature Extraction: Extract relevant features from the annotated dataset, such as body position, angle of joints, and alignment. These features can be used to train a machine learning model to recognize accurate and inaccurate performances of each pose.

Step 4. Model Training: Train a supervised machine learning model, such as a convolutional neural network (CNN), on the annotated dataset to classify each performance as accurate or inaccurate.

Step 5. Pose Detection: Use computer vision techniques to detect the pose being performed in the input image or video.

Step 6. Pose Normalization: Normalize the pose by scaling and rotating it to a standard position for comparison with the annotated dataset.

Step 7. Feature Extraction: Extract the same features used in the training dataset from the normalized pose. 6

Step 8. Pose Classification: Use the trained machine learning model to classify the normalized pose as accurate or inaccurate.

Step 9. Feedback: Provide feedback on the accuracy of the pose to the user, such as highlighting areas where they can improve their form or suggesting modifications to the pose.

Step 10. Iterate: Collect more data and retrain the machine learning model as needed to improve its performance.

This algorithm can be implemented using various machine learning libraries and frameworks, such as TensorFlow or PyTorch .

The model works in 2 phases: Training and testing.

3.1 Training :

In our training model it involves five steps which is as follows:

Step 1. Image Dataset has been passed for landmark detection.

Step 2. Thunder MoveNet module is utilised to generate 14 landmarks.

Step 3. New Landmarks are generated for centers of changes and the whole shape is transformed according to the image.

Step 4. The trained weights are updated

Step 5. Pose is classified to the classes using CNN and clustering and best weights are updated.

The training model is diagrammatically shown in figure 1.2

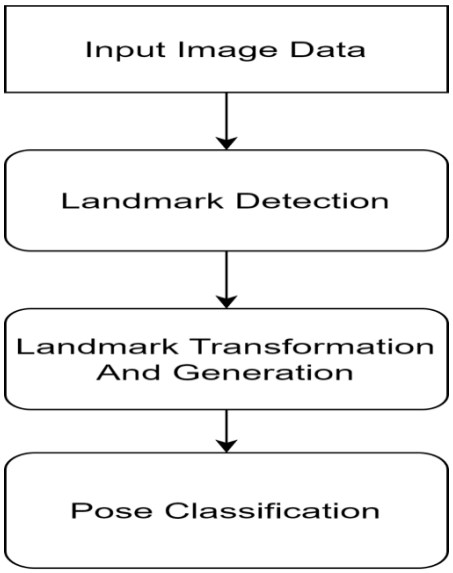

Fig 1.1 Training Model

3.1.2 Testing and Validation :

These are the steps involved in our testing and validation phase.

Step 1. Model imports the best weights evaluated during training.

Step 2. Video image is divided into frames according to frame rate of webcam (~30fps).

Step 3. Landmarks were detected and transformation and preprocessing to feed the landmarks into the model was done.

Step 4. The classification of pose according to the testing pose parameters were done using CNN.

Step 5. Comparison to best weights with the pose parameters is done to evaluate best pose time.

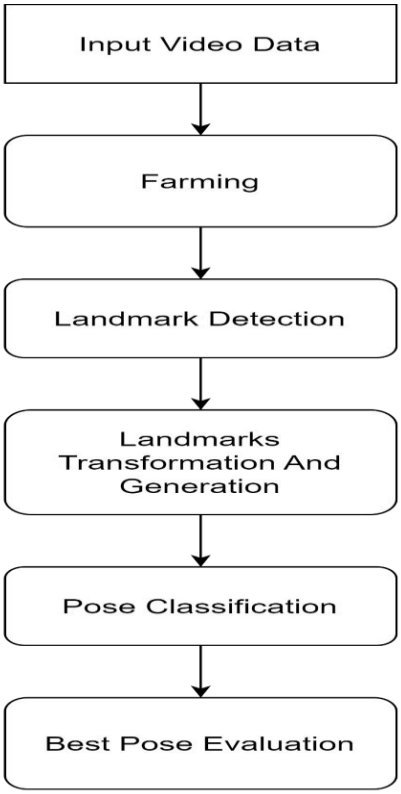

Fig 1.2 Testing and Validation

Flow of our Model

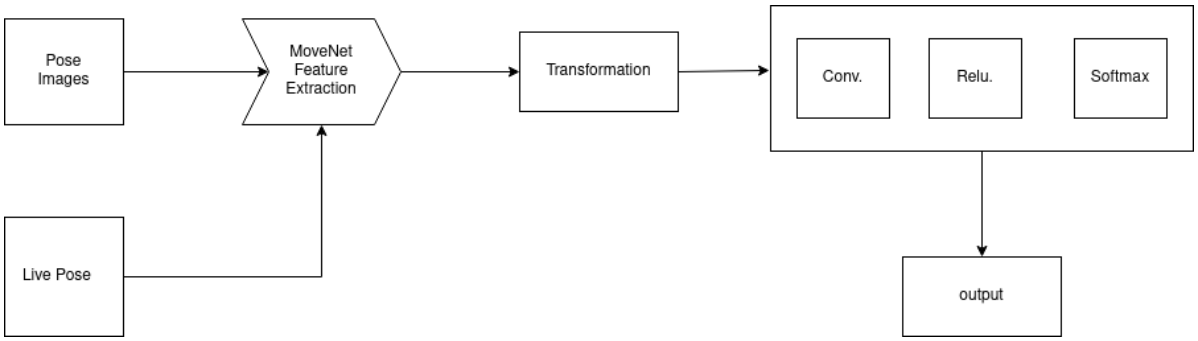

Fig 1.3 : Flow Model

The above diagram shows the flow of our model that how first pose images are passed to movenet engine and then we perform transformation after which we passed it through our model which generate the output as the matching yoga pose.

Chapter 4

Experimental Setup and Results Analysis

Our Web App Tutorial

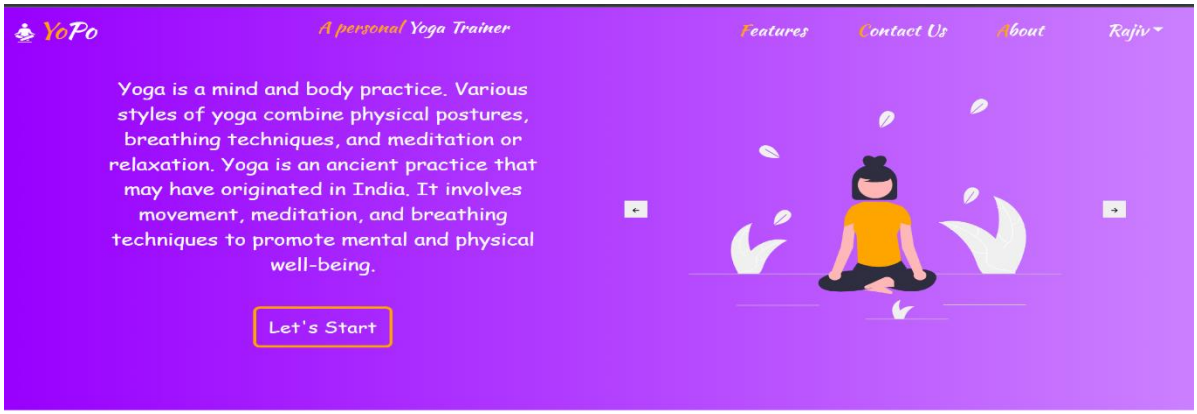

Fig 4.1 Home page

This is our Home page of the Web App in which we have all the necessary details mentioned.

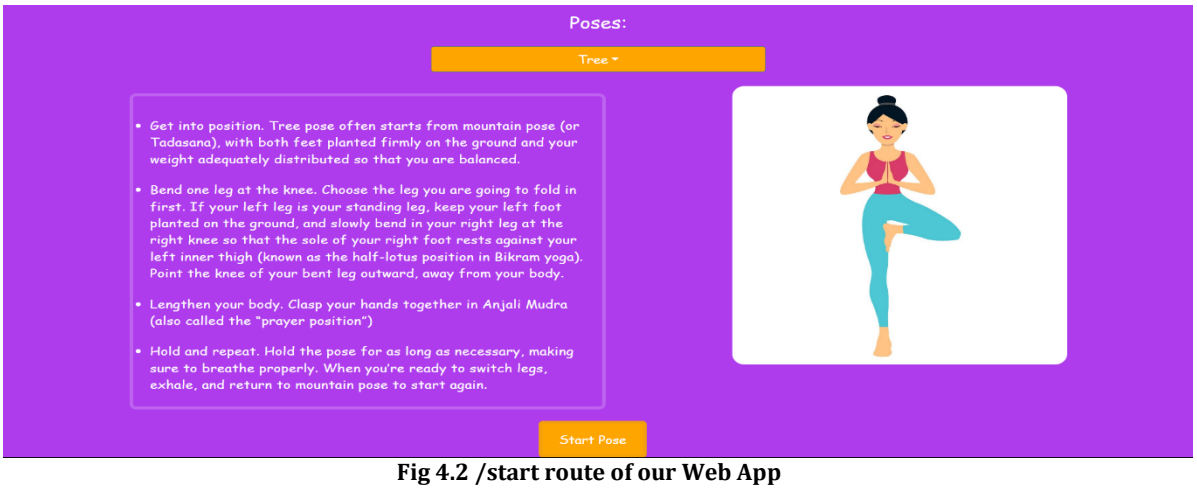

Fig 4.2 /start route of our Web App

The above image of Fig 4.2 shows the /start route where the yoga performer can start performing the yoga.

We have used **MoveNet: Ultra fast and accurate pose detection model** of Tensorflow that detects the movement of the body parts. Initially we track the lever through dots.

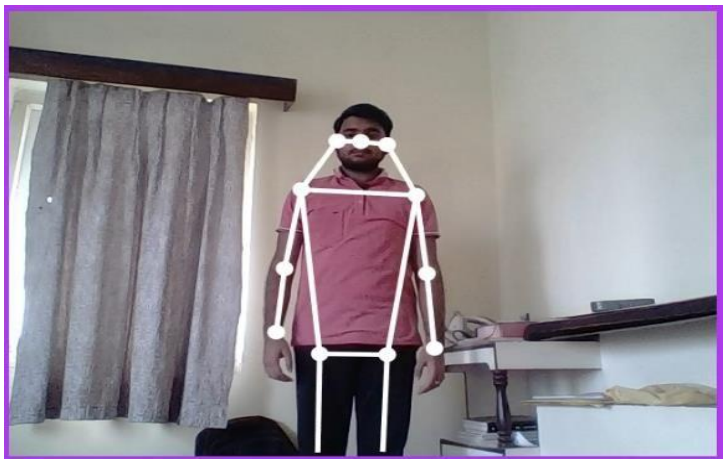

Fig 2: Showing the dots representation at Flexions

Figure 1 describes the visual representation of flexion points used and these points are treated as wrong or incorrect exoskeleton for any pose. Once the dots form the actual pose type structure it becomes green and starts to have a counter that indicate the correct pose.

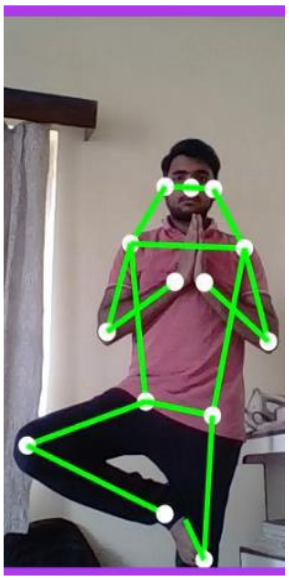

Fig 3: Showing Tree Pose

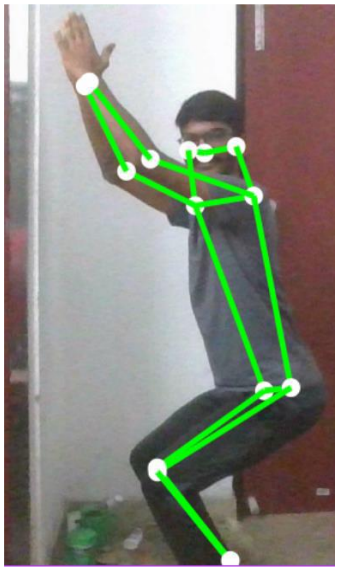

Fig 4:Showing Chair Pose

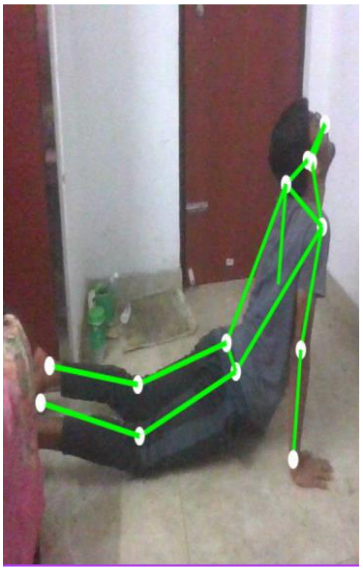

Fig 5:Showing Cobra Pose

Fig 6. Performing Dog Pose

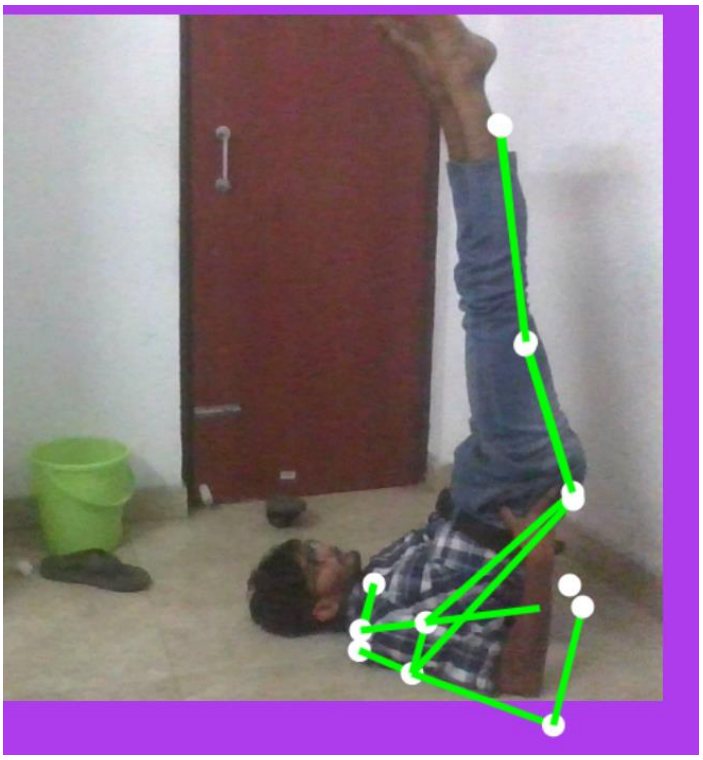

Fig 7.Performing Shoulder stand Pose

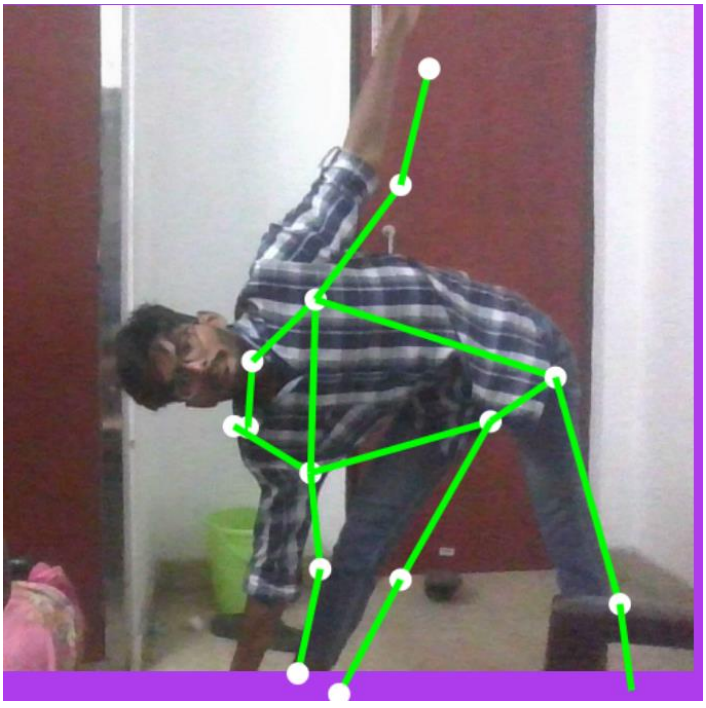

Fig 8. Performing Triangle Pose

Fig 9. Performing Warrior Pose

The model as described shows the flexion points which are points of our interest. The model detected those points accurately in a webcam of 30 fps. During the live testing, Tree pose in figure 3, chair pose in figure 4 , cobra pose in figure 5 , Dog pose in figure 6, Shoulder stand in figure 7, Triangle pose in figure 8 and Warrior pose in figure 9 were done. Inaccurate pose are indicated by white pseudo-exoskeleton and the correct pose were indicated by green pseudo-exoskeleton and deviation from the correct pose will change the dots color to white again.

Chapter 5

Conclusion and Future Work

Human pose estimation is different as it has to localize and assemble human body parts on the basis of an already defined structure of the human body. Application of pose estimation in fitness and sports can help prevent injuries and improve the performance of people's workout. suggests, yoga self-instruction systems carry the potential to make yoga popular along with making sure it is performed in the right manner.

The use of hybrid CNN on OpenPose data is seen to be highly effective and classifies all the yoga poses perfectly. A basic CNN and SVM(Support Vector Machine) also perform well beyond our expectations. Performance of SVM proves that ML algorithms can also be used for pose estimation or activity recognition problems .

The study presents the challenges of the project, including accurately detecting postures and providing accurate suggestions for improvement. The paper concludes with future directions for research and improvements in the accuracy of the system . Accurate yoga pose recognition systems are important for assisted exercises at home, especially for older adults.

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