

BUILD AN EXERCISE SUPPORTER APP WITH OPENCV AND CONVOLUTIONAL NEURON NETWORKS

I. INTRODUCTION

Social distancing and working from home help prevent transmission of the coronavirus (COVID-19) but can be conducive to unhealthy behavior such as bingeing on either fast food or soft drink, and spending more time on a couch staring at a screen, being a couch potato. Overall moving about less during the day. Scientists believe the reduction in physical activity experienced during the first few months of the pandemic could lead to an annual increase of more than 11.1 million in new cases of type 2 diabetes and result in more than 1.7 million deaths.

Vietnam generally is known as a country with below average health status. Due to the widespread of the disease, people need to start working out in order to improve their health against this pandemic. One of the most effective work out exercise to improve your strength that you can do at home so far is push up. However, it doesn't seem like we all know how to do it in the proper way, which is the main reason for us to develop this project.

II. RELATED WORK

Formerly, there was a push-up project, but its main task is to count how many times a person push up but doesn't recognise whether the person is doing push up in the correct or incorrect form.

Link: <https://aicurious.io/posts/2021-02-15-build-a-pushup-counter/>

III. DATA PREPARATION

Because this project is contemporary, there is a limitation in data, so we have to collect more by using our own data, and then label them alternately.

Data is classified into 2 categories:

- + Up: Taken while the person is pushing up on the highest, both arms are straight and perpendicular to the ground.
- + Down: The opposite of up, taken while the person is doing push up on the lowest, each arm make up a smallest acute angle.

For each categories, there are also 2 classes:

- + Right: Person doing push up in the correct form.
- + Wrong: Person doing push up in the incorrect form.

Total: 3300 images

- + Collect from the Internet: 20% (images, or crop frames from multiple videos)
- + Self made: 80% (5 different person)

Up	Right	900 images		
	Wrong	900 images		
Down	Right	750 images		
	Wrong	750 images		

IV. METHOD

(insert image later)

Steps:

1. Using Mediapipe to locate 3 bodyparts: shoulder, elbow and wrist.
2. Calculate the angle formed by 2 sides: shoulder - elbow and elbow - wrist.
3. Using signal processing (low-pass filter) to count push-ups detected in frame.
4. In each push-up, extract 2 frames at the highest and lowest angle measurements, corresponding to ups and downs.
5. Use 2 different models (Efficient Net and Transfer Learning with 4 Dense layers interleaved and Dropout) to evaluate whether the person's push up form in those 2 frames are correct or incorrect.
6. A push-up is correct when both up and down are right, if one of the two is wrong, it is considered a wrong push-up.

V. METRICS: ACCURACY AND CONFUSION MATRIX

- Model up: Accuracy: 90%

	Possitive	Negative
True	X	X
False	X	X

- Model down: Accuracy: 85%

	Possitive	Negative
True	X	X
False	X	X

- Combined two models: Accuracy: %

	Possitive	Negative
True	X	X
False	X	X

VI. SUMMARY AND FUTURE PLANS

Pros:

+

Cons:

- + Unable to perform detection if the person's head is facing the camera directly.
- + 95% of the data used for training is male.
- + Self-made dataset despite having a variety of costumes and backgrounds, but only created from 5 different people. Although the pretrained model (Efficient Net) has peak performance in extracting information on a person's body, but it will still be less effective in extracting information of other different people.
- + Partially dependent on Mediapipe, it will not be able to recognize and evaluate if Mediapipe does not recognize the person's poses.
- + Only inform people whether their form is currently correct or incorrect but not giving out the reason why.

Future works to improve results:

- + Collect more variety data to avoid gender bias, race bias.
- + Expand 'Wrong' class of each model, 'Wrong', 'Wrong Reason1', 'Wrong Reason2', 'Wrong Reason3', etc. Moreover, specify problem 'Why the pushup is wrong?'.

VII. REFERENCES

- Build a Pushup counter app with OpenCV and DeepLearning

<https://aicurious.io/posts/2021-02-15-build-a-pushup-counter/>

- Deep Learning Exercise repetitions Counter

<https://github.com/NetoPedro/Deep-Learning-Push-Up-Counter>

- Mediapipe Pose <https://google.github.io/mediapipe/solutions/pose>

- Low pass filter algorithm, Wikipedia https://en.wikipedia.org/wiki/Low-pass_filter

- Efficient Net, Rethinking Model Scaling for Convolutional Neuron Networks

<https://arxiv.org/pdf/1905.11946.pdf>

VII. APPENDIX