Live Yoga Pose Classification using Image Processing and Machine Learning

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Abstract: *An approach to accurately recognize various Yoga Pose Assessment using deep learning algorithms has been presented in this work. In this system, we propose a Yoga pose assessment method using pose detection to help the self-learning of Yoga. The system first detects a yoga pose using multi parts detection only with PC camera. In this system, we also propose an improved algorithm to calculate scores that can be applied to all poses. Our application is evaluated on different Yoga poses under different scenes, and its robustness is also. A hybrid Machine learning model is proposed using linear Regression for Yoga recognition on real-time videos, where Linear regression is used to extract features from key-points of each frame obtained from Open Pose.*

Keywords: Linear Regression algorithm, Machine Learning, Image pre-processing, pose Detection

I. INTRODUCTION

Human pose estimation is a challenging problem in the discipline of computer vision. It deals with localization of human joints in an image or video to form a skeletal representation. To automatically detect a person's pose in an image is a difficult task as it depends on a number of aspects such as scale and resolution of the image, illumination variation, background clutter, clothing variations, surroundings, and interaction of humans with the surroundings.

An application of pose estimation which has attracted many researchers in this field is exercise and fitness. One form of exercise with intricate postures is yoga which is an age-old exercise that started in India but is now famous worldwide because of its many spiritual, physical and mental benefits.
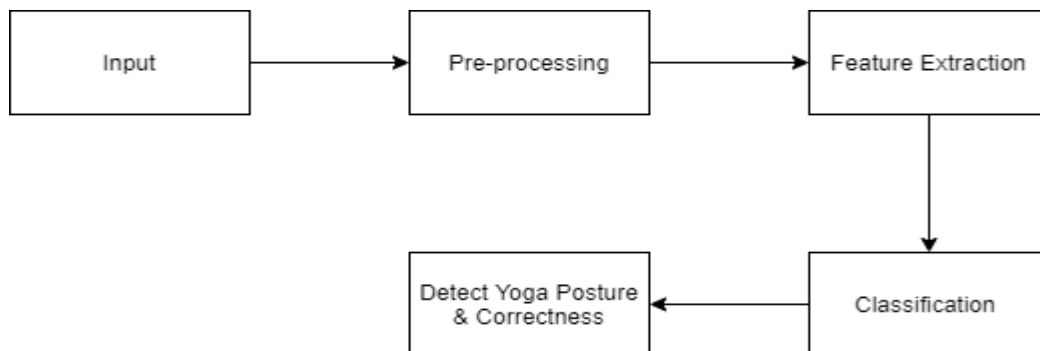

Figure 1: Flowchart of the procedure followed on the dataset

Although there are many advantages from exercises, improper exercises could lead to a hazardous lifestyle. Therefore, it is mandatory to have good guidance for people who are doing exercises on their own. A proper guidance will lead to gain many benefits from exercises and improve the health of a person. Yoga is a collection of disciplines or practices that originated in ancient India. Yoga is one of the six philosophical traditions of Hindu Orthodox schools. In the Western world, the word "yoga" also means a modern form of Hatha yoga, yoga as exercise, which consists largely of the postures called "asanas". Currently Yoga has become popular with people in the western world trying to get fit. Proper yoga postures will assist to build awareness, harmony and strength in both the mind and body. However, improper yoga postures will lead to various kinds of serious injuries such as strokes, and nerve damage. So following proper yoga postures is mandatory. Infinity Yoga Tutor, which is a yoga posture detection and correction system, uses a mobile-

based approach for correcting improper yoga postures of the people who are doing yoga with the knowledge they have and doing yoga by watching yoga videos or using yoga applications. Although there are some systems on yoga posture detection, there are no significant amount of systems for correcting improper yoga postures.

Figure 2. Example human poses from the yoga activity

This mobile based approach consists of both yoga pose detection and yoga pose correction abilities. Moreover, this system consists of giving visual instructions to the user in real time, which would help the user to maintain a proper asana throughout the practice. In addition, the system also allows the user to select one of three difficulty levels which has different levels of accuracy threshold, to help beginners as well as experienced yogis to perform proper asanas. All these features help to guide user to do yoga in a safe way and achieve the best results from yoga. The current development in technology helps and makes this cause much easier to succeed with numerous research already completed on Human Activity Recognition (HAR). In this work we focused on how to use the above models not only to detect but to guide the user to successfully practice poses much closer to perfection. Detecting human postures is a complicated task. A higher degree of accuracy as well as real-time inference is expected in most of the actual world application of human pose estimation today. However, with the aid of the popular keypoints detection libraries, the keypoints detection task has become easier in this proposed system. Since the accuracy of this system also depends on the pose estimation or the keypoints detection module, two different popular keypoints detection libraries are used to compare, contrast and identify the optimum library for this system. One of the selected libraries is OpenPose [2] which detects keypoints in each frame using part affinity fields and part confidence maps by following a greedy algorithm. The other method used for yoga pose detection is detecting keypoints with the aid of Mask RCNN [3] which is also known as Mask Region Based Convolutional Neural Network in order to detect human in the video while detecting keypoints in each video frame by applying Fully Convolutional Network and Region Proposal Network (RPN). The output obtained from the above keypoints detection modules are normalized and modelled to fit to the prediction model, which consists of Time-distributed Convolutional Neural Networks and LSTM layers with a dense layer of activation Softmax. This gives an output probability for 6 classes. This prediction result is streamed to the mobile application which is visually represented to the user and guided with guide video related to the predicted output and the accuracy of the user performed pose or asana

II. LITERATURE SURVEY

Paper No.1
Title: Implementation of Machine Learning Technique for Identification of Yoga Poses.
Author: Yash Agrawal, Yash Shah, Abhishek Sharma.
Year Of Publication: 2021
Keyword: YOGI - Yoga Gesture Identification dataset,Computer Vision, Machine Learning, Classification, Gesture Recognition
Method of Algorithms Used: CNN(Convolutional Neural Network)

Yoga is originated in ancient India and it is a group exercise associated with mental, physical and spiritual strength.Yoga and sports have been attracting peoples from so many years but from the last decade, a large number of people are adopting yoga as part of their life. This is due to the health benefits. It is important to do this exercise in right way specially in right posture. It has been observed that sometime due to lack of assistance or knowledge people don't know the correct method to do yoga and start doing yoga without any guidance, thus they injure themself during self-training due to improper posture.

Paper No. 2

Title: Recognition of Yoga Poses through an Interactive System with Kinect device **Author**: Edwin W. Trejo , Peijiang Yuan.

Year Of Publication: 2018

Keyword: Gesture recognition, Kinect Yoga, human computer interaction, supervised learning. **Method of Algorithms Used:** Gesture recognition. Kinect.Yoga human computer interaction. supervised learning . CNN(Convolutional Neural Network).

In daily life, Yoga has become a well-known discipline around the world that keep people in good physical and mental health. As well, gesture recognition is a field of investigation that takes great importance for the self-training of various sports using acquisition techniques such as Kinect device. This research proposes an interactive system capable of recognizing 6 poses for learning Yoga that can track up to 6 people at the same time. It is also integrated with command voices to visualize the instructions and pictures about the poses to be performance for the user. In order to get a strong database for recognition, the system used Adaboost algorithm though the software development kit specially for Kinect. All data was trained by an expert yoga trainer and final database showed above 94.78% as maximum value for poses analyzed in terms of accuracy

Paper No. 3

Title :- A New Dataset for Fine-grained Classification of Human Poses

Author: Manisha Verma, Sudhakar Kumawat, Yuta Nakashima1, Shanmuganathan Raman

Year Of Publication: 2020

Keyword: YOGI - YOga Gesture Identification dataset,Computer Vision, Machine Learning, Classification, Gesture Recognition

Method of Algorithms Used: CNN(Convolutional Neural Network)

Human pose estimation is a well-known problem in computer vision to locate joint positions. Existing datasets for learning of poses are observed to be not challenging enough in terms of pose diversity, object occlusion and view points. This makes the pose annotation process relatively simple and restricts the application of the models that have been trained on them. To handle more variety in human poses, we propose the concept of fine-grained hierarchical pose classification, in which we formulate the pose estimation as a classification task, and propose a dataset, Yoga-82§, for largescale yoga pose recognition with 82 classes. Yoga82 consists of complex poses where fine annotations may not be possible. To resolve this, we provide hierarchical labels for yoga poses based on the body configuration of the pose. The dataset contains a three-level hierarchy including body positions, variations in body positions, and the actual pose names. We present the classification accuracy of the state-of-the-art convolutional neural network architectures on Yoga-82. We also present several hierarchical variants of DenseNet in order to utilize the hierarchical labels.

Paper No. 4

Title: Infinity Yoga Tutor: yoga posture detection and correction system

Author: Fazil Rishan, Department of Software Engineering Sri Lanka Institute of Information

Technology Malabe, Sri Lanka. it17098342@my .sliit.lk Year Of Publication:- 2020

Keyword: Human Activity Recognition, Yoga Posture, OpenPose, Mask RCNN, LSTM, CNN.

Method of Algorithms Used: CNN(Convolutional Neural Network)

Popularity of yoga is increasing daily. The reason for this is the physical, mental and spiritual benefits that could be obtained by practicing yoga. Many are following this trend and practicing yoga without the training of an expert

practitioner. However, following yoga in an improper way or without a proper guidance will lead to bad health issues such as strokes, nerve damage etc. So, following proper yoga postures is an important factor to be considered. In this proposed system, the system is able to identify poses performed by the user and also guide the user visually. This process is required to be completed in real-time in order to be more interactive with the user. In this paper, the yoga posture detection was done in a vision-based approach. The Infinity Yoga Tutor application is able to capture user movements using the mobile camera, which is then streamed at a resolution of 1280 x 720 at 30 frames per second to the detection system. The system consists of two main modules, a pose estimation module which uses OpenPose to identify 25 keypoints in the human body, using the BODY_25 dataset, and a pose detection module which consists of a Deep Learning model, that uses time-distributed Convolutional Neural Networks, Long Short Term Memory and SoftMax regression in order to analyze and predict user pose or asana using a sequence of frames. This module was trained to classify 6 different asanas and the selected model which uses OpenPose for pose estimation has an accuracy of 99.91%. Finally, the system notifies the users on their performance visually in the user interface of the Mobile application.

Paper No. 5
Title: Yoga Posture Recognition By Detecting Human Joint Points In Real Time Using Microsoft Kinect
Author: Muhammad Usama Islam , Hasan Mahmud , Faisal Bin Ashraf , Iqbal Hossain and Md. Kamrul Hasan.
Year Of Publication: 2020
Keyword:- Human Posture Recognition, Real Time, Microsoft Kinect, Yoga, Pose detection Method of Algorithms Used: CNN(Convolutional Neural Network) Musculoskeletal disorder is increasing in humans due to accidents or aging which is a great concern for future world. Physical exercises can reduce this disorder. Yoga is a great medium of physical exercise. For doing yoga a trainer is important who can monitor the perfectness of different yoga poses. In this paper, we have proposed a system which can monitor human body parts movement and monitor the accuracy of different yoga poses which aids the user to practice yoga. We have used Microsoft Kinect to detect different joint points of human body in real time and from those joint points we calculate various angles to measure the accuracy of a certain yoga poses for a user. Our proposed system can successfully recognize different yoga poses in real time.

Paper No.6
Title: Yoga Pose Detection and Classification Using Deep Learning
Author : Deepak Kumar ,Anurag Sinha.
Year Of Publication: 2020
Keyword: Pose, Self-Learning , Posenet , Deep Learning , Pose classification.
Method of Algorithm Used: CNN (Convolution Neural Network)
Human posture assessment calculations can be broadly coordinated in two different ways. Calculations prototyping assessment of human stances as a mathematical estimation are named generative strategies while calculations demonstrating human posture assessment as a picture preparing issue are named discriminative strategies.
It has advanced from 2D to 3D present assessment and from single individual to multi individual posture assessment. employments present assessment to fabricate an AI application that identifies shoplifters while utilizes a solitary RGB camera to catch 3D stances of numerous individuals continuously.
One significant learning-based technique is profound realizing which is based upon Artificial Neural Organizations (ANNs). ANN is similar to the human cerebrum where the units in an ANN speak to the neurons in the human mind, and loads speak to the quality of association between neurons.Profound learning gives a start to finish design that permits programmed learning of key data from pictures. One famous profound learning model which has been generally utilized for present assessment is Convolutional Neural Network (CNN) which will be talked about later.

Paper No.7
Title: Yoga Pose Detection and Classification using machine learning Tecniqus
Author : Utkarsh Bahukhandi , Dr. Shikha Gupta
Year Of Publication:2021

Keyword: Pose Estimation, Computer Vision, Machine Learning, Classification, Yoga, Health, Classifiers, Logistic Regression, Support Vector Machine, KNN, Random Forest, Naïve Bayes.

Method of Algorithm Used: Logistic Regression, Support Vector Machine, KNN, Random Forest, Naïve Bayes.

Yoga is an art that originated in India a long time back. It helps boost the physical health of a person and cleanses the body, mind, and soul of a person.

Yoga can cure many diseases without any need for medicines With the introduction of Covid-19 humans understood one thing that it is health which is more important than anything else in this world and the situation is very difficult for everyone as there is bad news from everywhere in the world which makes disturbance to mental peace of everyone, hence yoga acts as a perfect recipe for this situation.

For detection of yoga poses in any system human pose estimation is required. Human pose estimation is the computer vision problem in which the human pose of any person is detected when the camera receives an image of a human in front of it. The detection of human poses is done using key points detection. These key points are the major points of the human body which include the nose, eyes, mouth, etc.

There are two different ways to detect these key points :

- Top-down approach: The major work behind the top-down approach is that it first finds bounding boxes that include every person in the frame. Next for every bounding box, it finds out the joint position of the person in the box. Hence every bounding box has its joints associated with it.
- Bottom-up approach: This approach is the opposite of the top-down approach. In this first, all the joints that are available in the image are found, and then joints corresponding to every bounding box are separated to classify them according to each person. Some major work is done in the yoga poses detection using the human pose estimation field.

Paper No.8

Title: Yoga Pose Classification Using Deep Learning

Author : Kothari, Shruti

Year Of Publication:2020

Keyword: – Human pose estimation, yoga, openpose, machine learning, deep learning

Method of Algorithm Used : Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN).

Human pose estimation is a challenging problem in the discipline of computer vision. It deals with localization of human joints in an image or video to form a skeletal representation. To automatically detect a person's pose in an image is a difficult task as it depends on a number of aspects such as scale and resolution of the image, illumination variation, background clutter, clothing variations, surroundings, and interaction of humans with the surroundings human pose estimation has benefited greatly from deep learning and huge gains in performance have been achieved . Deep learning approaches provide a more straightforward way of mapping the structure instead of having to deal with the dependencies between structures manually. used deep learning to identify 5 exercise poses: pull up, swiss ball hamstring curl, push up, cycling and walking. However, using this method for yoga poses is a relatively newer application

Paper No.9

Title: Yoga Pose Monitoring System using Deep Learning

Author : Debabrata Swain, Santosh Satapathy, Pramoda Patro, Pramoda Patro.

Year Of Publication: 2022

Keyword: Yoga Pose, Deep Learning, Asanas, CNN, LSTM, Media pipe, Pose prediction. Method of Algorithm Used : Convolutional Neural Network and Long Short Term Memory. (CNN and LSTM)

Significant work has been done in this field of real-time human monitoring for a variety of applications. The proposed research aims to take the existing literature into account and contribute towards an enhancement in the currently achievable results in the field of computer vision for human pose estimation. An attempt has been to devise a Deep Learning based system to efficiently detect yoga poses and practically work as a substitute for a trainer, by giving accurate feedback to the user. Kothari et al. in a comparative study between machine learning and deep learning

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techniques for yoga pose estimation carried out an experimental work involving both the technologies and analyzed the performance of the framework by using support vector machine, convolutional neural network, and Convolutional Neural Network along with Long Short Term Memory.

They calculated the cosine similarity of vectors by finding angles between all the vectors connecting any two joint points. If the calculated deviation is more than a set threshold value, the pose is classified as incorrect. The paper did not mention the overall accuracy obtained. S. Haque etc.proposed a model named ExNet, which is a multilayer convolutional neural network (CNN).

Paper No.10
Title: YOGA POSE DETECTION USING MACHINE LEARNING
Author : Rutuja Jagtap, Monali Zanzane, Rutuja Patil
Year Of Publication: 2022
Keyword. Media Pipe, Opencv, Machine Learning, Logistic Regression.
Method of Algorithm Used : Logistic Regression.
Human pose recognition is an extremely troublesome and difficult task within the discipline of computer vision. It desals with the localization of human joints in a picture or video to make a skeletal illustration. To mechanically discover a user's activity in a picture may be a troublesome drawback because it depends on a variety of aspects like scale and determination of the image, illumination variation, background muddle, venture variations, and interaction of humans with the environment. The matter with yoga is that, rather like the other exercise, it's of utmost importance to apply it properly as any incorrect posture throughout a yoga session is often unproductive and probably damaging. This results in the requirement of getting an educator to supervise the session and proper posture.

Human posture recognition has created vast advancements within the past years. it's evolved from second to 3D create estimation and from a single person to multi-person create estimation. It uses pose estimation to make a machine learning application that helps find shoplifters whereas uses one RGB camera to capture the 3D poses of multiple folks in the time period. Human pose estimation algorithms may be wide organized in 2 ways.

Algorithms prototyping estimation of human poses as a geometrical calculation are classified as generative ways whereas algorithms modeling human creation estimation as a picture process drawback are classified as discriminative methods. in a different way of classifying these algorithms relies on their methodology of operating and therefore the major work behind that approach. Algorithms ranging from a higher-level generalization and moving down are known as top-down ways, whereas algorithms that begin with pixels and move upwards are known as bottom-up ways.

Algorithm of LR
LR

- Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables.
- Logistic regression predicts the output of a categorical dependent variable. Therefore the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, it gives the probabilistic values which lie between 0 and 1.
- Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas Logistic regression is used for solving the classification problems.
- In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).
- The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.
- Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets.

- Logistic Regression can be used to classify the observations using different types of data and can easily determine the most effective variables used for the classification. The below image is showing the logistic function:

Steps in Logistic Regression: To implement the Logistic Regression using Python, we will use the same steps as we have done in previous topics of Regression. Below are the steps:

- Data Pre-processing step
- Fitting Logistic Regression to the Training set
- Predicting the test result
- Test accuracy of the result(Creation of Confusion matrix)
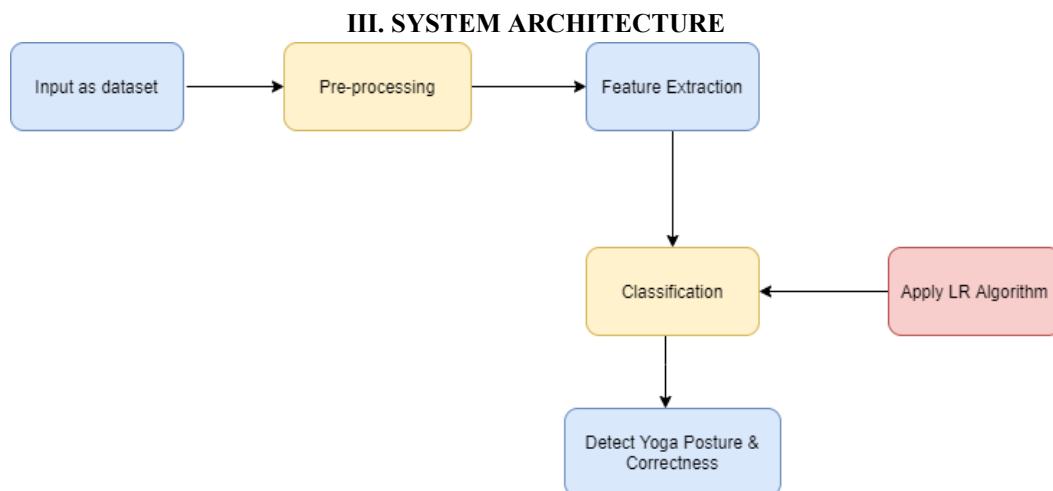- Visualizing the test set result.

III. SYSTEM ARCHITECTURE

Figure 3. System Architecture

IV. CONCLUSION

In order to support a healthy lifestyle for the community of yoga practitioners, we have proposed a system which is able to guide them to practice yoga more accurately in real time. This proposed system is capable of identifying yoga postures using an android mobile. When the user practices yoga, a live mobile feed is streamed to the server which has multiple modules interconnected to predict and output the asana and the accuracy. A video guide of the predicted pose is shown to the user in real time helping the user reach the stance properly.

V. FUTURE SCOPE

By seeing the benefits of Yoga, career opportunities in this field are increasing in India as well as in abroad also.

After pursuing yoga courses, you can work in Health clubs, Yoga & Pilates studios, special needs Centre, private gym and in individual clients homes

Based on Yoga pose, we can build a variety of applications, like fitness or yoga trackers. As an example, we present squats and push up counters, which can automatically count user statistics, or verify the quality of performed exercises.

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