

# Smart Gym Trainer



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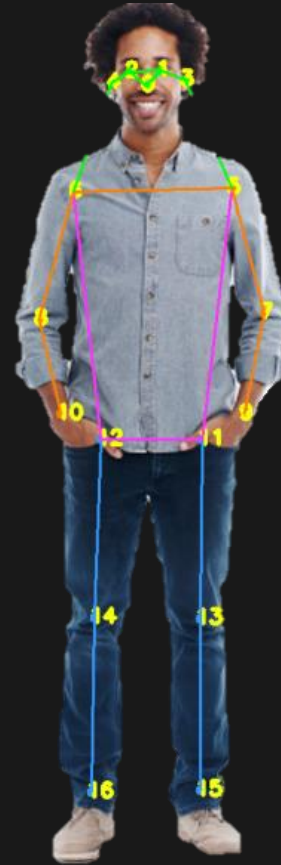


## Problem statment

Regular exercise is crucial for good health and fitness, which can be accomplished by going to a gym. However, it's important to keep in mind that improper execution of exercises can lead to injuries, some of which may go unnoticed.

# Methodology!

The objective of this project is to create a suitable workout plan that includes three essential stages: feature extraction, angle calculation using the  $\arctan2$  method, and distance measurement using the Euclidean concept. Moreover, the user will receive an audio feedback, narrated by voice-over script, informing them of their performance in case any faulty techniques are detected by the system.



# USED TOOLS

POSE ESTIMATION

Python

Is a high-level programming language, easy to learn, read and write.

YOLOv7

An object detection algorithm that uses PyTorch as its base for coding.



COCO

A large-scale object detection, segmentation and captioning dataset



## RELATED WORK



### MOTION TRACKING

Microsoft utilizes 3D HPE to monitor the movement of the human players and convert it, to display digitally in the game world.



### YOGA POSES TRAINER

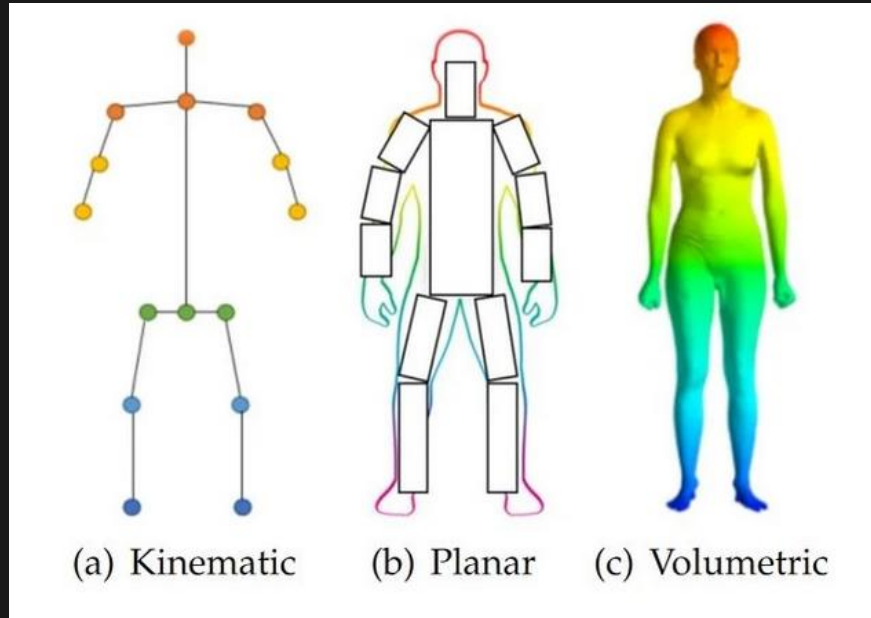
An AI-based technology assists in recognizing yoga poses and offer users feedback or recommendations.



### HUMAN POSE ESTIMATION

Many papers have discussed the differences between different body modeling which are kinematic, Planer Volumetric.

# MODELS FOR HUMAN MODELING





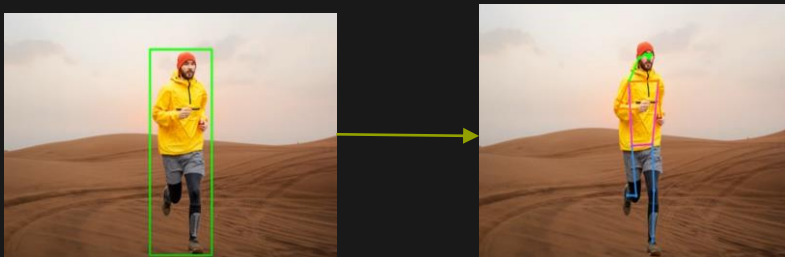
# What is YOLOv7!

YOLOv7 is a real-time object detector in a single-stage, as its acronym YOLO means "you only look once", detecting pose estimation for each frame only once. It's a recent addition to the YOLO family and integrates both Top-Down and Bottom-Up approaches for detecting human key-points.





# Top-Down VS Bottom-Up

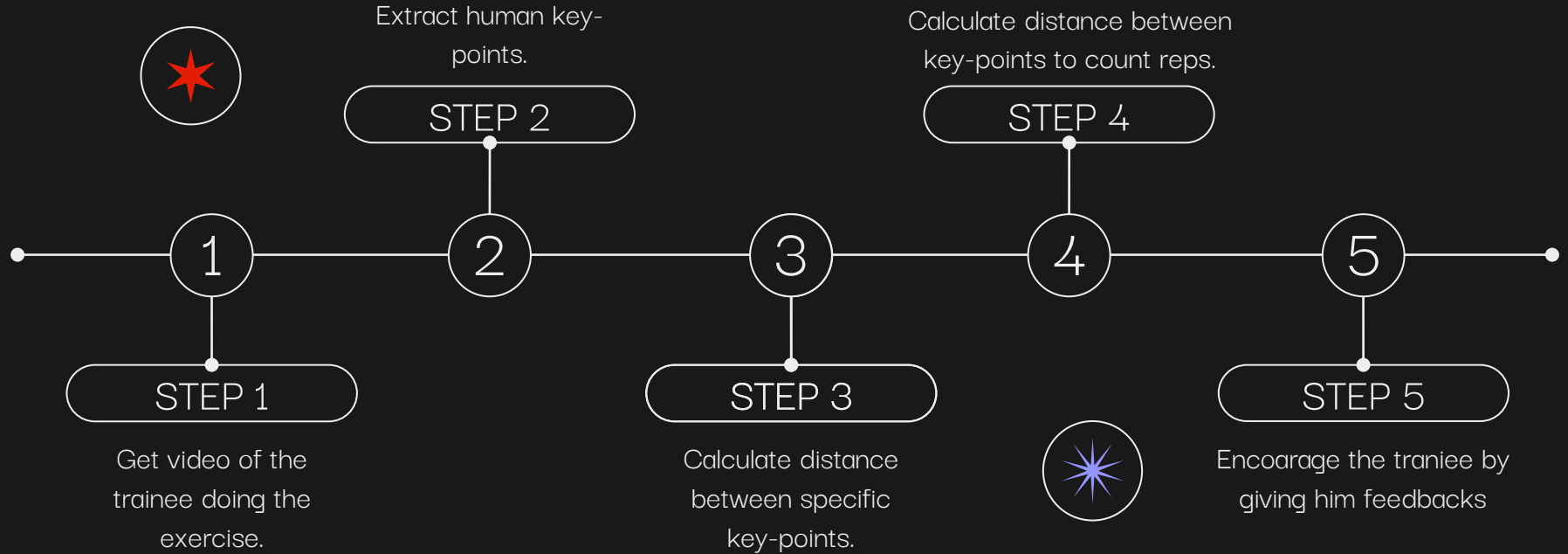


Top-Down method involves detecting individuals in the image and then locating their key-points using these bounding boxes. While it can yield an accurate outcome, it might become sluggish when there are multiple people in the frame.



the Bottom-Up approach uses heat maps to find key-points, then uses grouping algorithm to map the key-points for every person. As it is a single stage, so it is fast, but it won't be very accurate in case of crowded scenes.

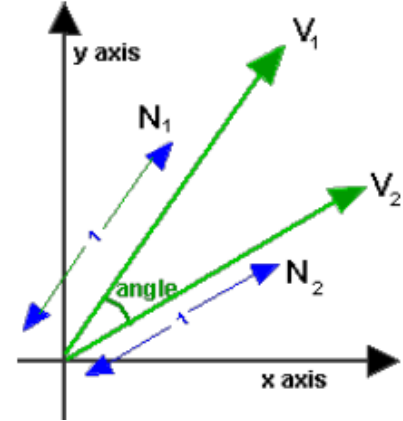
# PROJECT STAGES!





# Atan2 Equation

- For each key-point we extract from the frame has its unique number. Which consists of (x, y).
- The Atan2 equation output is the angle between the x-axis and the vector.
- The equation is applied to both vectors that need to be calculated.
- After we have calculated the angle between both vectors in radian, I have converted it into degrees for better representation.
- By using Atan2, we can calculate angles between key-points to count trainee reps.

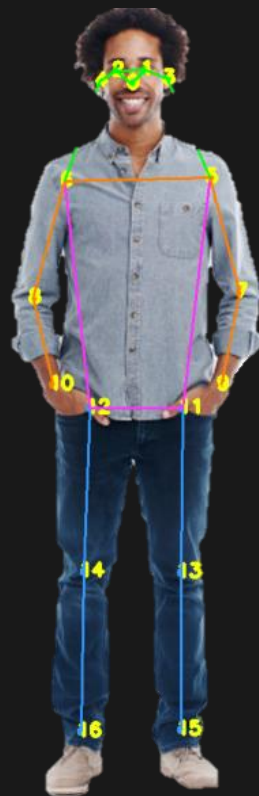
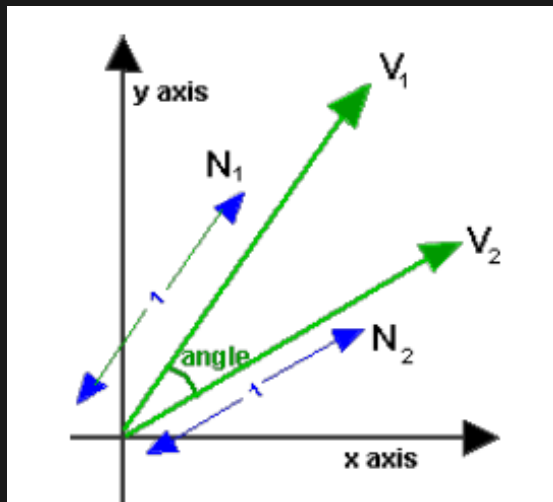


$$V2 = \text{Atan2}(y3-y2, x3-x2)$$

$$V1 = \text{Atan2}(y3-y2, x3-x2)$$

$$\therefore \text{new } \theta = V2 - V1$$

# POSE ESTIMATION LANDMARKS





# Euclidean Theorem

- Euclidean theorem has been used to calculate the distance between two key-points.
- Each extracted key-point from the frame has a unique number represented by (x, y).
- Through application of the Euclidean Theorem, I verify that the trainee is adhering to the prescribed guidelines.

$$d(p, q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2}.$$

# Results



- Biceps Curl exercise
  - Proper form
  - Improper form
- Squats exercise
  - Proper form
  - Improper form
- Push up exercise
  - Why it is Hard to Implement Push Up Exercise using YOLOv7?

# Biceps Proper form

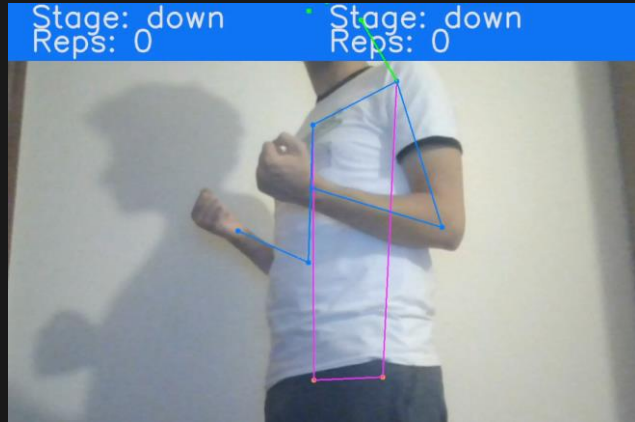


This explains how to perform the exercise properly with a 180-degree arm position and a required ROM. The wrist distance should be equal to or wider than the shoulder distance. After completing 10 counts, a message appears congratulating the trainee.





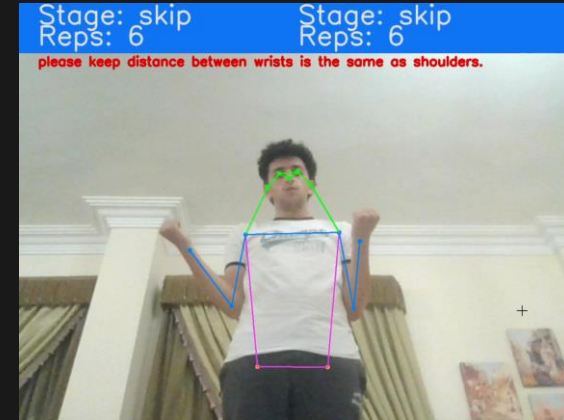
## Cutting ROM



## Exceeding Shoulder Angle Threshold

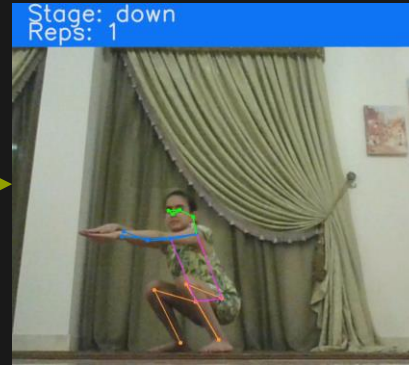
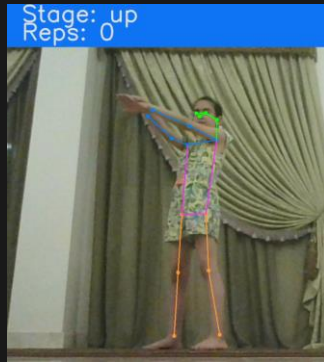


## Ensure Distance Between Wrists





# Squats Proper Form



Squats workout targets leg strength. Starting from standing up position with 180-degree knee and hip angle, the exercise begins counting when knees and hips are bent until the buttocks pass parallel to the ground.



## Cutting ROM

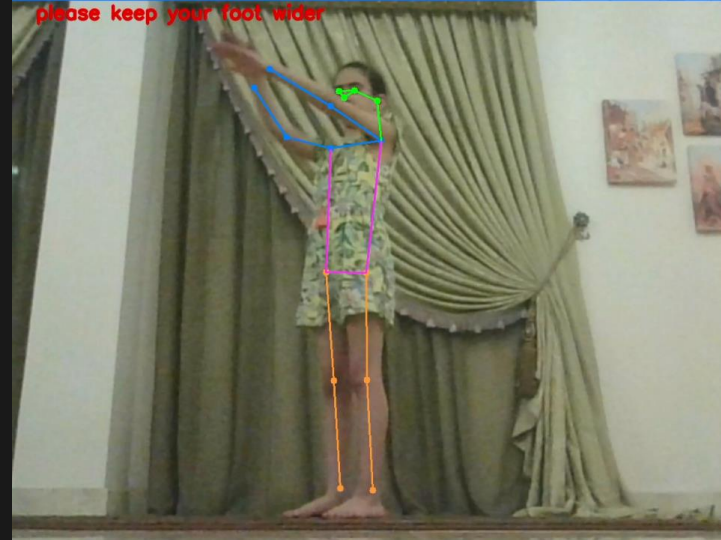
Stage: down  
Reps: 6



Ensure Distance Between  
Ankles

Stage: skip  
Reps: 0

please keep your foot wider

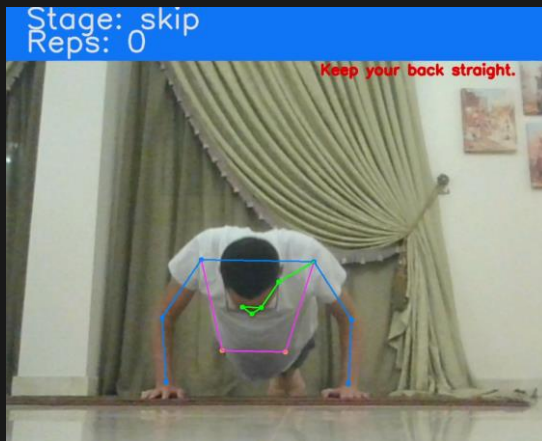


# Complication



## Why it is hard to implement push up?

To properly detect body parts during push up exercises using YOLOv7, two solutions are possible: using an algorithm that utilizes 3D to extract key-points accurately or using multiple cameras to capture vectors perpendicular to the body.





THANK YOU,  
ANY QUESTIONS!