Face Mask Detection Using Serialized Model on Real and Semi-Artificial Datasets

1. Dataset

Four datasets are used in this project. All of them are consisted of:

- 300 images of people waring mask (class: “with_mask”)
- 300 images of people “not” waring mask (class: “without_mask”)

However, they are different in two ways:

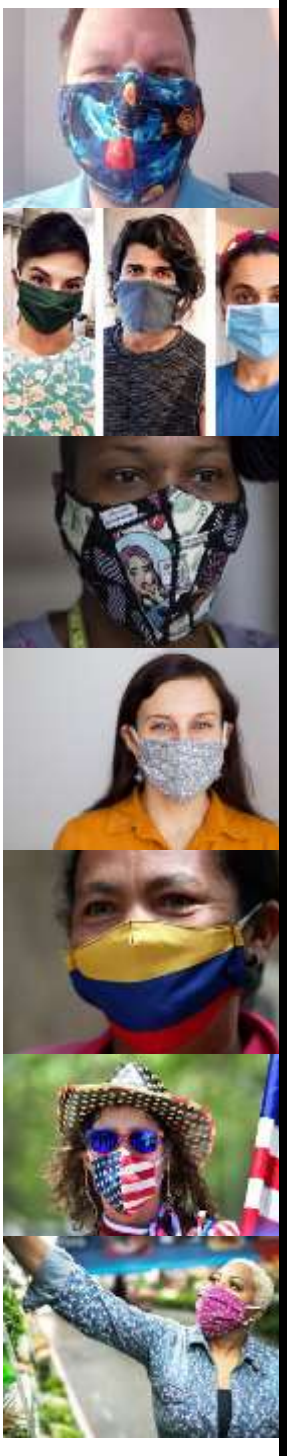
- Whether that images for with_mask class are real or artificially obtained;
- Whether masks are plain or patterned

So the resulting datasets are as follows:

- Dataset with plain artificial masks
- Dataset with plain and patterned artificial masks
- Dataset with plain real masks
- Dataset with patterned real masks

Table 1: Dataset Samples

Without_Mask	With_Mask	With_Mask	With_Mask	With_Mask

(Real)	Artificial White (A-W)	Artificial Pattern (A-P)	Real White (R-W)	Real Pattern (R-P)
300 images	150 images	150 images	200 images	100 images
				

1.1 Creating Artificial Dataset with White Masks (A-W) [1]

Since the number of existing photos of people wearing mask is limited, it would be helpful to create artificial dataset. It could be done by overlaying masks over people faces through following steps (figure 1):

- Building a dataset of normal images of people (including their faces);
- Extracting the face Region of Interest (ROI) using *face-recognition* library [2];
- Extracting facial features (e.g., ocalize the eyes, nose, mouth, etc.) using *facial-landmarks* code [3];
- Adjusting a tranparent mask (by resizing and rotating) to best fit the face, and then overlaying it on the face.

Figure 1: Overlaying artificial tranparent mask on people's faces

1.2 Creating Artificial Dataset with White Masks (A-P)

In order to increase the diversity of the artificial dataset, patterned masks have been used in dataset A-P. Seven different patterns have been used to create patterned transparent masks and then randomly applied to images (figure 2).

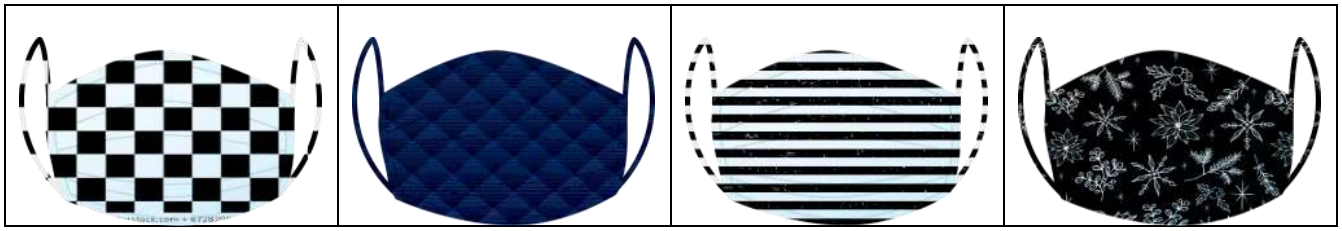


Figure 2: White mask and seven patterned masks

2. Training Mask Detection Model [4]

Instead of training the whole, the combination of a pre-trained base-model and a trainable head-model has been used. This approach is called fine-tuning and is a three-step process:

- Pre-trained base-model: MobileNet with pre-trained ImageNet weights, leaving off head of network
- Trainable head-model: constructed CNN network

The base-model is then frozen while the head layer weights will be trained and tuned. Fine tuning enabes us to take advantage of an advanced complex network without going through the long and heavy training process of whole model. Figure 3 shows both base and head models in this project illustrates how this strategy focuses traing process on a very small part of model.

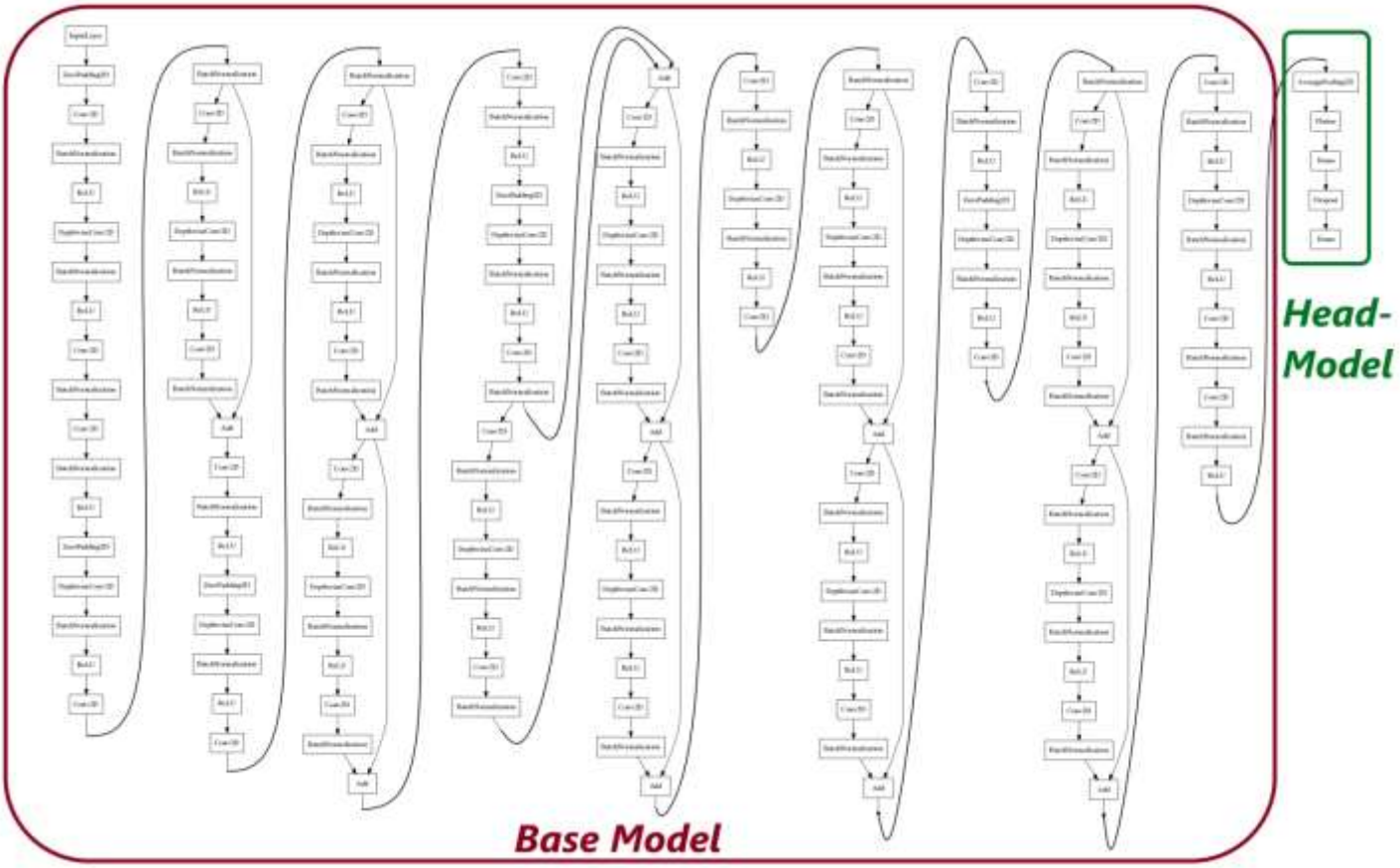


Figure 3: Base-model vs. head-model

3. Results & Discussion

3.1. Face Mask Detection [Trained on Artificial Dataset | Tested on Real Dataset]

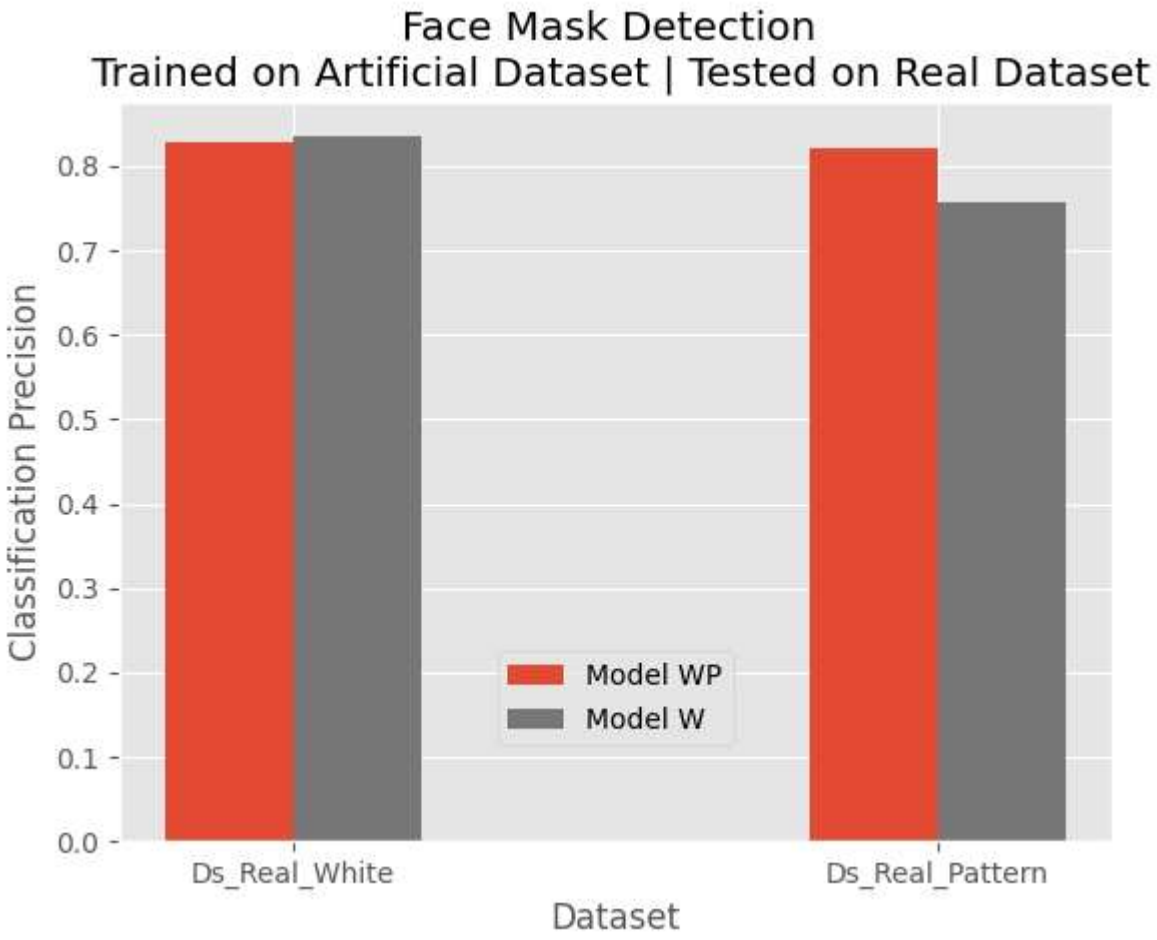


Figure 4: Face Mask Detection [Trained on Artificial Dataset | Tested on Real Dataset]

Remarks from figure 4:

- Even training on artificial masks results in more that 80% detection of real masks;
- Adding patterned masks to training dataset has negligible effect on detection rate for white masks but significantly increases the detection rate of patterned masks (from 79% to 83%).

3.2. Face Mask Detection [Trained on Real and Artificial Dataset | Tested on Real Dataset]

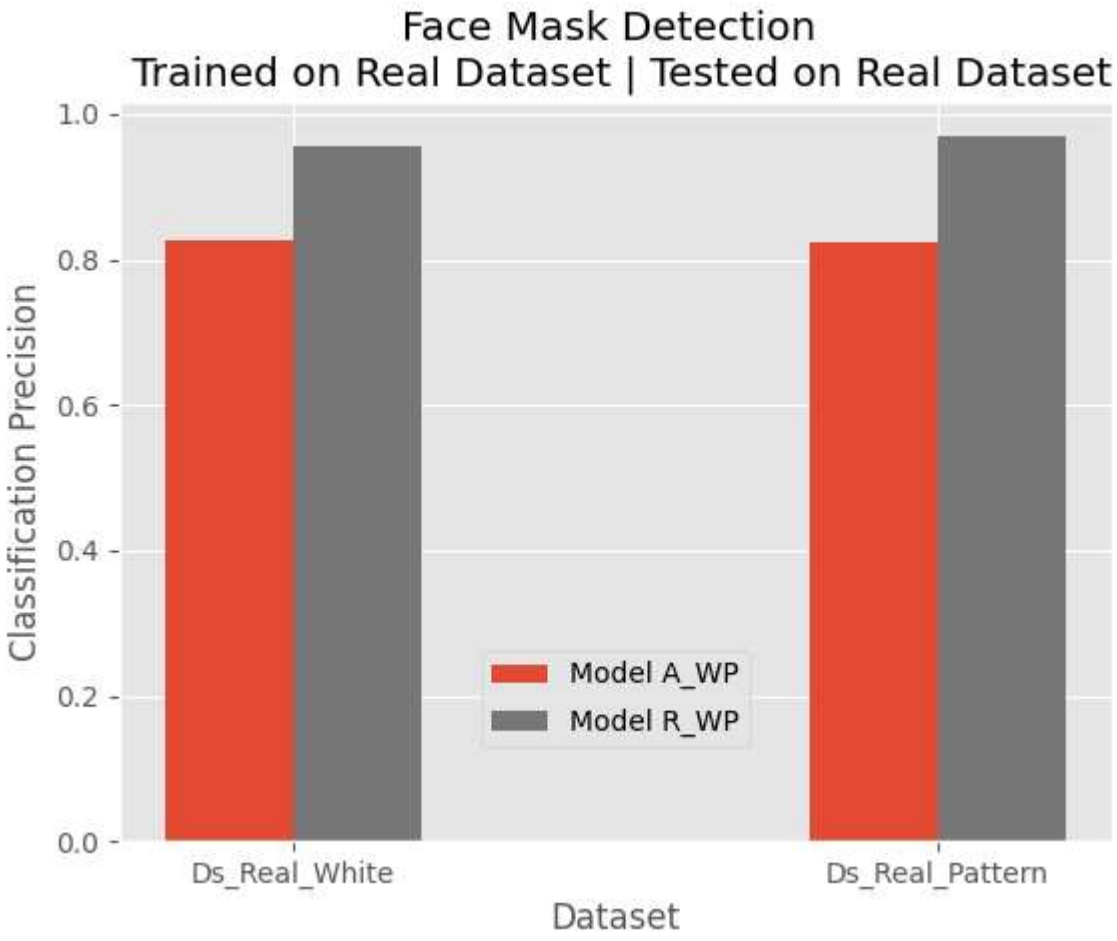


Figure 5: Face Mask Detection [Trained on Real and Artificial Dataset | Tested on Real Dataset]

Remarks from figure 5:

- Training on real dataset increases detection rate from 83% to 96% both for white and patterned masks.

3.3. Mask Detection Summary

The overall precision of mask detection models is summarized in folloing table. Following points can be concluded form this table:

- Even training on artificial masks results in more that 80% detection of real masks;
- Adding patterned masks to training dataset has negligible effect on detection rate for white masks but significantly increases the detection rate of patterned masks (from 79% to 83%).
- Training on real dataset increases detection rate from 83% to 96% both for white and patterned masks.

Table 2: Mask Detection Precision

Mask Detection Model (Training Dataset)	Detection Precision Testing Dataset: R-W	Detection Precision Testing Dataset: R-P
Model A-W	84%	76%
Model A-WP	83%	83%
Model R-WP	95%	97%

References

[1] https://github.com/prajnasb/observations/tree/master/mask_classifier/Data_Generator
[2] https://pypi.org/project/face-recognition/
[3] https://www.pyimagesearch.com/2017/04/03/facial-landmarks-dlib-opencv-python/
[4] https://www.pyimagesearch.com/2020/05/04/covid-19-face-mask-detector-with-opencv-keras-tensorflow-and-deep-learning/