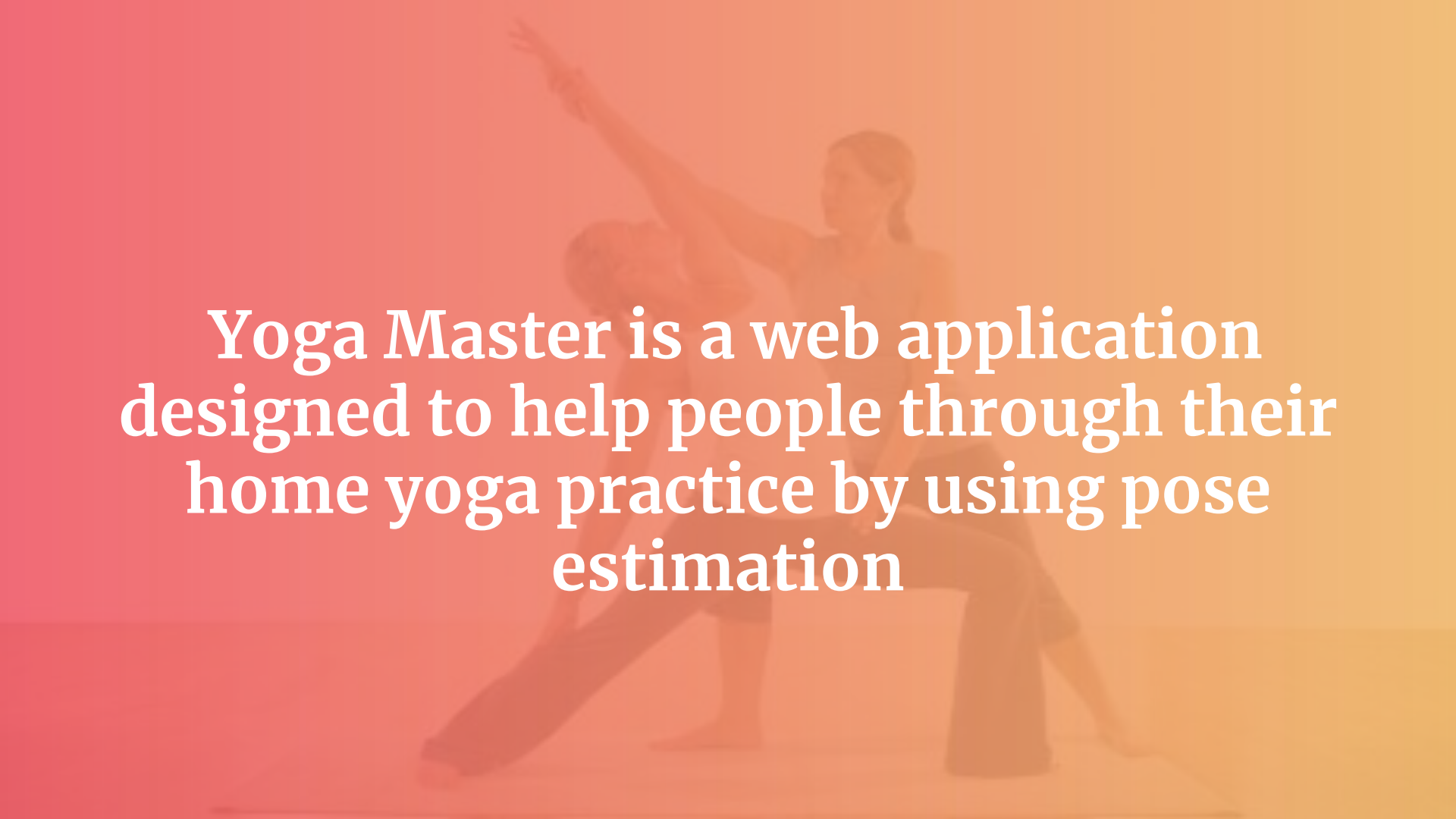
Yoga Master

Master your home yoga workout with the help of neural networks!



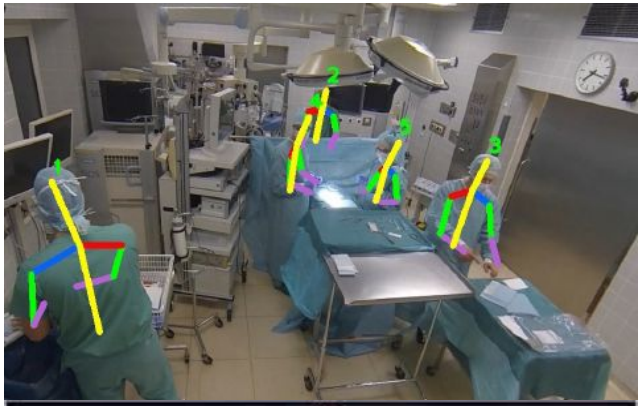
Yoga Master is a web application designed to help people through their home yoga practice by using pose estimation

Main Concept

Yoga Master:

- ➔ Guides the user through a sequence of target poses
- ➔ Tracks the **pose** of the user and the teacher
- ➔ **Compares** the poses
- ➔ Gives **feedback** to the users **s**howing the pose of the teacher (**target pose**) related to their own

Research Concept



Research Topics:
Computer Vision, Human Pose Estimation, Posture Recognition, Machine Learning, Neural Networks

State of the art research:
How can we detect and compare human poses?

Applications:
Training (e.g. surgeons on difficult operations), Fitness, Martial Arts , Dance learning systems and many more!

Design: Minimal System Prototype

TEACHER
Recorded video

USER
Live camera

Software Platforms

➔ **Pose estimation**: PoseNet on Tensorflow.js

Machine learning model which allows for real-time human pose estimation in the browser, a state-of-the-art pose estimation model that provides highly accurate pose data.

Advantages: Ubiquity/Accessibility, Shareability, Privacy

➔ **Visualization**: Processing (p5.js)

Devices

Camera

Average laptop webcam or phone camera.

- No need for high-res, infrared cameras or special sensors
- PoseNet still works well on low-res & black-and-white

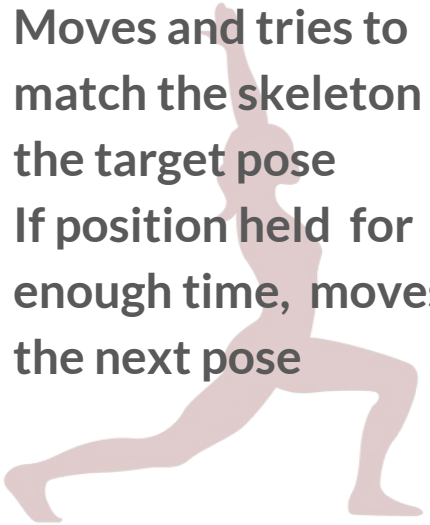
Display

Laptop screen or other.

Implementation

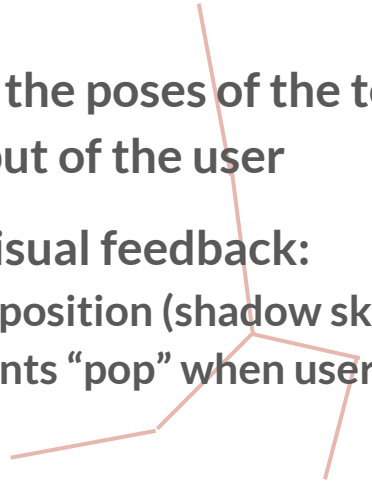
User

- Moves and tries to match the skeleton of the target pose
- If position held for enough time, moves to the next pose

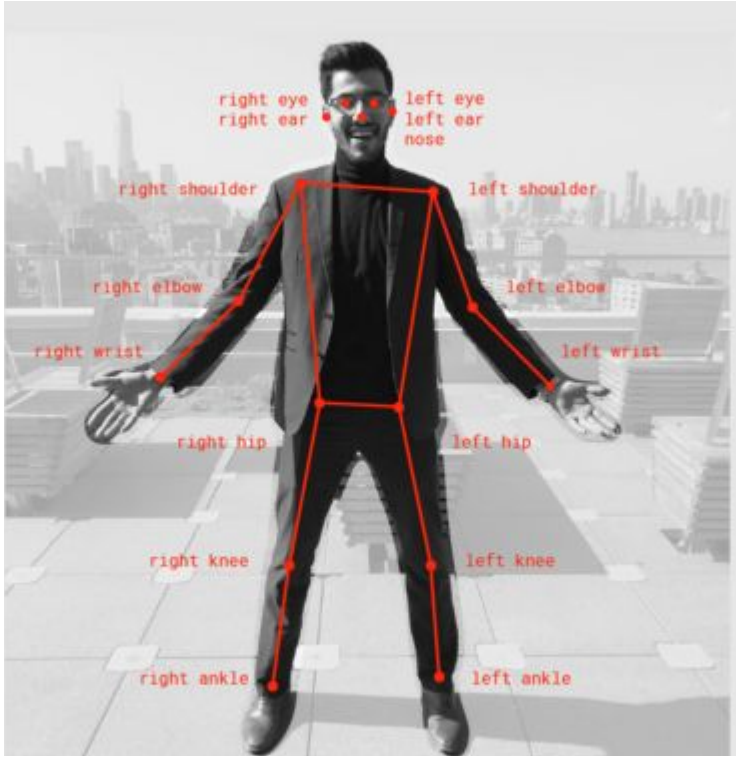


System

- Provides a set of poses of increasing difficulty
- Compares the poses of the teacher with the camera input of the user
- Provides visual feedback:
  - ✓ Target position (shadow skeleton)
  - ✓ Keypoints “pop” when user hits the target points



Pose Estimation



Pose estimation refers to computer vision techniques that detect human figures in images and video.

➔ **PoseNet:**

Detects 17 ***keypoints*** { (x,y) position; Confidence score

1. An input RGB image is fed through a convolutional neural network.
2. The decoding algorithm detects poses, confidence scores, keypoint positions and confidence scores from the model outputs.

Pose Estimation

➔ **How do we compare two sets of keypoints?**
A matching strategy needs to be defined.

Cosine distance:

$$D(Fxy, Gxy) = \sqrt{2 * (1 - cosineSimilarity(Fxy, Gxy))}$$

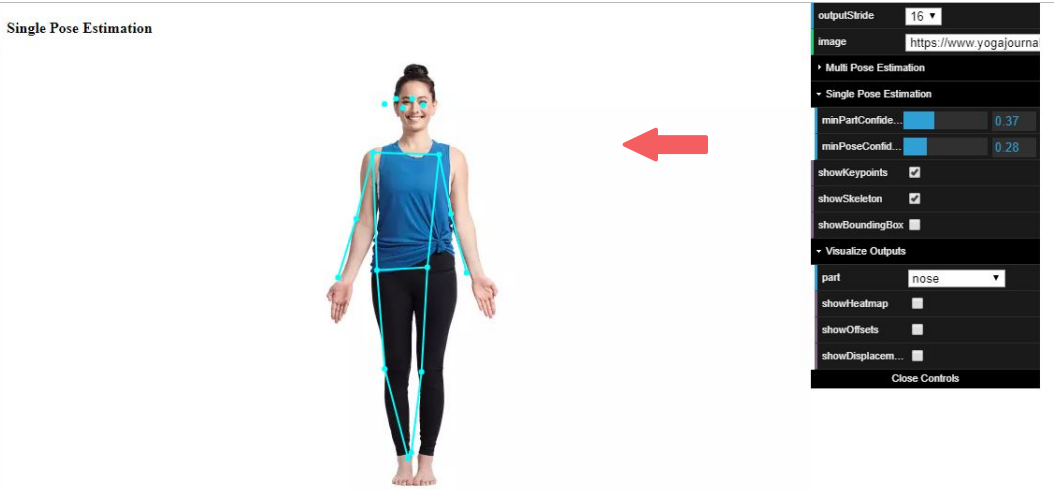
[1]

Cosine similarity:
Measures the angle between 2 vectors to assess their similarity.
It's a measure of orientation, not magnitude.

= how we will measure user performance

[1] *George Papandreou, Tyler Zhu, Nori Kanazawa, Alexander Toshev, Towards Accurate Multi-person Pose Estimation in the Wild, 2017 IEEE Conference on Computer Vision and Pattern Recognition*

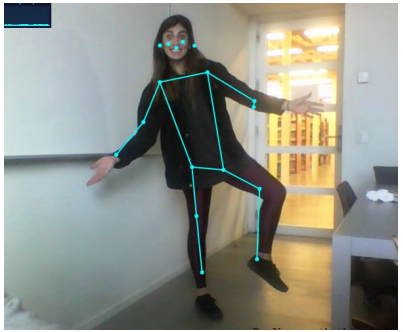
Pose Estimation Steps



1. Calculate the set of keypoints from a target pose image

Pose Estimation Steps

2. Refine target pose



3. Calculate user pose and mirror the keypoints

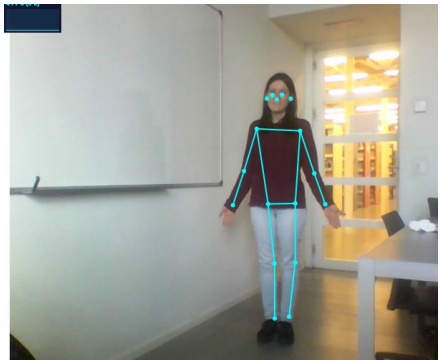
4. Draw skeleton of the target pose onto camera input with along target points

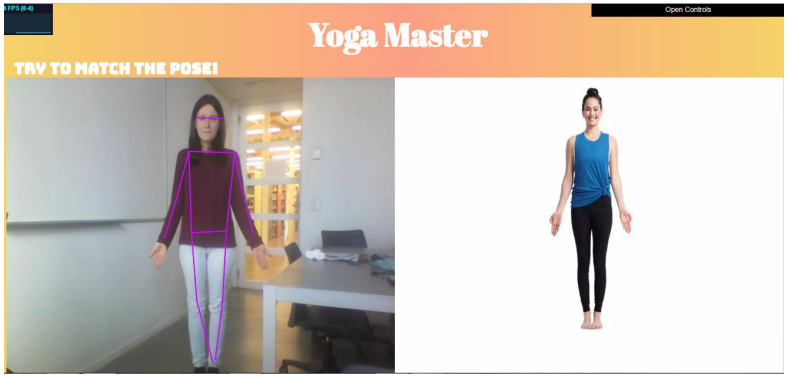
5. User moves trying to fit into pose

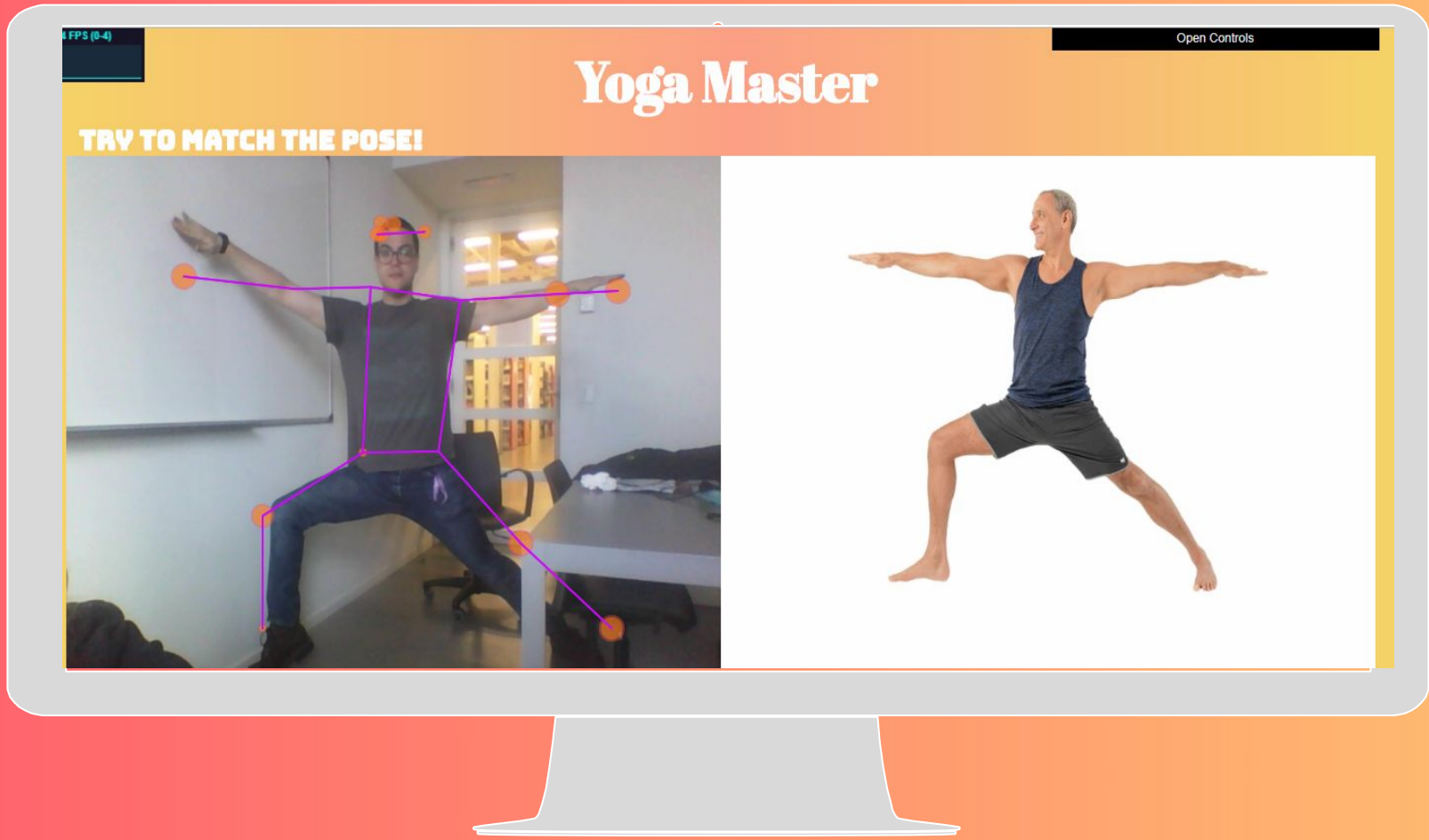
Pose Estimation Steps

6. **Real-time feedback**
   If user matches target points they fade out, if not the grow back

7. **Pose Comparison**
   If n points of the pose are matched (distance < d) for t time





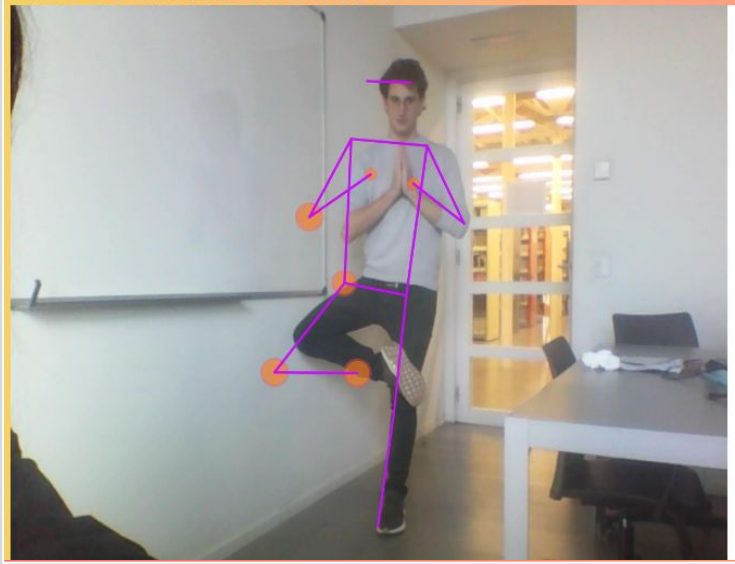

Open Controls
Yoga Master
TRY TO MATCH THE POSE!

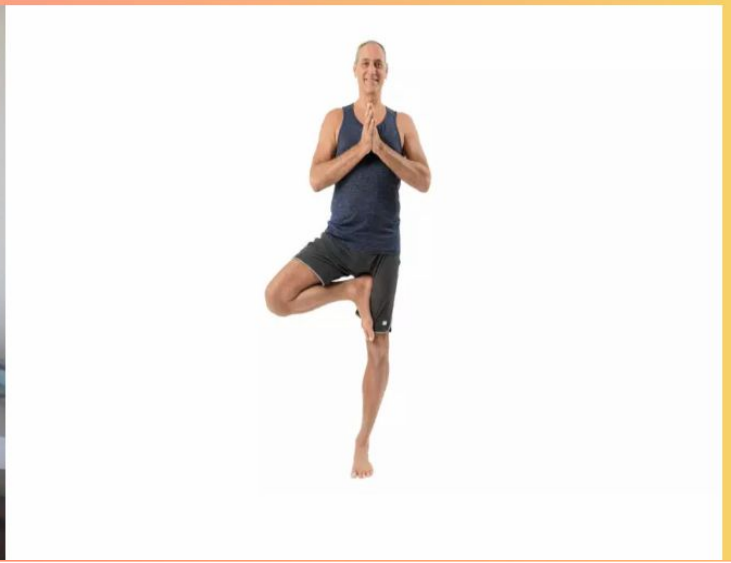
4 FPS (0-4)

Open Controls

Yoga Master

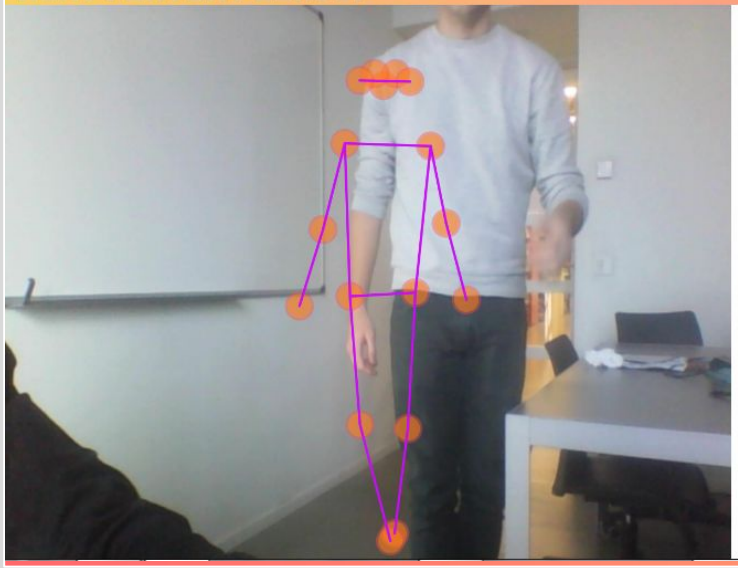
TRY TO MATCH THE POSE!





Yoga Master

NEXT PLAYER PLEASE!



Possible Issues and Solutions

➔ ***Sometimes it's easier for users to follow the "mirror" pose instead of the exact pose. Which one should be the correct one?***

Cosine similarity measures the angle between the poses and lets us know if they are exactly opposite or exactly the same, so we can select both versions as accurate!

➔ ***Sometimes users prefer to have their mat vertical to the laptop in order to follow the video more easily.***

Instructions will clearly state that the mat should be positioned horizontically, as in the video. However, there are better ways to overcome this problem...

Benefits for the user

➔ ***What is the problem we are trying to solve?***

- Many people practise yoga at home following video tutorials.
- It is not always easy to get the poses right without having feedback from a teacher or a mirror.

➔ ***What are the benefits for the user?***

- Yoga Master provides *visual feedback* to the user by comparing his or her pose with the teacher's.
- The users can quickly *correct* their *poses* and *alignment* and in time become *more aware of their posture*.
- The sequence is of *increasing difficulty*

Challenges we faced

- Aimed directly in real-time video pose estimation... too ambitious :(
- Accuracy on video was low
- Experimented with several strategies in order to draw keypoints as accurately and smoothly as possible
  - offset and scale skeleton
  - for every keypoint, keep calculating and drawing new position as:
    newX, newY = (1-confidence)*(oldX,oldY) + confidence*(estX, estY)
- Application worked partially and depended heavily on device's characteristics and performance..

➡ *In the end we went for fixed images to have a minimal prototype working.*

Improvements

- Video Input
- Sound feedback
- Improve UI/UX

Possible Extensions

- Multiple users
- Video pauses until pose is held
- Breath feedback

Group Members

Anna Bellmunt
Jordi Carrasco Frías
Óscar Guerrero
Lida Zacharopoulou

References

Chen-Chiung Hsieh, *Bo-Sheng Wu, and Chia-Chen Lee, A Distance Computer Vision Assisted Yoga Learning System, *Journal of Computers, Vol. 6, No. 11, November 2011,*

Chen, H. T., He Y. Z., Hsu, C. C., Chou, C. L., Lee, S. Y. and Lin, B. S. P. (2017)., Yoga Posture Recognition for Self-training. *Multimedia tools and applications, 77 (18).*

Parsing Human Skeletons in an Operating Room. Vasileios Belagiannis1,2 · Xinchao Wang3 · Horesh Beny Ben Shitrit3 · Kiyoshi.

George Papandreou, Tyler Zhu, Nori Kanazawa, Alexander Toshev, Towards Accurate Multi-person Pose Estimation in the Wild, *2017 IEEE Conference on Computer Vision and Pattern Recognition*

Real-time Human Pose Estimation in the Browser with TensorFlow.js, *https://medium.com/*

Namaste!