Yoga Posture Analysis Using Deep Learning Techniques

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Abstract:

Human pose estimation is a profound, established computer vision issue that has uncovered numerous past difficulties. Breaking down human exercise is advantageous in multiple fields like surveillance, biometrics, and many healthcare applications. Workout with yoga poses is famous these days since yoga activities can expand adaptability and muscular quality, and the respiration procedure will be improvised. The yoga postures evaluation is hard to check, so specialists will most likely be unable to benefit from the exercises ultimately. IoT-based yoga frameworks are required for individuals who need to rehearse Yoga at home. A few studies are recommended camera-oriented or wearable gadget-oriented yoga posture finding strategies with more precision. Nonetheless, camera-based plans have security and privacy issues, and the wearable device-based methods are illogical in the earlier applications. To build such systems, one must have a strong foundation and current research in pose estimation. In this project, we have developed a web application that is capable of analyzing yoga postures and gives the result only when the postures match with the trained models.

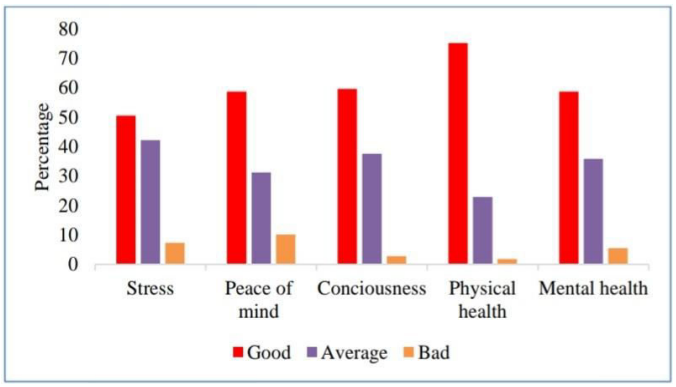
I. INTRODUCTION

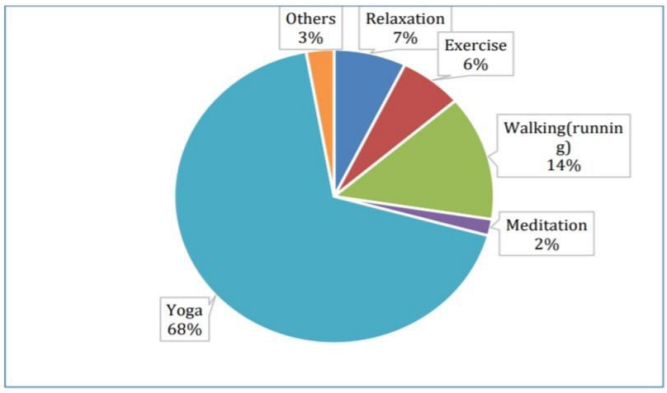
Yoga started in India many decades ago, gathering exercise related to mental, physical, and profoundstrength. Yoga and sports have been drawing in people groups for endless years, yet from the most recent decade, an enormous community accepts Yoga as a feature of their life. The reason is because of the medical advantages. It is critical to do this activity in the right manner, particularly in the right pose. At some point, because of no assistance or information, individuals don't have a better idea about the correct technique to perform Yoga and begin doing Yoga with no proper guidance. Accordingly, they harm them-self while self-preparing because of an ill-advised stance. Yoga ought to perform under the direction of a trainer, yet it is likewise not moderate for all individuals. These days individuals utilize their cell phones to figure out how to do yoga stances and begin doing that, yet while doing that, they don't realize that the yoga present they are doing is precise or not. To conquer the constraints, as mentioned earlier, numerous works have been proposed. Computer vision and data science methods are utilized Artificial Intelligence (AI) products that act as a trainer. It depicts the benefits of that present. In some articles, there applied AI and Deep learning modules on an enormous number of picture dataset, which includes different yoga poses (Laxman, 2020). Yoga utilizes a progression of physical postures called asana, breathing control, and meditation. Since Yoga focuses on both body and brain, it is unmistakably more remedial than work out. Yoga practice must consolidate the extendingof significant muscle gatherings, adding to physical ability and adaptability (Rowland et.al, 2020). A few yoga-based mediations directed in the community have been described. Regardless of how interventions assist indecreasing falls and the dread of losing, older people with these issues may not promptly approach such network-dependent projects. Particular old individuals' manifest inconvenience at rehearsing Yoga publicly, which isparticularly valid for ladies who want to do much at home and recreation. It is desirable to train Yoga in abounded area with no disturbance. In rural zones, notwithstanding, yoga coaches are scarce (Mohan, 2021), and this factor is a significant driver in the production of a self-helped yoga training framework. Learning is frequently connected with two criteria, area and time, and is relevant to exercise or Yoga by the older too. Given an overall hesitance concerning the old to exercise or practice Yoga, the spot and season of training are adaptableby their inclinations. Also, learning depends on the person's choices and inspiration to learn at their movement.

Alongside the advantages such as improved equalization, Yoga has a disadvantage. It tends to be rehearsed at home, in a composed setting, alone, or a gathering. Ideally, Yoga fits self-learning, too (Wang et.al, 2020). Yoga includes various successions of stances, which are assorted positions a person can expect. In Yoga, the exact posture is basic. The posture successions accepted during training are recognized and dissected to plan a self- preparing yoga framework, and wrong postures are evaluated. Due to advancements in deep neural networks, estimation of the pose has attained the best performance (Kothari, 2020 & Mathis, 2020). The nature of the central issue and skeleton comments in these datasets assume a significant part in achieving the state-of-the-art assessment models. Nonetheless, the manual explanation measure is inclined to human blunders and can be seriously influenced by different factors, for example, goal, impediment, light, viewpoint, and variety of stances (Palanimeera, 2020).

II. Need and Imapact of Yoga on Health Care

The COVID outbreak and resulting lockdown had constrained us all to stay at homes prompting a more unpleasant life (Borave, 2020). Public distancing had invigorated the chance to improve mental ability and Pranayama and Meditation (Bilmez, 2020). Yoga is perhaps the most straightforward physical, mental, and Spiritual work during this isolation period. "Yoga Practice deals with these psychological issues, and along with breathing, meditation is the best general practice which will be careful with our body, brain, and soul. Yoga can help lessen pressure and uneasiness and aids in improving the physical, just as assuaging negative mental impacts. Furthermore, it encourages you to plan your day better during lockdown time. The fundamental point of Yoga in our everyday life is to create Physical, Mental, Social, and Spiritual well-being (Rajendar, Mala et.al,2020). Yoga's impact on the people in the lockdown period is analyzed. The data collected from 109 persons, including 64 persons who are male and 45 are female. Few questions were raised to check the health issue-level and the respondents' subsequent answers. Further, five parameters are considered: stress level, peace of mind, consciousness, physical health, and the respondent's mental health. The analyzed results are shown in Figure 2 to Figure 4.





The respondents' stress levels in the lockdown period are about 50.5% good, 42.2% average, and 7.3% bad. Further, peace of mind is 58.7% good, 31.2% average, and 10.1%. The consciousness includes 59.6% good, 37.6% average, and 2.8% bad. These populations' physical health includes 75.2% good, 22.9% average, and 1.8% bad, and mental health has 58.7% good, 35.8% average, and 5.5% bad. The other factors that 15.6% of the population opted to stress levels increased, and 12.8% of people opted for frustration increased, 5.5% opteddepression increased, and 14.7% opted concentration decreased. Further, the study also collected the healthreasons mentioned earlier, among which many respondents opted for financial, professional, and personalreasons. Among these, 67.9% of respondents opted for Yoga as a health management technique, and 90.8% of people opted for Yoga's positive impact on better health.

III. Human Pose Estimation

Pose estimation is a computer vision technique to track the movements of a person or an object. This is usually performed by finding the location of key points for the given objects. Based on these key points we can compare various movements and postures and draw insights. Pose estimation is actively used in the field of augmented reality, animation, gaming, and robotics.

There are several models present today to perform pose estimation. Some of the methods for pose estimation are given below:

1. Open pose
2. Pose net
3. Blaze pose
4. Deep Pose
5. Dense pose
6. Deep cut
7. Move Net

Choosing any one model over another may totally depend upon the application. Also, the factors like running time, size of the model, and ease of implementation can be various reasons to choose a specific model.

2D vs 3D Estimation

Pose estimation can be done either in 2D or in 3D. 2D pose estimation predicts the key points from the image through pixel values. Whereas 3D pose estimation refers to predicting the three-dimensional spatial arrangement of the key points as its output. For this project, we will be using the Move net model for detecting human pose and extracting key points. The model can be easily implemented through a very helpful library, well known as TensorFlow and Center Net.

TensorFlow

TensorFlow.js is a JavaScript Library for training and deploying machine learning models in the browser and in Node.js. TensorFlow.js Data provides simple APIs to load and parse data from disk or over the web in a variety of formats, and to prepare that data for use in machine learning modes (e.g., via operations like filter, map, shuffle, and batch).

MoveNet

MoveNet is a bottom-up estimation model, using heatmaps to accurately localize human keypoints. The architecture consists of two components: a feature extractor and a set of prediction heads.All models are trained using the TensorFlow Object Detection API.The feature extractor in MoveNet is MobileNetV2 with an attached feature pyramid network (FPN), which allows for a high resolution, semantically rich feature map output.

IV. MoveNet Pose Processing Steps:

The person center heatmap is used to identify the centers of all individuals in the frame, defined as the arithmetic mean of all keypoints belonging to a person. The location with the highest score (weighted by the inverse-distance from the frame center) is selected. An initial set of keypoints for the person is produced by slicing the keypoint regression output from the pixel corresponding to the object center. Since this is a center-out prediction which must operate over different scales – the quality of regressed keypoints will not be very accurate. Each pixel in the keypoint heatmap is multiplied by a weight which is inversely proportional to the distance from the corresponding regressed keypoint. This ensures that we do not accept keypoints from background people, since they typically will not be in the proximity of regressed keypoints, and hence will have low resulting scores.The final set of keypoint predictions are selected by retrieving the coordinates of the maximum heatmap values in each keypoint channel.

Training Datasets

MoveNet was trained on two datasets: COCO and an internal Google dataset called Active. While COCO is the standard benchmark dataset for detection – due to its scene and scale diversity – it is not suitable for fitness and dance applications, which exhibit challenging poses and significant motion blur. Active was produced by labeling keypoints (adopting COCO's standard 15 body keypoints) on yoga, fitness, and dance videos from YouTube. No more than three frames are selected from each video for training, to promote diversity of scenes and individuals.Evaluations on the Active validation dataset show a significant performance boost relative to identical architectures trained using only COCO. This isn't surprising since COCO infrequently exhibits individuals with extreme poses (e.g. yoga, pushups, headstands, and more).

Optimization

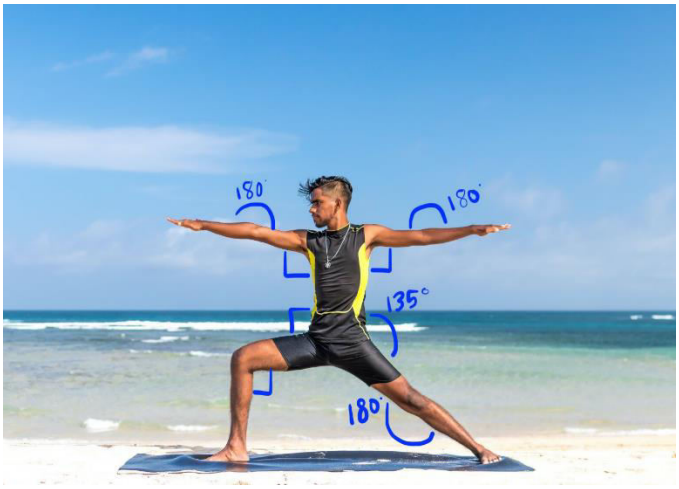
While a lot of effort went into architecture design, post-processing logic, and data selection to make MoveNet a high-quality detector, an equal focus was given to inference speed. First, bottleneck layers from MobileNetV2 were selected for lateral connections in the FPN. Likewise, the number of convolution filters in each prediction head were slimmed down significantly to speed up execution on the output feature maps. Depthwise separable convolutions are used throughout the network, except in the first MobileNetV2 layer.MoveNet was repeatedly profiled, uncovering and removing particularly slow ops. For example, we replaced tf.math.top_k with tf.math.argmax, since it executes significantly faster and is adequate for the single-person setting. To ensure fast execution with TensorFlow.js, all model outputs were packed into a single output tensor, so that there is only one download from GPU to CPU.Perhaps the most significant speedup is the use of 192x192 inputs to the model (256x256 for Thunder). To counteract the lower resolution, we apply intelligent cropping based on detections from the previous frame. This allows the model to devote its attention and resources to the main subject, and not the background.

Temporal Filtering

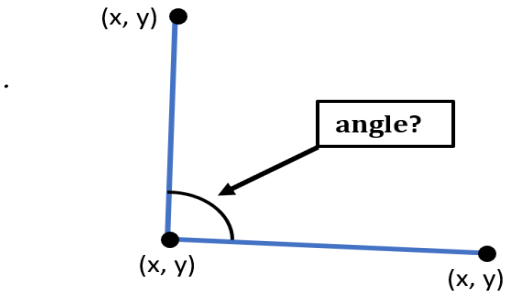
Operating on a high FPS camera stream provides the luxury of applying smoothing to keypoint estimates. Both Lightning and Thunder apply a robust, non-linear filter to the incoming stream of keypoint predictions. This filter is tuned to simultaneously suppress high-frequency noise (i.e. jitter) and outliers from the model, while also maintaining high-bandwidth throughput during quick motions. This leads to smooth keypoint visualizations with minimal lag in all circumstances.

Pose Classification with Angle Heuristics:

We will level up our model by also classifying different yoga poses using the calculated angles of various joints. We will first detect the pose landmarks and then use them to compute angles between joints and depending upon those angles we will recognize the yoga pose of the prominent person in an image.

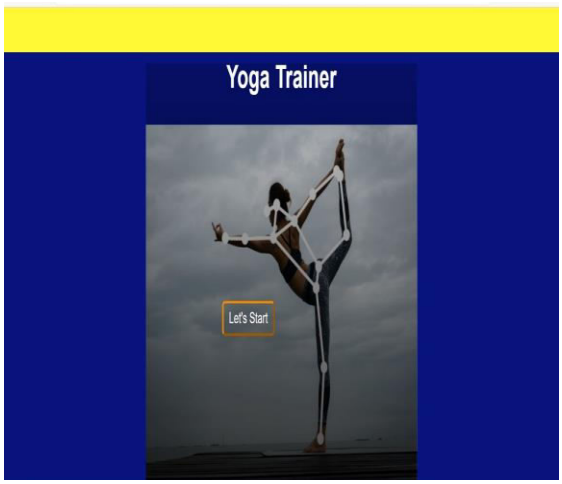


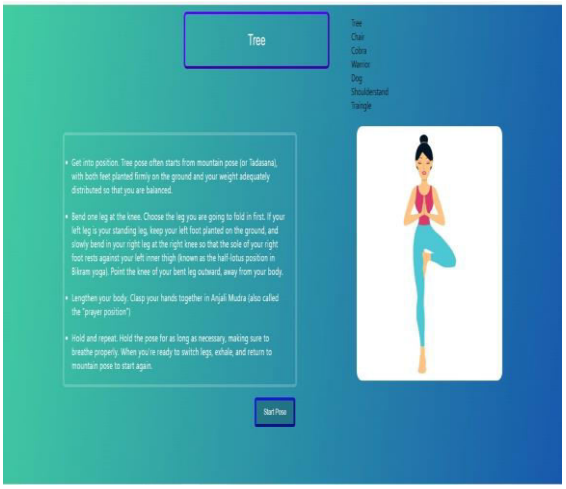
The first point (landmark) is considered as the starting point of the first line, the second point (landmark) is considered as the ending point of the first line and the starting point of the second line as well,
and the third point (landmark) is considered as the ending point of the second line.

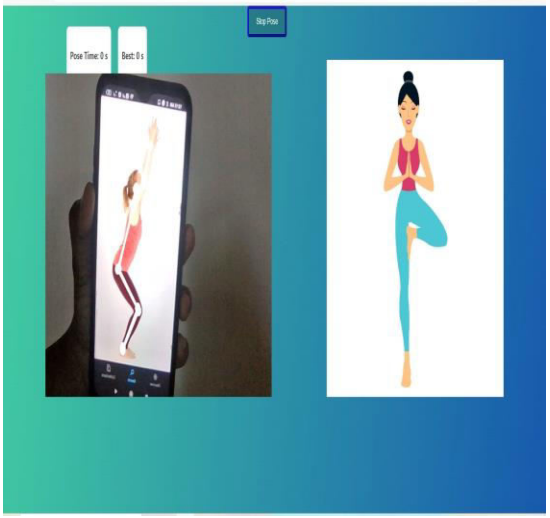


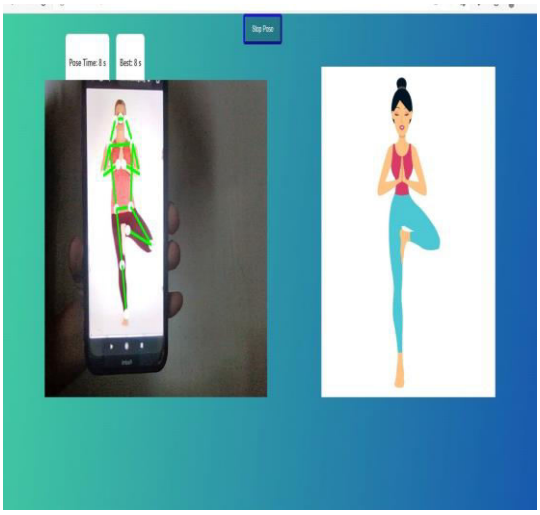
Results

Our project is capable of identifying 15 Key points in a human body.It uses Tensorflow to identify the yoga poses and it predicts 7 different yoga poses. And if the pose made by the person matches with our trained model, it will make the keypointsturn green from white.









CONCLUSION

Yoga and sports have been attracting people groups for endless years; however, countless individuals receive Yoga as a significant aspect of their life from the most recent decade. Studies have been done on yoga pose identification; however, recognition of pose is still tricky because of the lack of a real-time benchmark dataset. The development of self-training systems with the current approaches, for example, using an RGB camera, is computationally expensive. Furthermore, the accuracy and robustness of Kinect-devices are also low in detecting complicated human postures. In this paper, we have presented a brief analysis of the impact of Yoga on the healthcare system in daily life. Then, human pose recognition, along with the methodologies and human body models, is described. The present methods, including conventional machine learning to advanced deep learning strategies for yoga posture recognition are outlined. Hence, as per the best of our knowledge, the automated systems for detecting and recognizing the postures with better performance are yet to be developed. Developing such systems with optimal performance over a maximum number of poses is considered our future work.

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