Pose Based Form Correction Trainer

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INTRODUCTION

- Good form when performing any exercise is immensely helpful for targeting specific muscle group effectively and minimizes strain and injury
- We propose Form Correction Trainer, which helps beginners maintain correct form when performing any physical exercise or activity while also being more easily accessible.
- Form Correction Trainer will first correctly identify the predicted key-points of the person in the webcam.
- Then we will verify if the form of the exercise being performed by the user is correct.
- Finally, we give the user useful feedback on their poses specific to the joints they are doing incorrectly so that they can improve their form. This whole application is designed to be easily accessible to users performing their exercises in different environments such as their home, gym or a field.

ARCHITECTURE

- Input
  - webcam or a prerecorded video.
- Pose Estimation Module
  - MediaPipe framework for estimating key points and pose in our video input.
- Form Verification Module
  - Angle Evaluation : We calculate the angle between relevant key points depending on the exercise being performed in this method.
  - Machine Learning Approach : K Means Clustering
- Form Correction Module
  - Incorrect joint detection + Improvements that needs to be made on the user form.

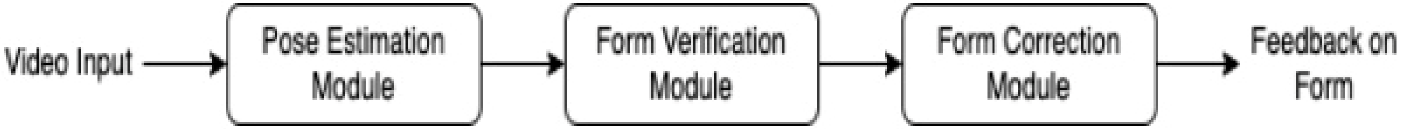
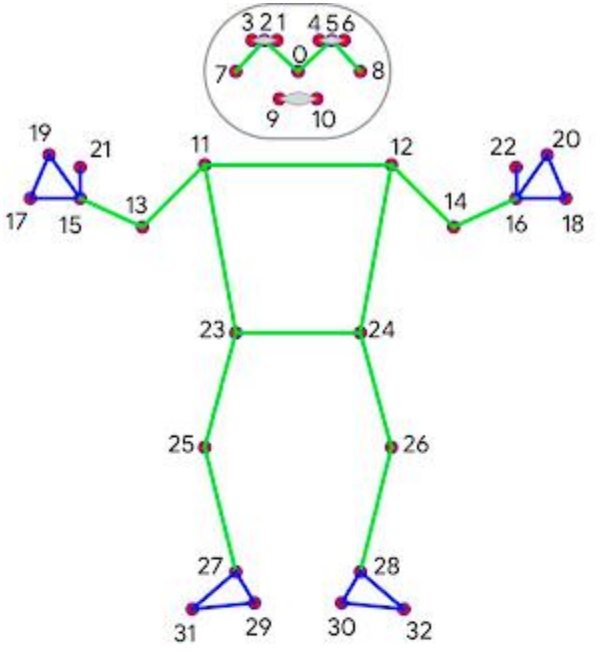


Figure 1. Form Corrector Pipeline

METHODOLOGY

- We use a Machine Learning Framework called MediaPipe for our Pose Estimation task
- MediaPipe utilises BlazePose for skeleton keypoint extractions. It infers 33 pose landmarks spread across the torso, arms, legs, and face and background segmentation mask on the entire body.
- It provides more pose landmarks and accurately localises keypoints making it suitable for fitness applications.



0. nose
1. right eye inner
2. right eye
3. right eye outer
4. left eye inner
5. left eye
6. left eye outer
7. right ear
8. left ear
9. mouth right
10. mouth left
11. right shoulder
12. left shoulder
13. right elbow
14. left elbow
15. right wrist
16. left wrist
17. right pinky knuckle #1
18. left pinky knuckle #1
19. right index knuclke #1
20. left index knuckle #1
21. right thumb knuckle #2
22. left thumb knuckle #2
23. right hip
24. left hip
25. right knee
26. left knee
27. right ankle
28. left ankle
29. right heel
30. left heel
31. right foot index
32. left foot index

METHODOLOGY

Form Verification can be done using two approaches:

1. Angle Evaluation:

- We calculate the angle between relevant key points depending on the exercise being performed.
- We first collect references for the correct form for our exercises through multiple online exercise resources.
- Then we performed experiments to determine angle threshold for joints pertaining to each specific activity.

2. Data centric:

- We’ve utilised classification via machine learning approach to identify the relation between the keypoints/joints.
- Here Input is a sequence of angles between the targeted keypoints/joints at every time step.
- Euclidean distance is used to measure the distance between two keypoints for similarity calculation

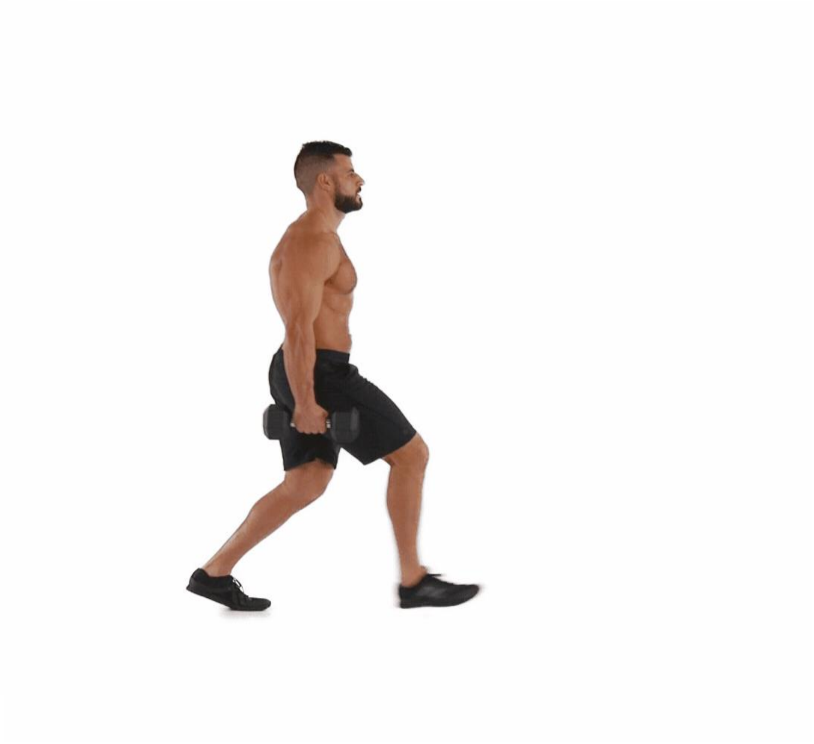
Angle Evaluation

For bicep curl, we use

- Elbow, shoulder and hip - shoulder angle
- Shoulder angle **>=** 35° **-** avoid excess arm rotation.

For Lunges, we use be

- Knee (Hip, knee and ankle) angle >= 80° - avoid excess knee bending



RESULTS

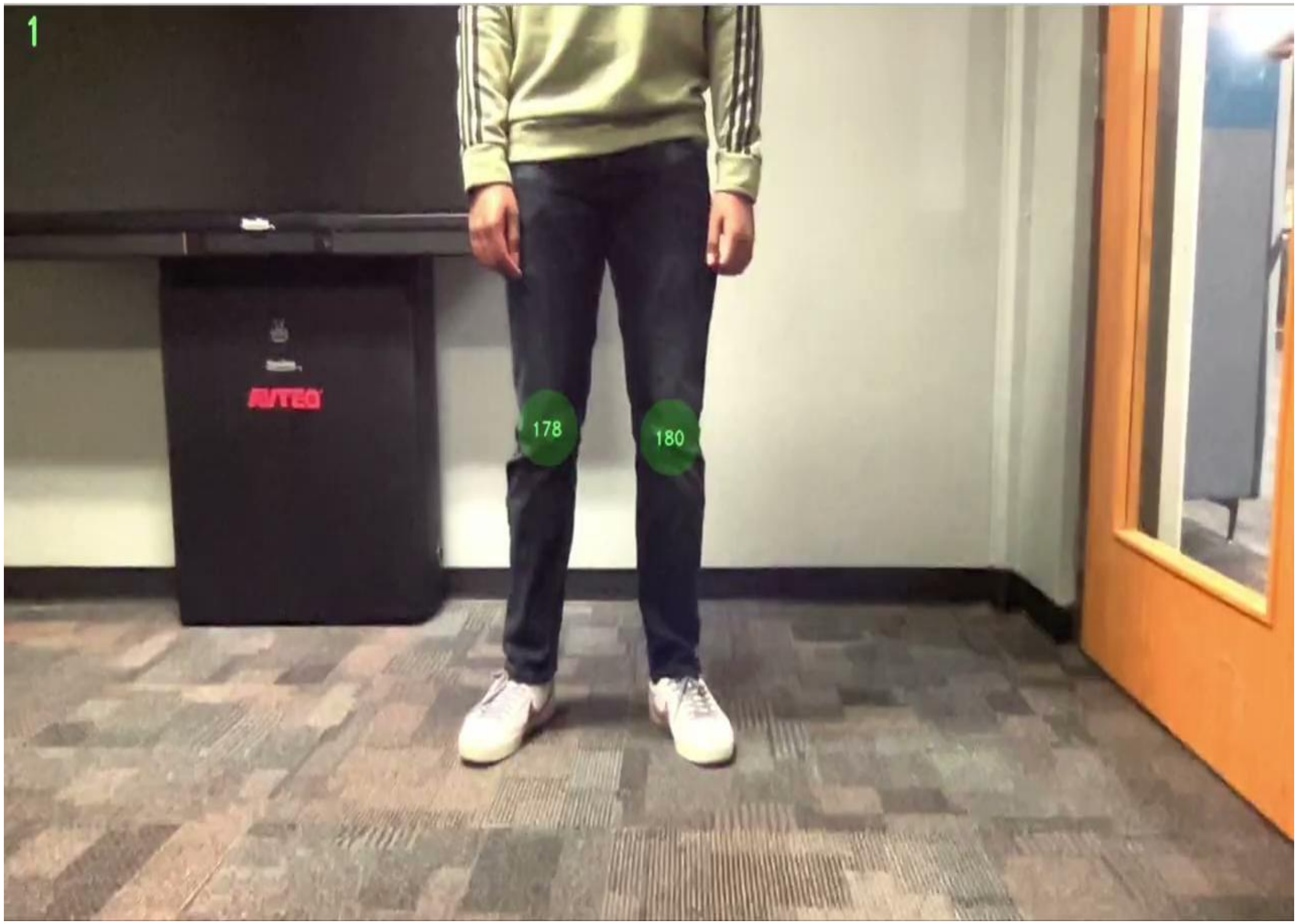
Demo:

- Bicep Curl

RESULTS

Demo:

- Lunges



Data Centric Approach

- Video clips of 1 repetition of particular exercise are collected.
- Angles between the targeted keypoints/joints for a particular exercise are recorded for each time step.
- The resulting sequences are of different lengths since repetition of each exercise have varied time of completion.
- Euclidean distance is used to measure distance between keypoint vectors
- Lastly, we’re using KNN Algorithm to segregate the wrong and correct pose classes for each exercise.

CONCLUSION

- We can see that Pose Based Form Correction Trainer accurately verifies the form of users and provides constructive feedback. We use geometric angle evaluation methods to detect any deviations in proper form and highlight the joint in the camera video for correction.

- With in-depth data analysis and more suitable machine learning algorithm we can develop models which would accurately classify the poses without explicitly coding the relationships between the targets.

- We plan on extending our model to include more variety of exercises of varying complexities. We can also include other physical activities such as yoga and weightlifting and extend our model capabilities to allow multiple person pose estimation.