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VIRTUAL YOGA TRAINER

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1. INTRODUCTION

In today's world, people are occupied with their schedules of hectic work. Due to those busy time schedules, most of the people are facing many health issues. According to the university of Rochester Medical Centre, top ten medical issues are physical activity and nutrition, overweight and obesity, tobacco substance abuse, mental health, injury and violence, environmental quality, immunization and access to healthcare.

Therefore, people are in need of a healthy lifestyle. A healthy lifestyle consists of healthy food, healthy physical activities weight management and stress management etc. It is feasible for people to maintain a healthy life easily by following healthy physical activities.

There are several types of exercises such as aerobics, strength building, balance training, cardio and yoga. People can do exercises by going to an instructor or a studio or by watching videos on exercises or with their own knowledge. Due to the lack of free time in their daily routine, most people prefer to do exercise on their own with the use of an instruction manual or guides that could be found online.

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. 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.

Virtual yoga Trainer uses computer 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 system for correcting improper yoga postures. This RPi based approach consists of both yoga pose detection and guides the user to perform correct yoga posture. 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.

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 key point detection libraries, the key point detection task has become easier in this proposed system. Since the accuracy of this system also depends on the Pose estimation or the key point detection module. Two different popular keypoints detection libraries are used to compare, contrast and identify the optimum library for the system. One of the selected libraries is Openpose, which detects 25 key points 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 mediapipe library which detects 32 keypoints of the user's body to create skeleton.

The output obtained from the above keypoint detection modules are normalised and modelled to fit to the prediction model, which consists of machine learning based model. This predicted result is visually represented to the user using a display.

2.BACKGROUND AND RELATED WORK

2.1PROBLEM FORMULATION

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 hath yoga, yoga as exercise, which consists largely of the postures called as "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. Therefore, following proper yoga postures is mandatory for good health and to achieve the best results of yoga.

Virtual yoga trainer uses vision based approach for detecting improper yoga postures of the people who are performing yoga with the prior knowledge they have and doing yoga by watching yoga videos or using yoga applications. Moreover, this system consists of giving audio and visual instructions to the user in real time which would help the user to maintain a proper asana throughout the practice.

2.2 LITERATURE REVIEW

1. M. Gochoo et al., "Novel IoT-Based Privacy-Preserving Yoga Posture Recognition System Using Low-

Resolution Infrared Sensors and Deep Learning," in IEEE Internet of Things Journal, vol. 6, no. 4, pp. 7192-7200, Aug. 2019.

• In this paper the authors have proposed a new approach for yoga postures detection using low-resolution infrared sensors. A deep convolutional neural network (DCNN) and a low-resolution infrared sensor based wireless sensor network (WSN) has been utilised in this system.

2. M. U. Islam, H. Mahmud, F. B. Ashraf, I. Hossain and M. K. Hasan, "Yoga posture recognition by detecting human joint points in real time using microsoft kinect," 2017 IEEE Region 10 Humanitaria Technology Conference (R10-HTC), Dhaka, 2017, pp. 668-673.

• The authors have introduced a system using Microsoft Kinect and it has captured various keypoints of the human body in real time. It is very expensive when Microsoft Kinect is also having security concerns. So, it is not that much suitable for a yoga posture detection system. The authors have proposed this system to recognize the yoga postures, but it did not guide the user to correct the improper yoga posture. Therefore, it is also to be addressed.

3. S.K. Yadav, A. Singh, A. Gupta, et al., "Real-time Yoga recognition using deep learning," Neural Computing & Applications, vol. 31, pp.9349-9361, May 2019.

4. Santosh et all, Amardeep, Abhishek and Jagdish have presented a real time yoga posture recognition method using deep learning. They have used OpenPose for keypoints detection and proceeded those keypoints to convolutional neural network to extract features. Then LSTM has taken part to identify the changes of the postures over the time. Finally, it has predicted the yoga posture.

5. P.K. Borkar, M.M. Pulinthitha, A. Pansare, 2019, "Match Pose – A System for Comparing Poses," International Journal of Engineering Research and Technology(IJERT), vol. 08, issue 10, Oct 2019.

• The authors have proposed a system called Match Pose which can be used to compare user's real time pose with a selected pose. They have used the poseNet algorithm for real-time pose estimations of users. They have used pose comparison algorithms to compare and check whether user's real-time poses are imitated successfully. Proposed system allowed the user to select only an image which a user wishes to imitate. Yoga poses involving finger positions cannot be compared in the system.

6. U. Iqbal, A. Milan, J. Gall, "Pose Track: Joint Multi-person Pose Estimation and Tracking," 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 4654-4663.

• The authors have proposed a method that jointly models human pose estimation and tracking in a single formulation. They have presented body joint detections in a video by a spatio-temporal graph and solved an integer linear program to partition the graph into sub-graphs that correspond to plausible body pose trajectories for person. They have casted the problem as an optimization of a densely connected spatiotemporal graph connecting body joint candidates spatially and temporally. They have proposed a dataset called PoseTrack, which provides annotations to quantitatively evaluate human pose estimation and tracking. The dataset provides detailed and dense annotations for each person in each video.

On referring to all these papers, several gaps were identified. Some models were very expensive while some models had some serious security related issues. Thus all these issues were to be addressed to make an efficient yoga correction model.

3. Proposed Topology

Detecting human postures is a complicated task. However, with the aid of popular keypoints detection libraries, this task has become easier in the proposed system. There are many open source pose detection libraries available among which we have used mediapipe pose detection and classification library for our system. This library is very easy to use and easily available.
In the proposed system, Virtual yoga trainer utilizes mediapipe library and with the help of this, detects the human posture and returns the feedback whether the posture is correct or not.

Flowchart

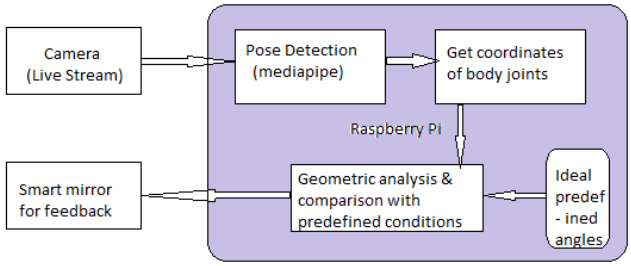

Fig.1 Flowchart of the proposed system

Stage 1 : Taking input from camera
In the very first stage, the camera initializes and gets the live streaming of the person performing yoga as input. This input is then feeded in the keypoints detection libraries for getting the coordinates of the body.

Stage 2 : Keypoints Detection
Keypoint detection consists of locating key object parts. For example, the key parts of our faces include nose tips, eyebrows, eye corners, and so on. These parts help to represent the underlying object in a feature-rich manner. Keypoint detection has applications that include pose estimation, face detection, etc.
The landmark model in mediaPipe Pose predicts the location of 32 pose landmarks (see figure below).

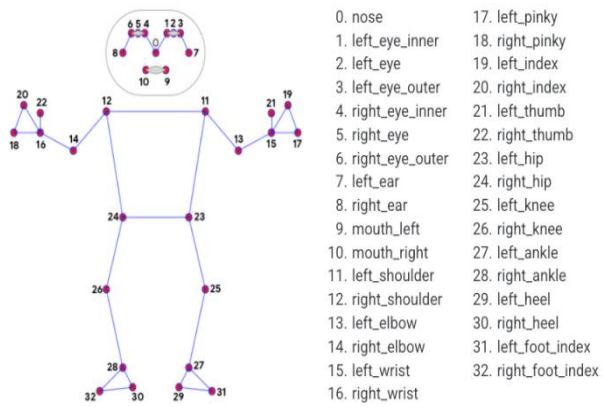

Fig.2 Keypoints of human body identified by mediapipe

Stage 3 : Geometric analysis of keypoints and comparison with dataset

Once the keypoints are detected, geometrical analysis is performed on them. Here the pose is estimated and the results are compared with the keypoints of the ideal yoga postures present in the dataset. If some error exists in the posture our model gives a feedback to the user by both audio and visuals.

4. IMPLEMENTATION

4.1 Dataset Collection

Currently, finding a precise and effective yoga-pose dataset on the web is a challenge in itself. YOGI dataset, which is publicly available dataset comprising of different yoga postures. It is a mixture of both standing poses and sitting poses, it makes use of the whole body in depicting any yoga pose. The poses have a variety of different hand and leg folds. YOGI dataset consist of 10yoga poses which were captured using burst feature of the DSLR camera. The images of these dataset were taken with high precision and accuracy. There are 10 yoga poses, each class containing around 400 to 900 images. The complied Colour Image dataset consists of 5459 images. Yoga-pose of four classes are shown in Fig. 1.

Fig.3. Sample images from YOGI dataset

4.2 Methodology

After collecting the YOGI dataset the following steps were followed as shown in fig.4

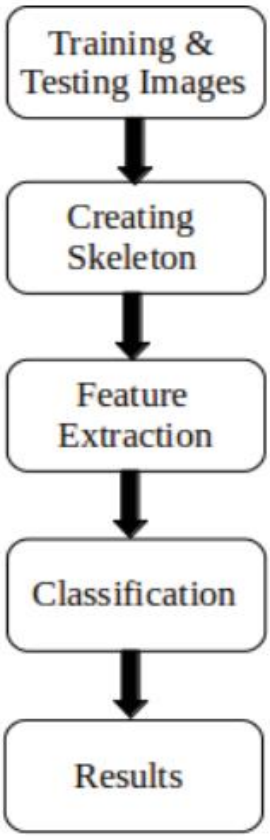

Fig.4 Flowchart of procedure

A. Live streaming from camera

This is the first step of our project. In this step we are required to get the live images of the person performing yoga. For that purpose, we need a camera module. The camera should be of good quality as the captured image should be clear. We are using a 5 megapixel camera in our project . This camera will be placed with our microprocessor board, where the person performs yoga. Now the camera start working and it starts video streaming . Now with the help of opencv we convert the video streaming into images and create the array of images.

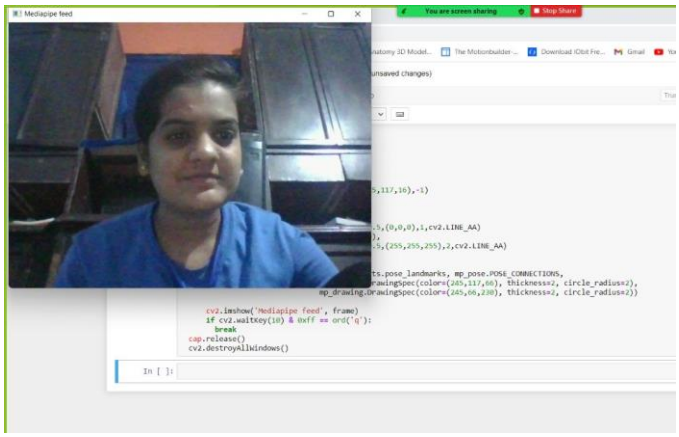

Fig.5 Input image from camera

B. Creating Skeleton

In this stage, the Brightness of every image taken from camera is increased and the parameter enhance was set to a value of 2.0 for uniformity. Followed by this, the new images were resized to 500x500 resolution to best fit the pose estimation algorithm for the accurate and precise outcome. The mediapipe pose-estimation algorithm is used to create a skeleton of the person performing the yoga poses, the algorithm marks each joint of the body and connects it with a skeleton/stick diagram as shown in Fig 6. The algorithm works very accurately in real-time as well.

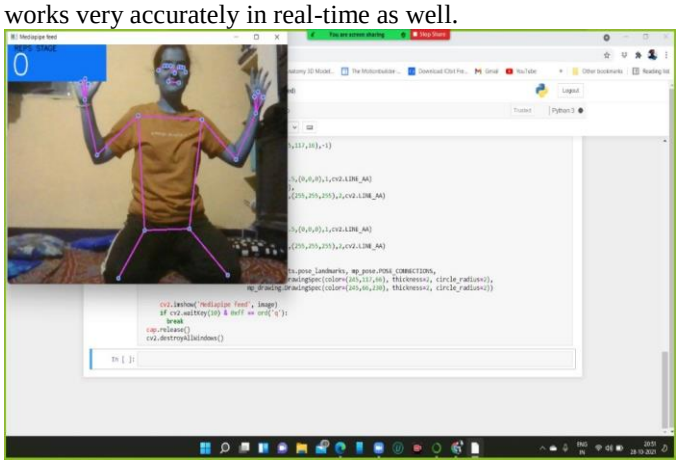

Fig 6. Creating skeleton

Feature Extraction

In the next stage, using mediapipe-estimation algorithm the coordinates of the joints are extracted, the number of joints are shown in Fig 7. The coordinates are used to calculate 12 different angles which will be used as features to detect and correct the yoga poses. The formula for calculating the angle is shown below.

Here's an equation

a^2=b^2+c^2-2bccosA
(1)

Where,

a = Distance between point pl and p2
b Distance between point p2 and p3
c= Distance between point pl and p3
A = Angle made by point p2

To find the distance between two points

a=√〖(xl-x2)〗^2+√〖(y2-y1)〗^2
(2)

Where
(xl. y1) is the coordinate of point pl
(x2.y2) is the coordinate of point p2

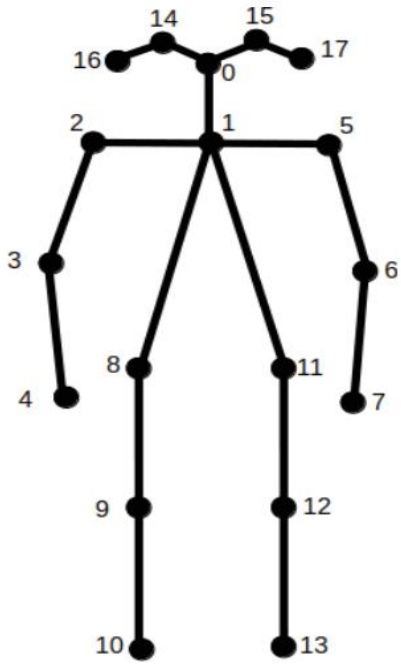

Fig.7. Skeleton

D. Training & Classification

The data obtained after preprocessing was split into 2 groups, 80% for training and 20% for testing respectively. Each model was being trained with 100 epochs on a system with AMD Ryzen 5 3550H, 8GB RAM and 2GB of Nvidia GeForce GTX 1650, which in average took 2 minutes for a single epoch during training. But most models converged early and stopped at an average epoch of 60.

Single model trained with mediapipe's keypoints data was selected as the optimum solution and was integrated to the system. The selected model was able to achieve an accuracy of 99.87% on training data and 99.91% on test data or unseen data. The model has performed close to perfect in most of the poses, In the final stage, the features are stored in a CSV file and labelled accordingly.

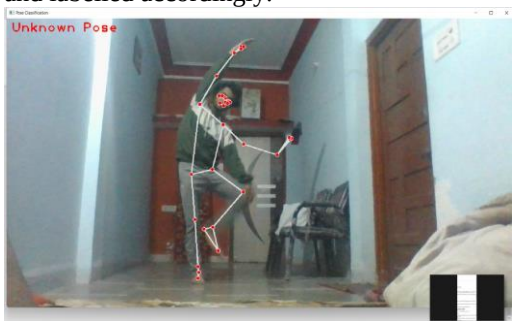

Fig.8 Unknown pose

Fig.9 warrior pose

Fig.10 Tree pose

E. Results

Multiple models were trained with keypoints data obtained from mediapipe and Mask RCNN pose estimation modules to find the optimum module for this system, and it was observed that the model trained with keypoints obtained from mediapipe was able to perform well overall with the least amount of delay when tested with real-time feed. As mentioned above, the model was able to predict with an accuracy of 97.87% for train data and 95.91% on unseen test data. Although individual models created for head, torso and legs had impressive accuracy values, the time taken to predict was higher than the other models.

5. CONCLUSION/ FUTURE SCOPE

5.1 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 a camera module. When the user practices yoga, a live feed is streamed to the server which has multiple modules interconnected to predict and output the asana and the accuracy.

The dataset was trained on multiple models for keypoints obtained from two different pose estimation modules, mediapipe in order identify the most suitable pose estimation module for the current system, when mediapipe was finally selected as the appropriate pose estimation module which was later integrated to the system. Prediction module which consists of a time-distributed CNN layer that extracts spatial features and a LSTM layer which identifies spatial changes with temporal changes. The selected model which uses mediapipe to detect keypoints, achieved an accuracy of 98.87% for dataset used for training and 96.91% for unseen test data. The integrated model also performed exceptionally well when tested in real.

5.2 Future Scope

1. To implement the model using Deep Learning algorithms.
2. To increase the number of yoga postures in the Virtual yoga trainer.
3. To display the accuracy of the yoga posture performed by the user.

REFERENCES

1. M. Gochoo et al., "Novel IoT-Based Privacy-Preserving Yoga Posture Recognition System Using Low-Resolution Infrared Sensors and Deep Leaming," in IEEE Internet of Things Journal, vol. 6, no. 4, pp. 7192-7200, Aug. 2019.

2. M. U. Islam, H. Mahmud, F. B. Ashraf, I. Hossain and M. K. Hasan, "Yoga posture recognition by detecting human joint points in real time using microsoft kinect," 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Dhaka, 2017, pp. 668-673.
Available:
http://ieeexplore.ieee.org/stamp.jsp?tp=&arnumber=8289047 &isnumber=828 8891

3. S.K. Yadav, A. Singh, A. Gupta, et al., “Real-time Yoga recognition using deep learning," Neural Computing & Applications, vol. 31, pp.9349-9361, May 2019.

4. P.K. Borkar, M.M. Pulinthitha, A. Pansare, 2019, "Match Pose – A for Comparing Poses," International Journal of Engineering Research and Technology (IJERT), vol. 08, issue 10, Oct 2019.

5. U. Iqbal, A. Milan, J. Gall, "Pose Track: Joint Multi-person Pose Estimation and Tracking," 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 4654-4663.:

