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Classification of Yoga Posture Using POSENET

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Abstract: *Yoga which originated in India is a way of exercise to bind your spiritual (Mental Health) as well as Physical (body) in proper coordination of their respective functionality. Indian-origin yoga is mainly for the maintenance of health in many countries all around the world. Therefore the yoga posture of the body is an important factor that affects health. Many doctors suggested Yoga to be beneficial for the speedy recovery of the injuries also because the best tool to fight against mental-health problems like Depression, Anxiety , Post-traumatic stress Some of the Yoga Practitioners do not perform their yoga posture properly which leads to many body problems like pain in the joints, disc-misalignment, shoulder pain, etc. According to the study report of researchers nearly 87% of musculoskeletal pain or worsen injuries and more than 10 percent said yoga had cause pain in their hands, wrists, shoulders and elbow. There are various systems which work on yoga pose detection which uses open pose, pose net and various classification models such as CNN, random forest etc. Most of these systems work on static images and detect the key points from a body. However there is hardly any system that uses the real time videos of the user. So we are proposing a system which will feature artificial intelligence and machine learning. We are introducing an online Android application for classification and rectifying your Yoga. Application will be created using android studio IDE, flutter, which is an open-source UI software development kit. It will analyze your body movements when you are performing yoga using Pose Net and CNN as a classification model with a trigger warning mechanism. Posenet is a real-time pose detection technique. We are using posenet to detect human beings poses in an image or videos. Programming language we are using is Dart, which is used to create flutter applications. The T ensorflow created Pose Net model extracts the key points from the user camera and passes the output as an input to the custom created classification model using TensorFlow Lite and ML-Kit to predict the posture performing. If the posture fails during the time the buffer system is introduced, it will restart your performing stance and will make you do that again until it gets properly synchronized and classified.*

Keywords: AI, Machine Learning, Android Studio, Flutter, Posenet, CNN, Dart, Tensorflow

I. INTRODUCTION

Machine Learning is a part of AI (Artificial Intelligence) is a study of computer algorithms improving itself automatically through experience and use of the data provided. It is used for data analysis that automates the data model. The machine learning domain is the most sorted out among the major mew technology. Mainly for its automated models and best algorithms which mainly solves many simple life problems. Proposed System also uses machine learning domain knowledge to solve the problem statement. Yoga which originated in India is a way of exercise to bind your spiritual (Mental Health) as well as Physical (body) in a proper coordination of their respective functionality. Being one of the oldest exercising forms, Yoga proves many of the aspects where people found stability in their life with calmness, spiritual evolution, proper body functioning and the most important proper balance of their diet as well as the functionality of body functionality. Yoga practice gives us the advantages of flexibility, managing energy levels, proper sleep posture, increasing muscle strength, proper functioning of circulatory and cardio health, and healing of injuries as well as chronic pain. Many medical Experts suggested Yoga to be beneficial for the speedy recovery of the injuries as well as the best

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tool to fight against mental-health problems like Depression, Anxiety ,Post-traumatic stress. One of the surveys said that 89% of yoga practice leads to the relief of joint pain, muscle pain and depression. Now here is the reason we are suggesting our model. Some of the Yoga Practitioners do not perform their yoga posture properly which leads to many body problems like pain in the joints, disc-misalignment, shoulder pain, etc. Our model will analyse your body movements when you are performing the yoga and will rectify your mistakes with a trigger warning and it will restart your performing stance and will make you do that again until it gets properly synchronized with the trained data. For example:

1.Posenet:

Posenet is a real-time pose detection technique with which you can detect human beings poses in images or videos. Pose estimation is the task of using an ML model to estimate the pose of a person from an image or a video by estimating the spatial locations of key body joints (key points). It works in both cases as single-mode(single human pose detection) and multi-pose detection(Multiple humans pose detections.

Fig 1: Key points detection by Posenet

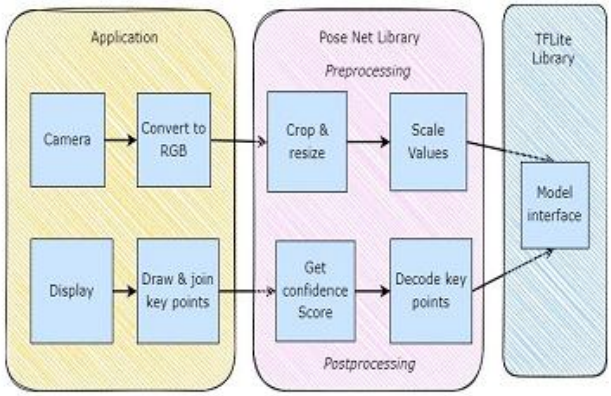

Fig 2: Working of Posenet Model

2. CNN (Convolutional Neural Network):

The convolutional neural network (CNN) is a class of deep learning neural networks. CNNs represent a huge breakthrough in image recognition. They're most commonly used to analyze visual imagery and are frequently working behind the scenes in image classification.

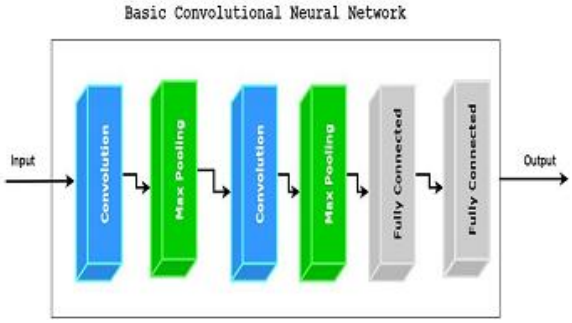

Fig3: Workflow of CNN Model

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II. LITERATURE SURVEY

A. Development of a yoga posture coaching system using an interactive display based on transfer learning

In this system, authors have used total six different pre-trained models which are MobileNet, MobileNetV2, InceptionV3, VGG16, VGG19, and DenseNet201 [28–32] to extract key features from the yoga postures performed by users. The accuracy achieved by these models is 98.31%. After extracting the required features from the pre-trained model, the classification model is used to classify the yoga postures among different categories.

The advantages of this technique used by system is the output indicated that the transfer learning model based on MobileNet worked well with the DA on the yoga posture dataset by enabling a considerably best overall accuracy of the prediction model than achieved compared to any other competitive models in this study but the disadvantage is because of inaccessibility to the same type of yoga posture dataset, direct comparison with the literature is impossible.

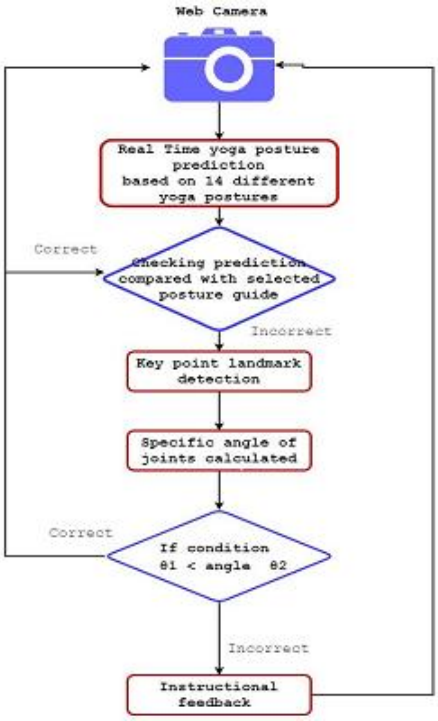

Fig. 4 – Flow diagram of proposed system

B. Interactive Yoga T raining in Virtual Environment

The proposed system is based on 3 component

1. One Interface unit comprising 16 Inertial Measurement Unit (IMU) and 6 tractors;
2. TV screen with PC;
3. VR application running on PC.

Understanding the user' s movements is enhanced by MoRep (Motion Replication) by comparing the user' s posture With virtual instructor' s postures. System also gives relevant and Professional feedback content. Advantage of the system is the VR system can guide a user to imitate the Yoga pose and also can correct the user's wrong pose by providing audio, visual, and haptic feedback.

C. Yoga Pose Detection Using Deep Learning Technique

In this system, they have used a popular library in Python, Open pose to detect the pose of a person. To identify the face, hand and foot keypoints Openpose uses CNN-architecture. After detecting these key points, they are connected in such an order that gives a skeletal image of the human-body.

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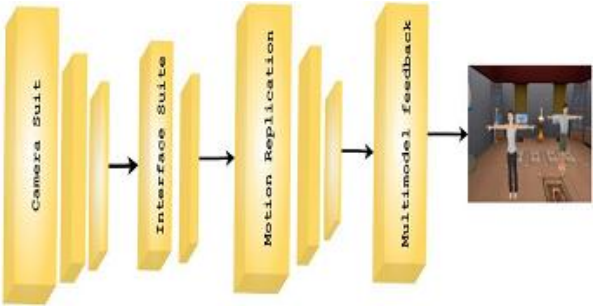

Fig. 5 – Diagrammatic Representation of Proposed Signet Architecture

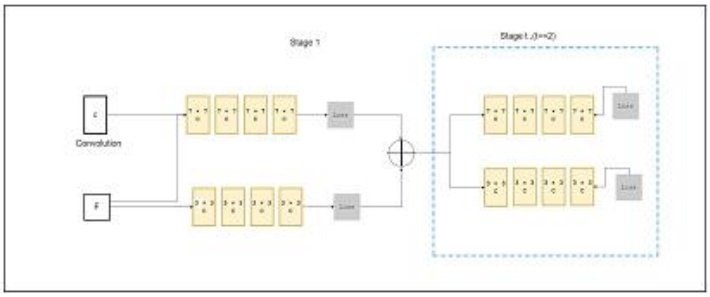

Fig. 6 – [6]

D. Yoga Pose Classification Using Deep Learning

Authors have used the python openpose library to detect the key points from the body. For recorded videos pose extraction is done offline otherwise key points identified by camera using user input are passed to the classification model. Authors have used the combination of CNN and LSTM (Long Short Term Memory) and accuracy achieved by the system is 93.31%.

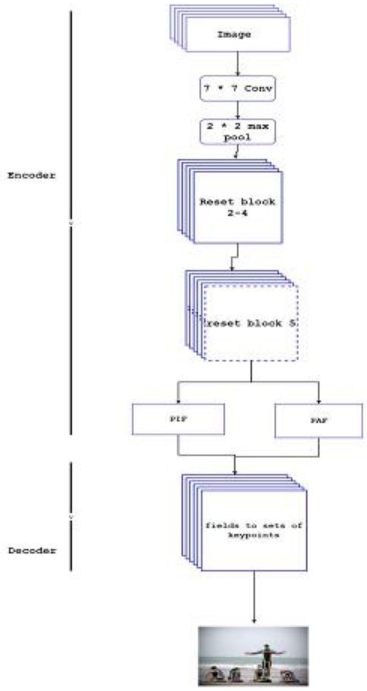

Fig. 7 – Proposed Deep CNN Structure

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E. Recognition of Yoga Poses through an Interactive System with kinect based on confidence value

This system proposes a technique to classify six different yoga poses using a Kinect sensor. Authors have created the database for pose recognition using Adaboost algorithm. The accuracy achieved is 92%. The interactive system uses this database trained by the algorithm for recognition of discrete gestures in real time and is up to track 6 people at the same time.

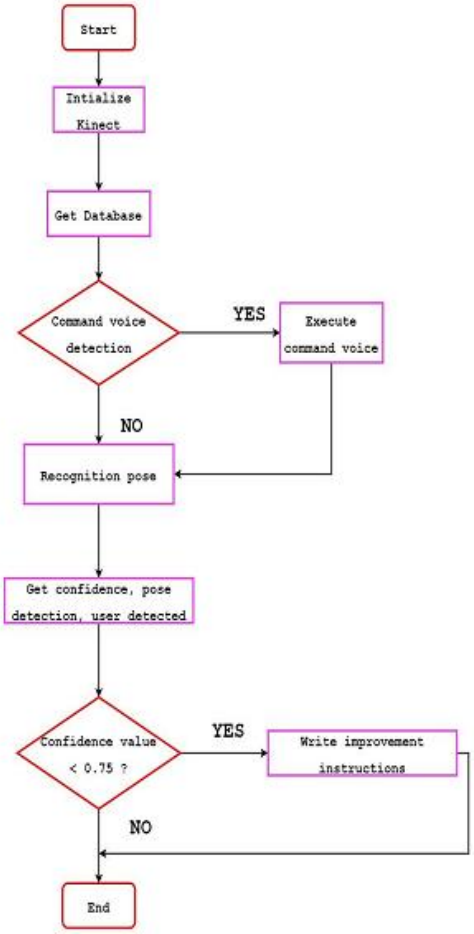

Fig. 8 – Proposed System

F. Implementation of Machine Learning Technique for Identification of Yoga Poses.

In this system, authors have used tf-pose-estimation algorithms to create the skeleton of a person performing yoga poses, The algorithm marks each joint of the body and connects it with a skeleton/stick. After this the features are stored in a CSV file and labelled accordingly. In this system total 6 classification algorithms are used which are KNN, Naïve Bayes, Logistic Regression, Random Forest, SVM and Decision Tree with different parameters. 94.28% accuracy altogether was attained of all machine learning models.

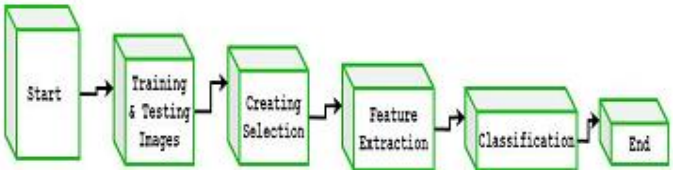

Fig. 9 – System Flowchart

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G. Infinity Yoga Tutor: Yoga posture detection and correction system

The proposed system uses the combination of technologies like Electromyography and Machine learning to recognise the yoga poses of a person. The study includes 10 subjects, 5 males and 5 females. The data was collected during five yoga postures. System has used 3 different classification algorithms and 87.34% of accuracy is achieved by the Random Forest algorithm which is best among all 3 algorithms.

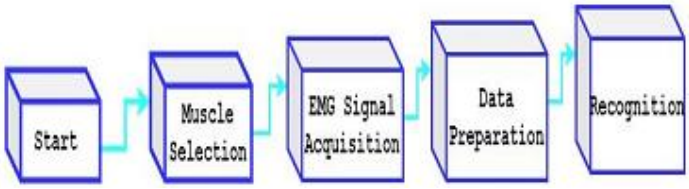


Fig. 10 – Proposed framework for continuous SLR using Leap Motion sensor

H. A Proposal of Yoga Pose Assessment Method Using Pose Detection for Self-Learning

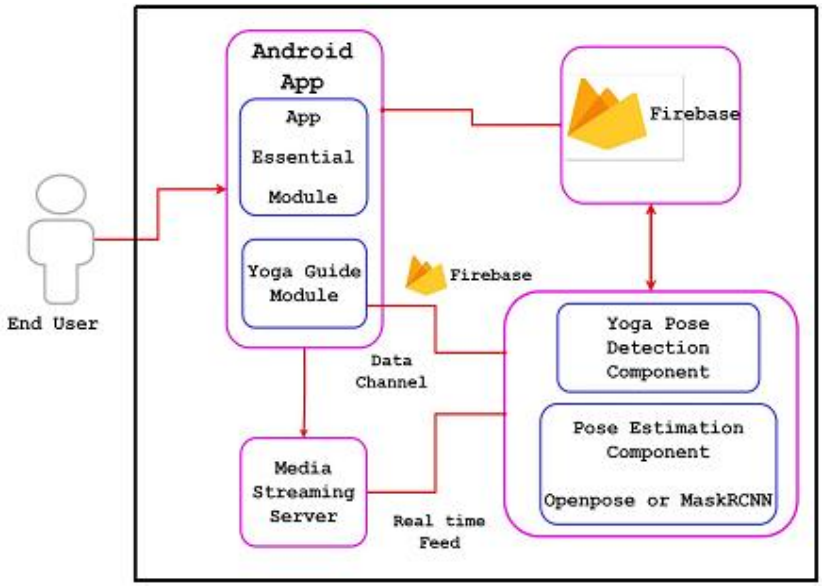
In this system, With the help of a PC camera, here we are assessing a pose using the openpose library from python. Then for classification authors have used CNN(Convolutional Neural Network) which is one of the main categories to do image recognition, image classification, object detection and part detections. The proposed system classifies the pose into 4 categories which are perfect, good, not good and bad using the angle difference.

I. Infinity Yoga Tutor: Yoga posture detection and correction system

The proposed yoga posture correction and detection The system contains four components.

1. Keypoints Detection using OpenPose
2. Keypoints Detection using Mask RCNN
3. Higher Probability Prediction &
4. Comparison Android Trainer Application

The user's video is captured and streamed in real-time. Then the system detects joints and the keypoints using pose estimation library either Openpose or Mask RCNN. The selected model which uses posenet for detecting keypoints provides accuracy up to 99.91% on testing data and 99.87% on training-dataset.:



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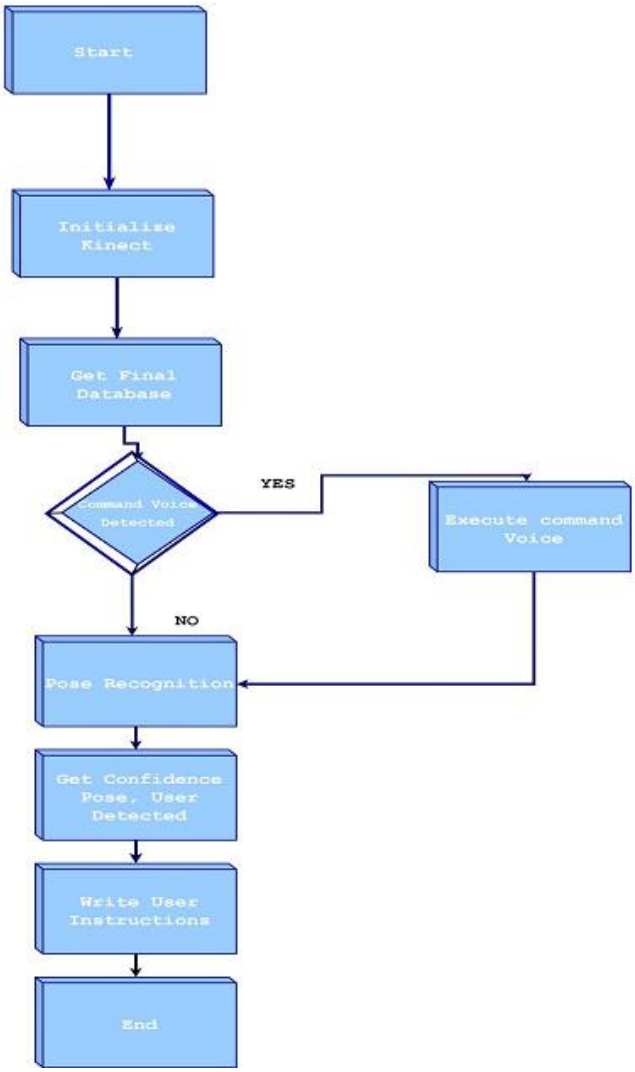
J. Recognition of Yoga Poses through an Interactive System with Kinect device

This research introduces an interactive project idea capable of classifying 6 yoga poses for learning Yoga. This system can track 6 people at a time. Adaboost algorithm is used to get a strong database for recognition. Whole data is trained by an expert yoga trainer and the final database shows accuracy of 94.78%. This is an interactive system that uses Kinect v2 for 6 yoga poses recognition with the command voices to make system visualize the instructions and visuals about the yoga poses to be performed but The project uses the various databases which are not feasible.



III. COMPARATIVE ANALYSIS

Sr. No.	Title of the Paper	Author and Year	Advantage	Disadvantage
1	Development of yoga posture coaching system using display-based transfer learning	25 June 2018 Edwin W. T rejol, Peijiang Y uan2.	The results showed that the transfer learning model on MobileNet had worked very well with DA on our yoga posture dataset by enabling a considerably better overall	Due to considerably less accessibility to the same yoga posture dataset, direct comparison

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			accuracy of the prediction as compared to achieved by the other competitive models in this study.	with the Literature is not possible.
2	Interactive Yoga Training in Virtual Environment	Zhiqiang Luo, Weiting Yang1, Zhong Qiang Ding1, Lili Liu1, I-Ming Chen1, Song Huat Y eo1 23 March 2019	The visual and audio feedback will increase the accuracy of the yoga poses The haptic feedback provides spatial information of human postures independent of the visual channel.	Requires more liquid funds for motion sensors and VR. It may correct the user's wrong pose by providing audio, visual and haptic feedback.
3	Yoga Pose Detection Using Deep Learning Techniques	S. Sankara Narayanan, Devendra Kumar Misra, Kartik Arora, Harsh Rai May 10 2021	The use of OpenP ose, PyQt and a Neural Network model on the dataset containing the 3D values is seen to be highly effective than the 2D values and classifies all the 3 yoga poses perfectly.	In case of overlapping between humans or body parts, the OpenP ose library will face challenge in detecting accurately.
4	Yoga Pose Classification Using Deep Learning	Dr. Robert Chun May 5 2020	The classification scores are almost close to 1 thereby showing us the perfect classification for all the classes. The diagonal section in the normalized confusion matrix is 1.0 for all classes and 0.99 for vrikshasana. The count of misclassifications for vrikshasana is only 177 which is considerably much less as compared to the previous two models. Also, the accuracy of the model and model loss curve represents a good fit with Null fluctuations.	The proposed models currently classify only 6 yoga asanas. There are a number of yoga asanas, and therefore creating a pose estimation model that can be reliable and best suited for all the asanas is a challenging problem.
5	Recognition of Yoga Poses through an Interactive System with kinect based on confidence value	Edwin W. Trejo, Peijiang Yuan 20 July 2018	The system be used for the development of assisted Yoga activity that can improve the user's performance.	The increase in movements and speed of the user decreases the accuracy and flops the system.
6	Implementation of Machine Learning Technique for Identification of Yoga Poses.	Yash Agrawal, Yash Shah, Abhishek Sharma 12 April 2020	The variety of techniques used increases the accuracy with detailed analysis.	Requires more time and users are confused because many algorithms are used.

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7	Recognition of yoga poses using EMG signals from lower limb muscles	Pratchaya Anantamek, Narit Hnoohom 30 Jan 2019	The system assesses 1) detecting the pose or skeleton. 2) calculating the difference of the body angles. 3) indicating the incorrect part between learner and instructor. 4) classifying the pose into four levels.	The accuracy of the system decreases during each step, resulting in accurate data.
8	A Proposal of Yoga Pose Assessment Method Using Pose Detection for Self-Learning	Maybel Chan Thar, Khine Zar Ne Winn, Nobuo Funabiki 7 Nov 2019	The Random Forest Decision Tree algorithm yielded the best performance for EMG data when compared with the other algorithms.	The results of the SMO algorithm shown in are less accurate than the other algorithms.
9	INFINITY YOGA TUT OR : YOGA POSTURE DETECTION AND CORRECTION SYSTEM	Fazil Rishan, Binali De Silva, Sasmini Alawathugoda 4 Dec 2020 Infinity Yoga Tutor: Yoga posture detection and correction system	The dataset was trained on multiple models for key points obtained from two different pose estimation modules, OpenPose and Mask RCNN in order identify the most suitable pose estimation module for the current system.	The model had a difficulty differentiating Tadasana and Vrikshasana at certain times, this could be because the movements leading to both the poses are almost similar.
10	Recognition of Yoga Poses through an Interactive System with Kinect device	Edwin W. T rejo l, Peijiang Y uan2.25 June 2020	An interactive system that uses Kinect v2 for 6 Yoga poses recognition with command voices to visualize the instructions and pictures about the poses to be performed.	The project uses various databases which is not feasible.

IV. Findings And Contribution

4.1 Findings

- After doing detailed analysis of above mentioned research papers we observed that there are very rare systems that work on real time feed to recognize yoga postures performed by yoga practitioners.
- Most of the systems work on static images and datasets.
- Most of the systems are based on web based designs which is quite difficult to understand by the non-technical users.

4.2 Objectives

- The objective is to develop an application that can detect live yoga postures.
- To build a system that can help to correct improper yoga postures performed by yoga practitioners.
- To build an easily understandable interface by the users.
- To build a system that uses technologies like machine learning and artificial intelligence to classify and rectify the performance of yoga practitioners.

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4.3 Algorithm

The system will be built using the machine learning model named as Posenet. Posenet is a real-time pose detection technique with which you can detect human beings poses in images or videos. Pose estimation is the task of using an ML model to estimate the pose of a person from an image or a video by estimating the spatial locations of key body joints (key points). It works in both cases as single-mode (single human pose detection) and multi-pose detection (Multiple humans pose detections). Pose estimation refers to computer vision techniques that detect human figures in images and videos, so that one could determine, for example, where someone' s elbow shows up in an image. It is important to be aware of the fact that pose estimation merely estimates where key body joints are and does not recognize who is in an image or video. The pose estimation model takes a processed camera image as the input and outputs information about keypoints.

Keypoint Confidence Score: This determines the confidence that an estimated keypoint position is accurate. It ranges between 0.0 and 1.0. It can be used to hide key points that are not deemed strong enough.

Keypoint Position: 2D x and y coordinates in the original input image where a keypoint has been detected.

Data: The data extracted is used as an input. The data in csv file contains the x, y and confidence score of the pose of every frame. The data is being imputed continuously to the classification model.

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