Smart Gym Trainer

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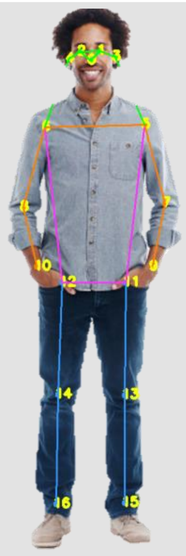
Abstract

The most important details in this text are that 80% of people make mistakes while exercising, and that there is an acceptable form for exercising. An application could replace the personal coach with a body skeleton that can count for the correct counts while the exercise is being done, and that at the end of every set, the program will evaluate the set and determine what can be done to boost trainee performance. For example, the program should count when the trainee pushes his hips back and then stands up again to the normal position, while his neck and back are in one line.

Introduction

- Many diseases such as stroke, metabolic syndrome, and arthritis. can be prevented by performing regular exercise as it helps improve cognitive function. It improves your mood and boosts your energy.
- YOLOv7 is an application that detects keypoints as it helps me to map trainees to their correct form and evaluate every set, giving them a warning when they do something wrong. This ensures that the trainer knows how to do the exercise correctly.
- The main objective of this project is to develop a machine learning application using YOLOv7 and to help trainees perform the exercise in the right from. According to many professional coaches, there is no perfect form, but we are trying to increase it as much as possible to avoid injuries.

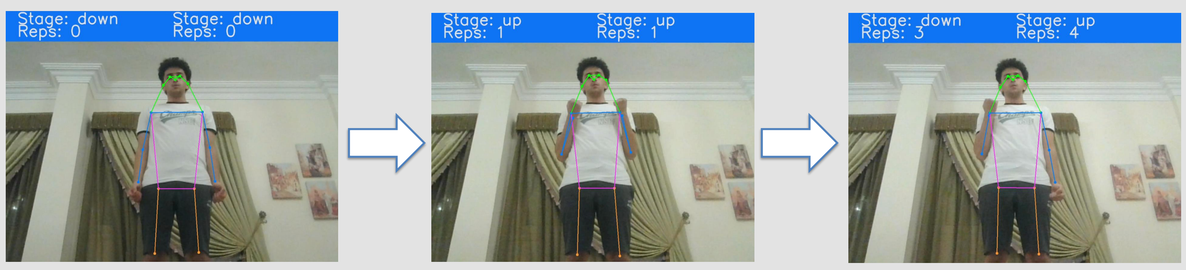


The displayed picture is the pre-trained keypoints detection with numbering each body joint with yolov7-w6-pose.pt.

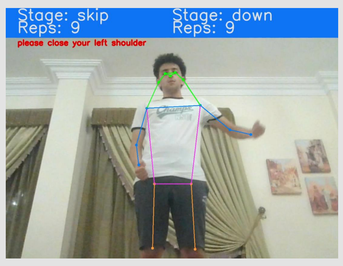
A. Nazir and M. A. Wani, "You Only Look Once - Object Detection Models: A Review," 2023 10th International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, 2023, pp. 1088-1095.

Results

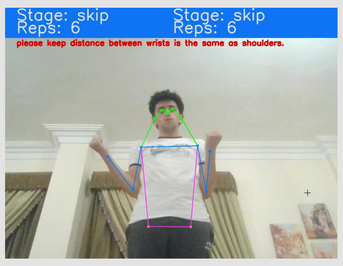
Biceps Curl:



- To do the exercise correctly, start with your arm at a 180-degree position. Bend your arm until the required 30-degree angle is reached. Keep the distance between your wrists equal to or wider than the distance between your shoulders, while keeping shoulder angle within the threshold.

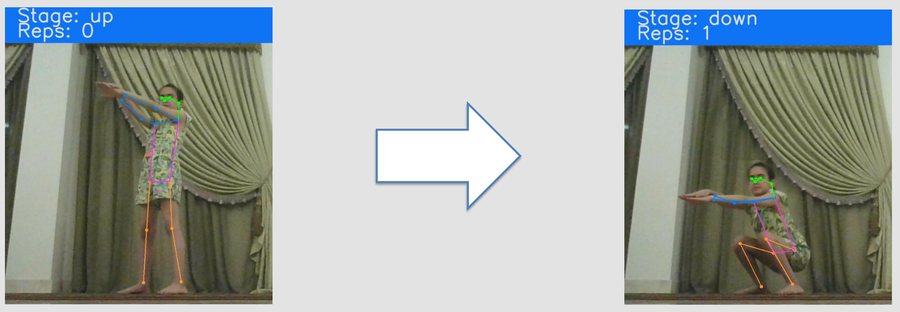


- Exceeding left Shoulder Angle Threshold that prevent the trainee from completing the count.

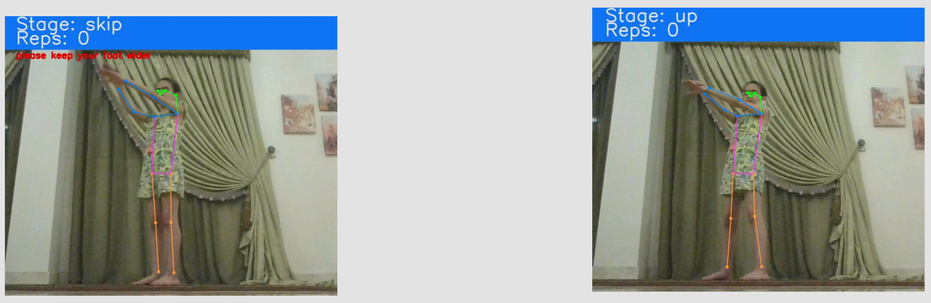


- Exceeding Distance Between Wrists that prevent the trainee from completing the count.

Squats:

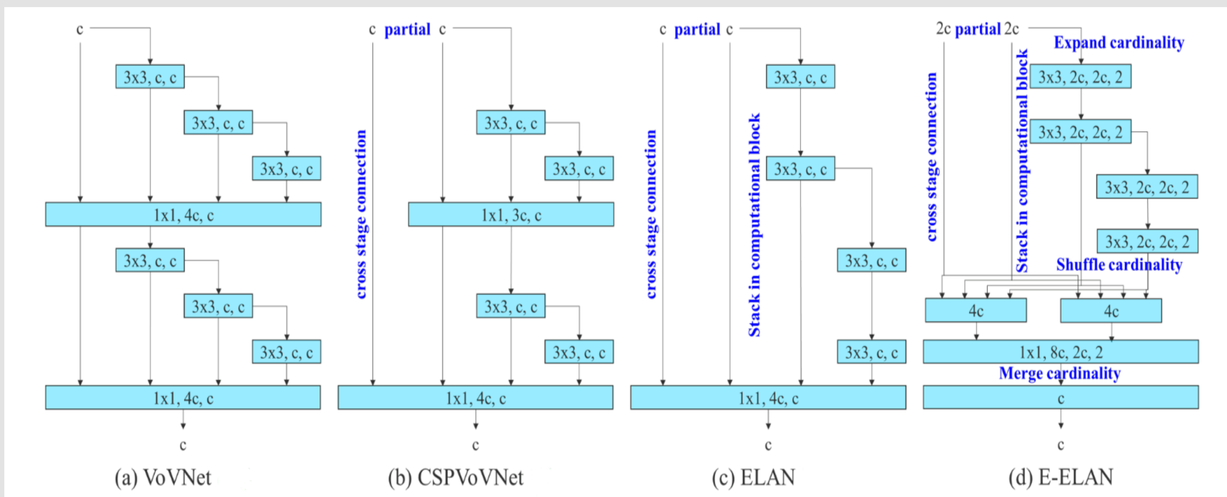


- Squats target leg strength through body resistance exercise. Starting from standing position with 180-degree knee and hip angle, counts as the subject bends both knees and hips until their buttocks pass parallel to the ground.



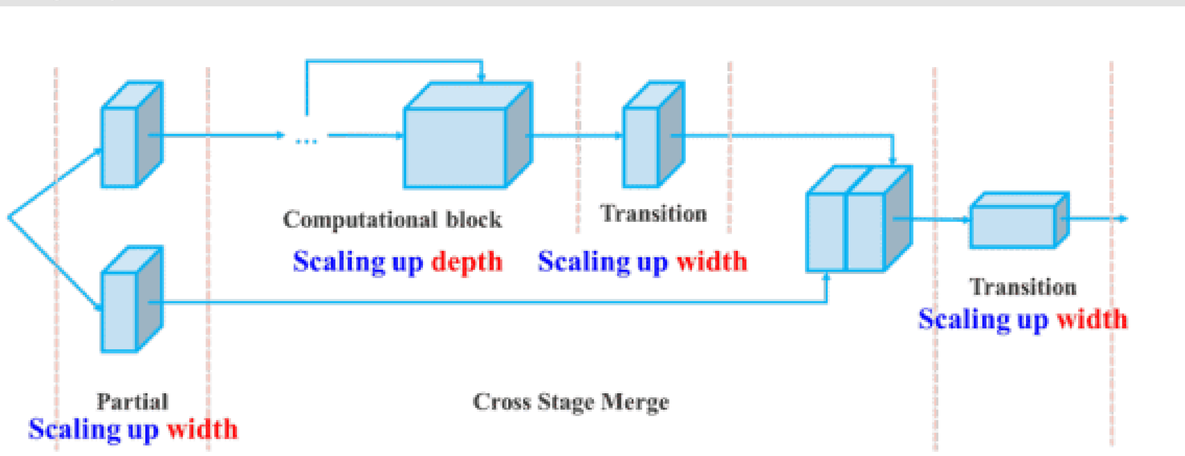
- Trainee's legs should be wider than their shoulders with a slight gap, as depicted in the figure above. As the distance between the trainee's ankles was insufficient, they had to widen their legs slightly to meet the requirement.

YOLOv7 Architecture



E-ELAN

- Factors and techniques in creating effective neural network topologies include number of parameters, computing power, computational density, and other factors that affect network inference speed. Model scaling, shortest and longest gradient route control, and cardinality strategies can boost network learning capacity. Extended-ELAN (E-ELAN) expands on ELAN by altering computational block design, using group convolution and shuffle-fling merged cardinality to boost cardinality of additional features. The gradient of the original architecture is not changed by this.

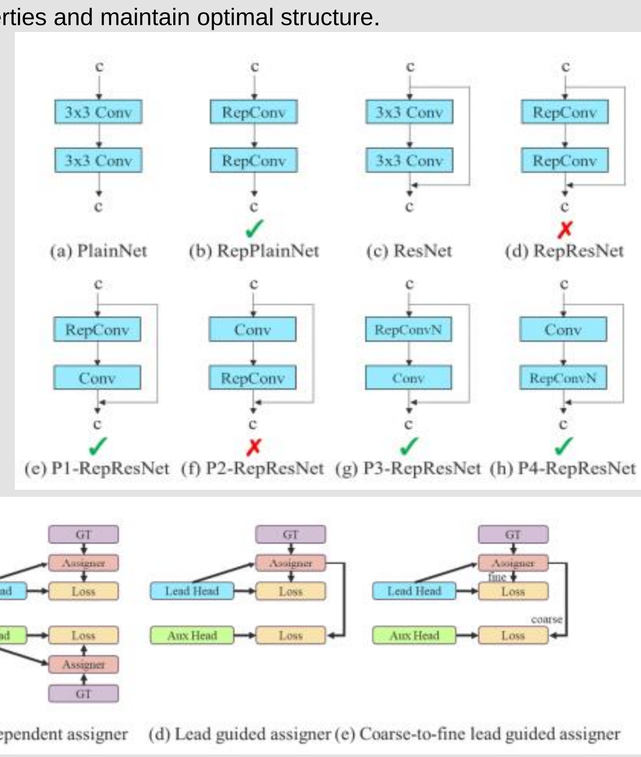


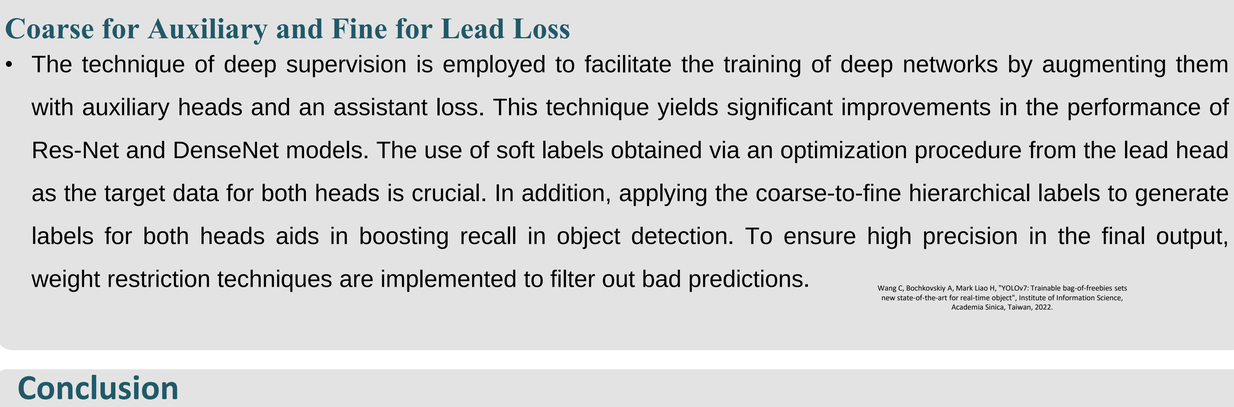
Model Scaling for Concatenation-Based Models

- Model scaling for concatenation-based models involves adjusting various attributes to generate models of different scales. Width, depth, resolution, and stages are considered for scaling. Vanilla and group convolutions' influence on width and depth scaling is analyzed. Scaling factors impact each other in concatenation-based models, requiring simultaneous consideration of different scaling factors. A compound model scaling method is proposed to preserve the model's initial design properties and maintain optimal structure.

Planned Re-Parametrization Convolution

- RepConv's accuracy is lower on ResNet and DenseNet than on VGG, so gradient flow propagation routes were used for intentional re-parameterized convolution. Identity connections in RepConv cause issues with residual in ResNet and concatenation in DenseNet, making gradients for feature maps less diverse. RepConvN, which doesn't have identity connections, was proposed as a solution and was used on PlainNet and ResNet.





Coarse for Auxiliary and Fine for Lead Loss

- The technique of deep supervision is employed to facilitate the training of deep networks by augmenting them with auxiliary heads and an assistant loss. This technique yields significant improvements in the performance of Res-Net and DenseNet models. The use of soft labels obtained via an optimization procedure from the lead head as the target data for both heads is crucial. In addition, applying the coarse-to-fine hierarchical labels to generate labels for both heads aids in boosting recall in object detection. To ensure high precision in the final output, weight restriction techniques are implemented to filter out bad predictions.

Wang C, Bochkovskiy A, Mark Liao H, "YOLOv7: Trainable bag-of-freebies sets new state-of-the-art for real-time object", Institute of Information Science, Academia Sinica, Taiwan, 2022.

Conclusion

- This project aims to develop a machine learning application using YOLOv7 to help trainees perform exercises in the right form. It is divided into four parts: Extended efficient layer aggregation network (E-ELAN), Model scaling, Planned re-parameterized convolution and Coarse for auxiliary and fine for lead loss. YOLOv7 detects keypoints of human for each frame and calculates angle between body joints using arctan2, as well as distance between two points using Euclidean theorem. The main goal and passion is to save people from injuries.