Pose Trainer: Correcting Exercise Posture using Pose Estimation

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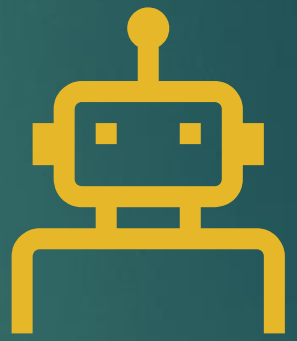
Introduction

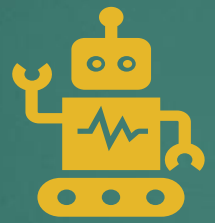
Problem Statement: Incorrect exercise posture can lead to injuries and reduce the effectiveness of workouts



Objective: Develop a system that uses pose estimation to correct exercise posture

Methodology

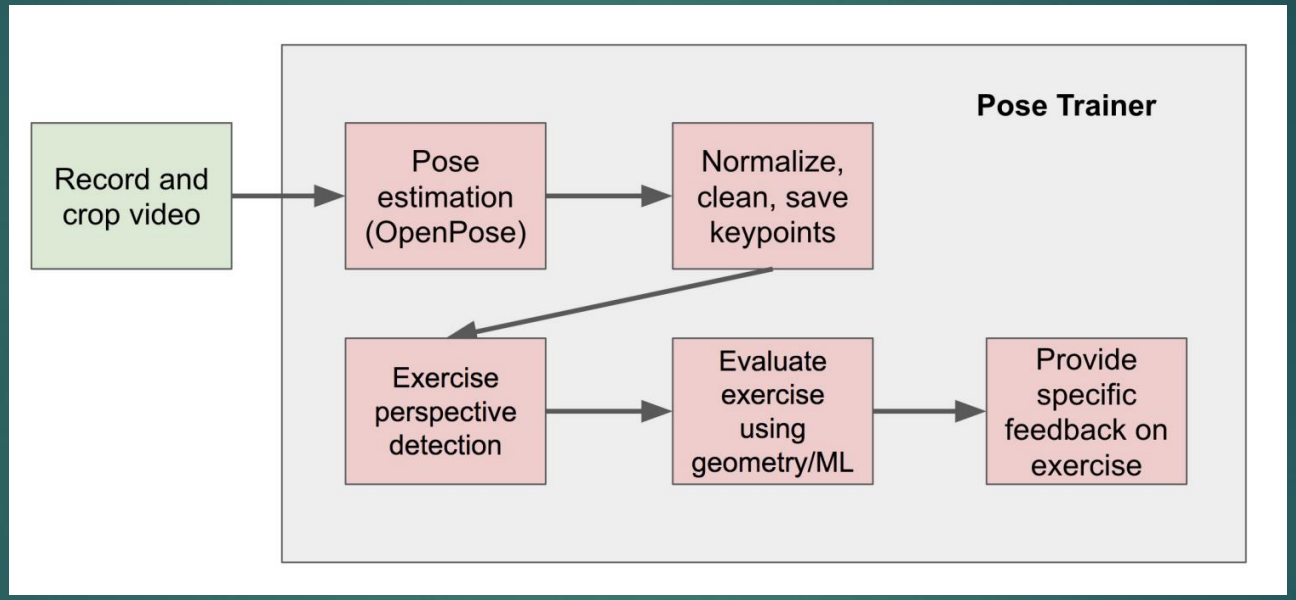
Data Collection: Make a dataset of exercise videos labeled



Pose Estimation Model: Use a deep learning model (OpenPose) to detect keypoints of the human body.

Posture Correction Algorithm: Compare detected keypoints with reference keypoints of correct posture, with both geometric and KNN model. Provide feedback.

Pipeline overview



Results

	Precision	Recall	F1 Score	Examples
Bicep Curl				
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**
Front Raise				
Correct	1.00	1.00	1.00	6
Incorrect	1.00	1.00	1.00	6
Avg/Total	**1.00**	**1.00**	**1.00**	**12**
Shoulder Shrug				
Correct	1.00	0.75	0.86	8
Incorrect	0.71	1.00	0.83	5
Avg/Total	**0.89**	**0.85**	**0.85**	**13**
Shoulder Press				
Correct	0.67	0.86	0.75	7
Incorrect	0.83	0.62	0.71	8
Avg/Total	**0.76**	**0.73**	**0.73**	**15**

Table 1. Confusion matrix for our DTW classification model

Conclusion

Summary: The Pose Trainer system effectively uses pose estimation to correct exercise posture, reducing the risk of injury and improving workout effectiveness.

Future Work: Plans to enhance the system by incorporating more exercises, improving real-time performance, and integrating with wearable devices.

Our project

Project: Exercise detection and correction

Objective: Enhance exercise posture correction using MediaPipe, geometric evaluation and machine learning techniques

Team: Aiman Nadeem, Kaia Kolstad

Exercise detection

Objective: Automatically identify the type of exercise being performed.

Model: Swin3d base, pretrained Transformer on Kinetics-400 dataset. Finetuned on labeled exercise data.

Performance: Achieved 96.30% test accuracy

Exercise evaluation

Exercises Covered: Squat, Push Up, Pull Up, Plank, Russian Twist

Geometric Model: Defines angles and motion criteria for correct execution.

K-Nearest Neighbor Model: Used for verifying correctness of push up and squat exercises.

System workflow

1. Capture exercise video
2. Use MediaPipe to detect keypoints
3. Classify exercise type using the detection model
4. Verify exercise correctness using geometric and KNN models
5. Provide feedback to the user

Demo correct

Demo incorrect

```
Using device: cpu
No exercise type provided. Predicting exercise type...
Predicted action: pushup
Geometric evaluation: Incorrect form.
Elbow angle too large. Go further down.
 Minimum angle: 100.45°. Minimum angle should be between: 5° and 60°
KNN evaluation: Incorrect form.
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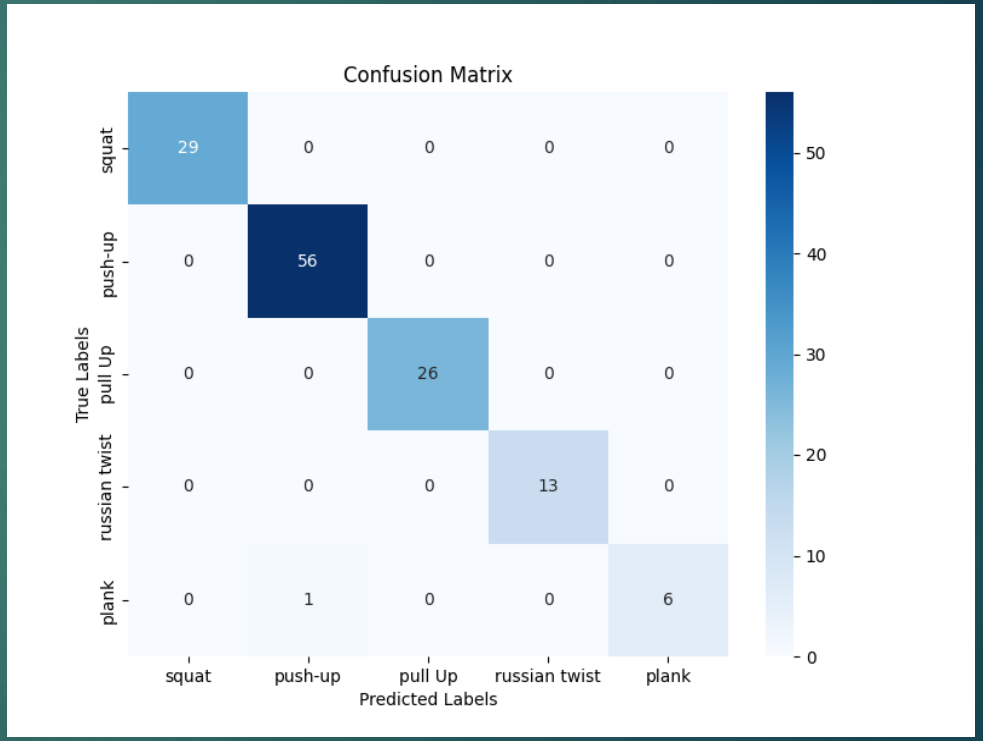
Limitations

- Small datasets
- Small number of exercises
- Exercise detection not robust



Conclusion

Summary:

Successfully developed a system using MediaPipe, geometric models and machine learning to correct exercise posture and classify exercises.

Future Work:

Expand to more exercises

Expand to repetition counter

Improve real-time performance

Develop program into an app/ better user interface

References

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