Posture Recognition And Correction In An Active Training Scenario

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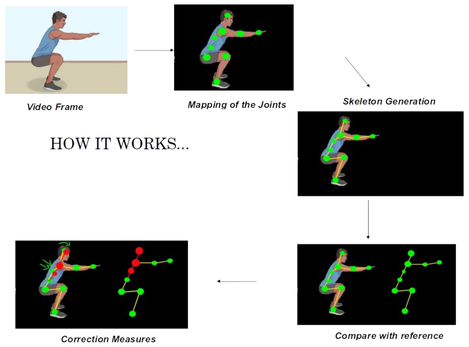
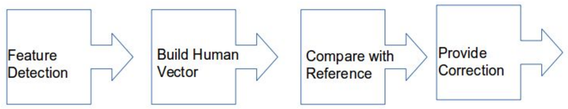
Abstract

In any sport or weight training session, the posture maintained by the person is most important, not only to ensure that the person performs his best, but also to ensure their safety. This is not usually a concern when the person trains under a trained professional, who ensures that the person is maintaining the correct posture.But in a self-taught session, the person training who in most cases is an amateur, may end up severely injuring himself. In this project we aim to develop a platform that checks if the person training is maintaining the correct posture, and in case he is not doing so, provide the corrections necessary.



Methodology



Feature Detection:

- It mainly deals with obtaining silhouettes of the human body and possible key points.
- The most important evaluation key points for feature detection are Viewpoint change, Dimensional change and Brightness.
- The methods used to detect the said features are edge detection, corner detection and blob detection.
- The features could also be evaluated using Feature Descriptors such as SIFT,SURF and ORB.

Build Human Vector:

- The silhouette of the human body on its own is not sufficient to provide us with the key points for human pose estimation.
- The human pose estimation method should build a human vector or a skeleton on top of the human body whilst marking of necessary key points.
- In image processing approach, the image is reduced to a skeleton of itself. This action is performed on the silhouette obtained from the previous stage.
- The deep learning approach uses datasets which contains the joints important for pose estimation.

Compare with Reference:

- The main focus while comparing the test with the reference model is to check the angles between the joints of interest.
- Hough Transform is a popular technique which we use to detect lines, if it is represented in mathematical form. It can detect the even the slightest distortion of the line.
- Co-ordinate Method uses the co-ordinate axes values to determine the angles of various line segments on the human vector.

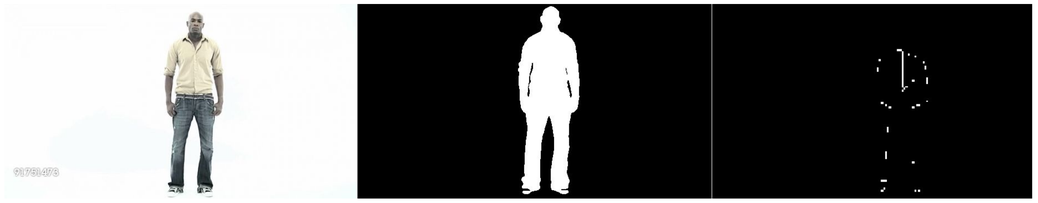
Provide Correction:

- After obtaining the angles between various joints, the user can run the video of the required squat, obtain the frames with the lowest point of the exercise and the angles obtained from these frames are compared with an ideal reference.
- The user then gets the feedback of whether the posture is a good or a bad one along with necessary angles and the correction is provided for a bad posture so as to make the pose as ideal as possible.

Analysis

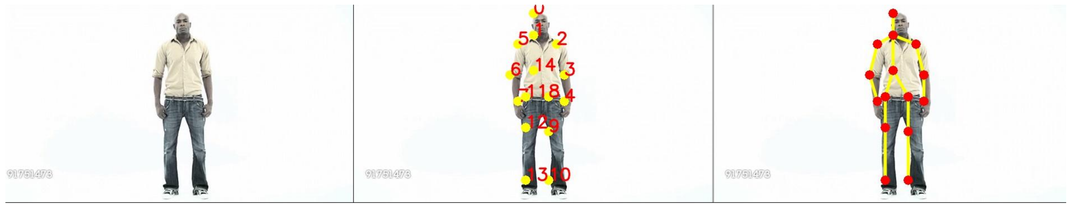
Image Processing Approach :

- Skeletonization is a preprocessing operation which reduces the foreground in a binary image to binary objects that are 1 pixel wide.
- This conserves the original region's connectivity while discarding most of the original foreground.
- It also provides region-based shape features.
- There are three major skeletonization techniques: Skeletonize, Medial Axis Skeletonization,Morphological thinning.
- The two requirements to be fulfilled in order to render a "true skeleton" are: Topological , Geometrical.
- In order to obtain a perfect skeleton, a perfect silhouette needs to be achieved. Achieving the perfect silhouette is not guaranteed every time which hinders the implementation range of this approach .

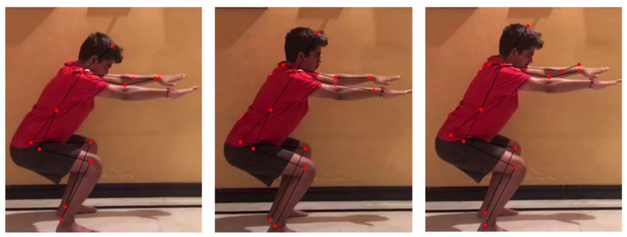


Deep Learning Approach :

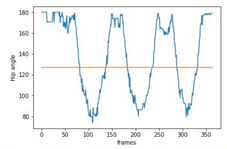
- The top-down approach utilizes a detection module to identify humans and then apply the pose estimator for a single-person to locate the key points on the human body.
- The bottom-up approach detects human key points from all probable human nominees and then combines these key points into each individual's limbs based on numerous data association techniques.
- One such example of bottom up approach is OpenPose .
- It is a bottom-up depiction of "association scores via Part Affinity Fields (PAFs)", a set of 2D vector fields that encode the position and direction of limbs over the image domain.
- The system takes a color image of size l × b as input and produces the "2D locations of anatomical key points" for the detected human in the image as output.
- A "feed- forward network" concurrently estimates a set of "2D confidence maps S" of the locations of different body parts and a set of "2D vector fields L of part affinities", which provides the extent of part linkages.Inside the network , the blobs from the image is under scrutiny of this process.
- Lastly, the affinity fields and the confidence maps are parsed by greedy inference to output the 2D key points.
- This algorithm is implemented on the MPII dataset which has 15 key points on the body .



Results



SQUATS

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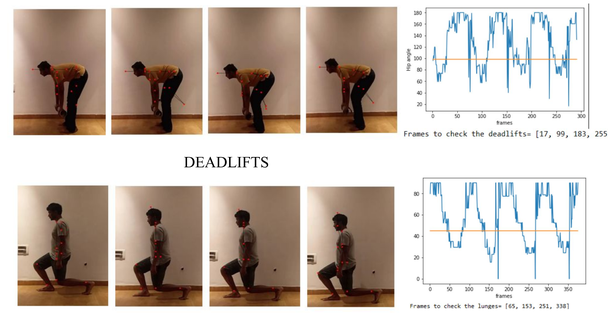
Frames to check the squats= [109, 210, 310]

 [9.614569270900958, 88.15412283615896, 84.85764045905742, 9.413414170810924,
46.89651830320929, 56.64597424848321]
Good Squat!
Just 9.413414170810924 degrees for a perfectly straight back
Hip angle= 46.89651830320929
Maintain the knee angle around 70 degrees
Knee angle= 56.64597424848321

 [9.754999821838268, 86.38081550819919, 83.08433313109765, 9.272983619873614,
52.71548920460387, 69.78937870988113]
Good Squat!
Just 9.272983619873614 degrees for a perfectly straight back
Hip angle= 52.71548920460387
Knee angle= 69.78937870988113

 [4.7390723185129815, 81.16516960695667, 87.48325650075608, 20.25436179424178,
51.9641449213743, 76.23257458917114]
Good Squat!
Just 4.7390723185129815 degrees for a perfectly straight back
Hip angle= 51.9641449213743
Knee angle= 76.23257458917114
```

Results



DEADLIFTS

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Frames to check the deadlifts= [17, 99, 183, 255]
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LUNGES

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Frames to check the lunges= [65, 153, 251, 338]
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The same has been implemented for bridges and planks.

Discussions

- The image processing approach fails because the keypoints obtained using feature descriptors are not at desired locations,feature matching techniques gives many outliers, the skeletal build depends on the quality of the silhouette and does not pass through our desired keypoints and the total computational cost is high .
- The OpenPose algorithm based on deep-neural network was sparse and robust and required minimal adjustments for implementing on our platform.
- It made use of certain aspects of the image processing approach and utilized this to obtain the human vector with the highest accuracy possible.
- In order to determine if the person's posture was improper or not, we added extra functionality to provide us with the angles made by the various parts of the body such as the angle between the torso and thigh, the angle between the thigh and the shin.
- With the additional functionality of angle measurements, we were able to track the body movement of the person, and were able to determine what parameters would constitute a good posture.
- Once these parameters were obtained, we were able to determine if the person's posture was proper or not and provide corrections necessary to get the proper posture.

Future Work

- The OpenPose algorithm can be used in the medical field for rehabilitations and in the field of sports and fitness.
- In future, an implementation of OpenPose on a mobile platform will enhance its usage and have widespread impacts similar to HomeCourt.
- To increase the usage of the algorithm, work can be done for pose classification merely from the skeleton, and further incorporating this into the pose tracking and correction. This will make the algorithm universal and not restricted to identification of a set of poses.

References

[1]Z. Cao, T. Simon, S.-E. Wei and Y. Sheikh, "Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields," *CoRR,* vol.abs/1611.08050, 2016.
[2]M. Hassaballah, A. Ali and H. Alshazly, Image Features Detection, Description and Matching, 2016.
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