Feedback Based Posture Correction for Gym Exercises Using Human Pose Estimation

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Abstract

Fitness exercises are good for personal health. However doing 'wrong' or ineffectively can be no good and may lead to injury. There are certain exercises that experts want people to stop due to complications and risk involved in incorrectly performing them. Exercise mistakes are often introduced when users lack understanding about the pose and proper form of the exercise. In our work, we introduce an application that detects the user's exercise, evaluates their pose according to the exercise and provides feedback about the exercise along with the additional feature of exercise tracking at real time.

Objective

- Estimate key joint of human body using Pose Estimation in realtime to detect quality of exercise of a person.
- Provide proper feedback to the user.

Introduction

The process of predicting the location of body part and joints from an image is known as pose estimation. It involves tracing the skeleton system of human body in any visual data. It is also important to note that pose estimation has various sub-tasks such as single pose estimation, estimating poses in an image with many people, estimating poses in crowded places, and estimating poses in videos. It can be used in various areas but our goal is to use in posture correction during gym exercise.

Exercise are very beneficial to the health if done correctly but also can be very dangerous if posture and form is incorrect. Some exercises such as deadlift can cause big accident if form is incorrect. Our idea for this project is to develop a software app which can identify whether the person is performing exercise correctly and give feedback on how to improve form. There is always much more people in gym than trainer so trainer can't keep eye on everyone. That might cause problem for those person who are not being focused by the trainer at that moment. Our software,SmartTrainer, will try to minimize that problem by monitoring those people and giving them proper feedback.

Theory

This project implemented the Human Pose Estimation to correctly predict the keypoint on the human body for further analysis.

[1]OpenPose using CNNs produces all the keypoints coordinate and confidence in json format.

[2] CNN is a type of Neutral Network which uses convolution layer as a hidden layer which can detect patterns in the given input. CNN helps to find major key points of human body from the given input video dataset.

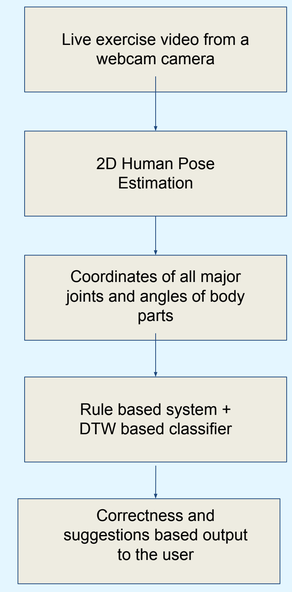
[3] Dynamic Time Warping(DTW) finds the similarities between two different time series of different duration which can be used to compare two different video sequence.

Methodology & System Setup

This project has mainly two parts, 2D Human Pose Estimation and Exercise correction detection. Real time video of an exercise is captured from the webcam camera of the user's device. This RGB format video/image sequence is fed into the OpenPose based 2D human pose estimation model. The video will be such that the person performing an exercise routine is clearly visible. Pose estimation is performed to get the detailed pose data: data about the x,y coordinates and visibility of 15 key joints in the body.

This data is used to calculate the required angles of different parts of the body according to the exercise (Eg. Upperarm forearm angle). The result is then fed to a rule based system as well as a classification and comparison based system to analyze the exercise routine. Four exercise types are supported: bicep curl (side view camera orientation), bicep curl (front view camera orientation), push-ups and shoulder press.

If the exercise is performed correctly, the repetition count of the exercise is automatically recorded and displayed in the user interface of our application. If not, then feedback is generated to notify the user and display the appropriate steps for correction. All the correct and incorrect repetitions of the exercise are tracked along with the feedback for incorrect sequences. The progress of the individual exercise is also stored in a database for a complete log of history. The replays of incorrect exercises can also be viewed from the user interface.



Results and Analysis

For human pose estimation, we tested different models such as OpenPose and BlazePose. OpenPose yields best result among the estimation models. Similarly, the results for exercise correctness classification and feedback generation were based on the rules and thresholds which we formulated through detailed geometric analysis. The following results were seen:

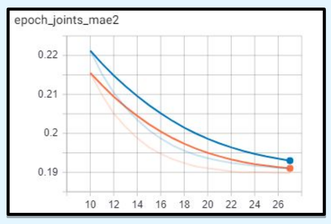


Fig.: Loss graph on BlazePose Model

Fig.: OpenPose Result on Bicep Curl Exercise

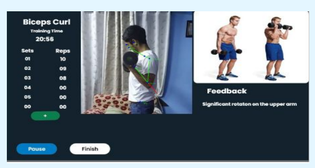


Fig.: Final Feedback System

	precision	recall	f1-score	support
correct	0.80	1.00	0.89	4
incorrect	1.00	0.67	0.80	3
avg / total	0.89	0.86	0.85	7

Fig.: DTW Classifier on Bicep Curl Exercise

OpenPose yields great result on standard dataset COCO. For exercise evaluation, DTW classifier produces a great result on classifying correct and incorrect exercise, for example, for bicep curl exercise, it correctly predicts 80% of incorrect exercises as incorrect. Feedback system is a heuristic system, upon visual examining, feedbacks provided by the system are all according to the rules that we have implemented ourselves. Since, pose estimation for exercise and fitness field is still a hot topic for research, advancement on it will produce even better results on feedback systems in the future.

References

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Biography

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Conclusions

We have developed an end to end application that uses computer vision for pose estimation to check correctness of exercise form and provide personalized feedback. Pose estimation is applied to evaluate the exercises video to generate the key points. The keypoints are then processed by a rule based system to check the correctness of exercise pose. Exercise pose is classified correct and incorrect by the evaluation system and correct feedback is selected provided to the user in case of incorrect exercise pose. This application can be developed into a product by adding more exercises and improving the quality of feedback.

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