Face-Mask Compliance Recognition and Tracking

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Objective

Tracking the spread of an infectious disease (COVID) is a way to identify potential spread.

One of the ways in which this can be identified is to track a person who is wearing a mask incorrectly. Such a person might be a potential spreader.

Current methods of face detection does not work with masked faces due to lack of data.

We tested Zisserman et al's Resnet-18 model for face recognition on masked faces, as seen on right - was trained on Labeled Faces in the Wild dataset - 3M+ faces, and achieved 99%+ accuracy.

The intermittent detection of faces suggests that a major chunk of information is lost when a mask is worn.

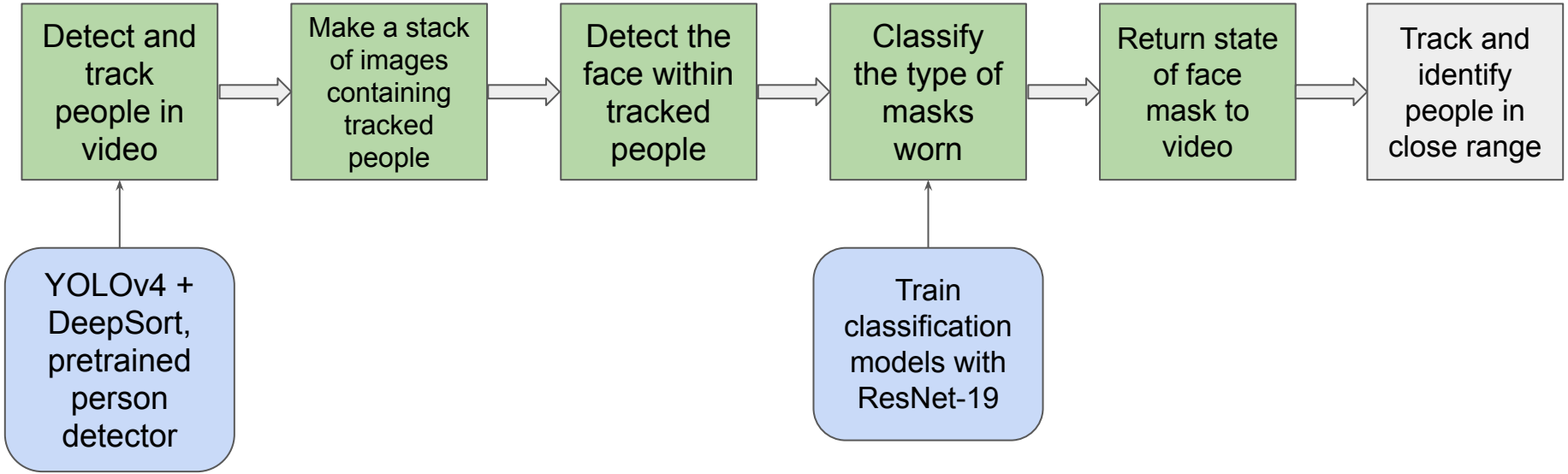
Objective

Our goal is to identify people wearing masks incorrectly or not wearing a mask at all. Then, we track them and identify other people who might come into contact with them.

To break down the project, we divided the goal into 3 parts:

1. Detect all faces in the video (masked and unmasked)
2. Classify detected masked faces into correctly masked and incorrectly masked
3. Track all persons in contact with improperly masked people in a video

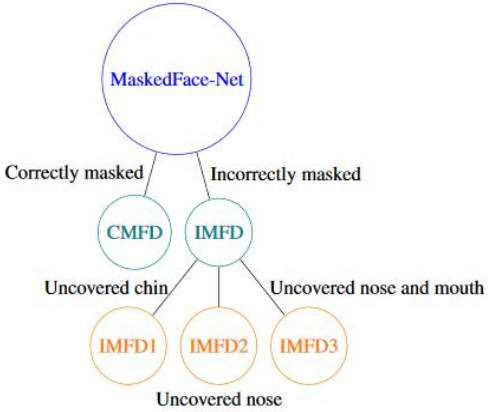
Workflow

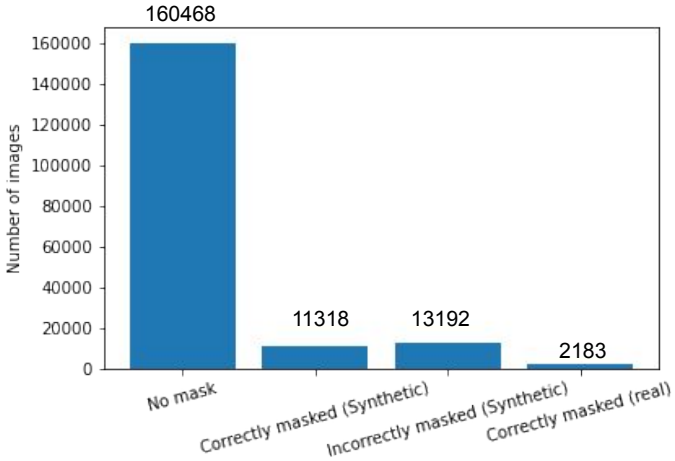


Green: Steps completed as of now

Datasets

We used a mix of synthetic and real data, in total ~200k images.





Detect and Track People in Video

Simple Online and Realtime Tracking - uses Deep Appearance Descriptor for consistent person tracking between frames.

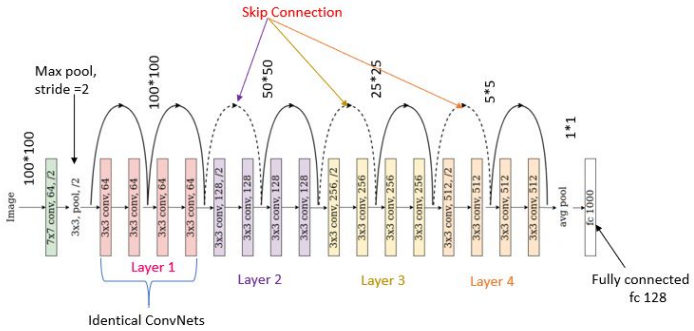
YOLO: One-stage object detection network optimized for real-time detection.

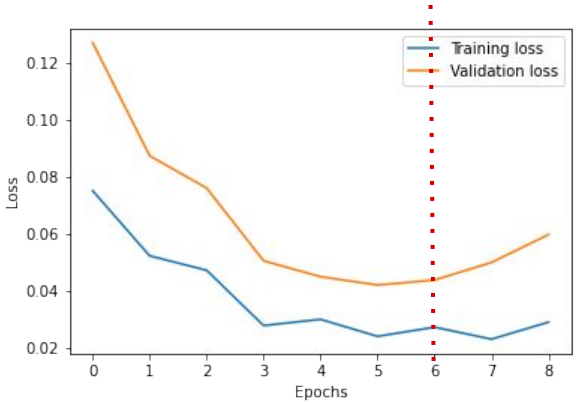
Face Detection

First the individual person is detected

And following that, the face recognition is run on the pedestrian bounding box.

Classification of Face Subimages





A ResNet-18 model is trained to classify the face subimages into no mask, correctly masked and incorrectly masked.

Loss function: Cross-entropy Loss
Optimizer: Adam
Learning rate: 1e-4
Batch Size: 256

Weighted sampler is used to mitigate the class imbalance problem

Selected epoch 6 as the stopping point for error quantification.

Data Augmentation

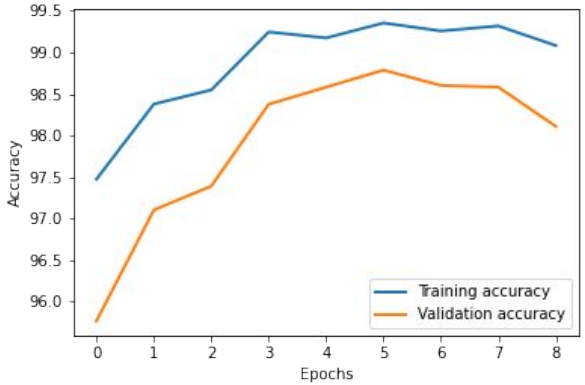
All faces were first resized to 128x128, they were centered.

A number of augmentations were used to ensure a generalized network detection for both training and validation, including:

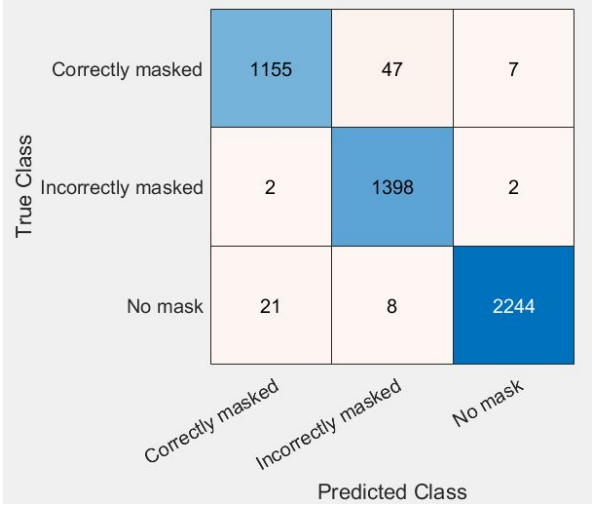
- Random Perspective distortions
- Random Affine scaling/rotations
- Horizontal and Vertical Flips

A few examples are shown.

Results



Test accuracy = 98.21%

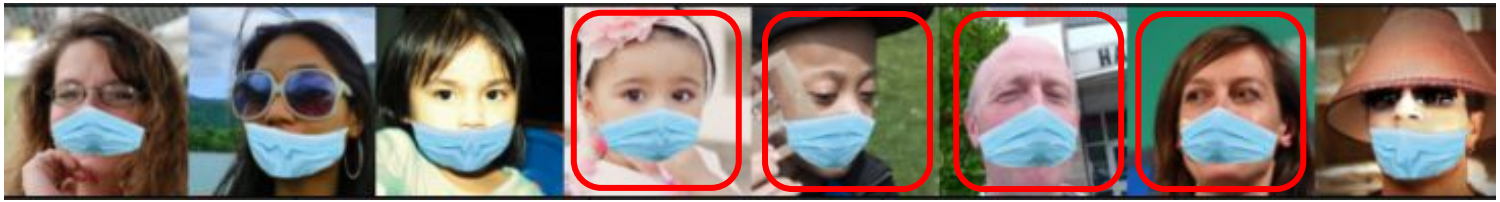


We used GradCAM for interpreting the network's output.

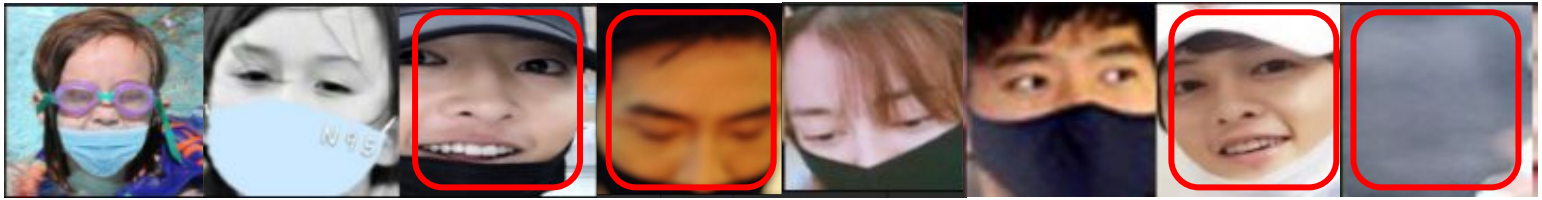
The network makes the decision by using information mostly coming from the mouth area.

Misclassifications

Classified as incorrectly masked



Classified as correctly masked



Classified as not masked

Future Work and Collaboration

- Track and identify people in videos within a close range of a person not compliant with face mask rules

- We divided the tasks in the beginning and worked on them
- The final integration of different parts was done using Google Colab

References

- MaskedFace-Net -- A Dataset of Correctly/Incorrectly Masked Face Images in the Context of COVID-19 https://arxiv.org/abs/2008.08016
- Detecting Masked Faces in the Wild with LLE-CNNs https://openaccess.thecvf.com/content_cvpr_2017/papers/Ge_Detecting_Masked_Faces_CVPR_2017_paper.pdf
- YOLOv4: Optimal Speed and Accuracy of Object Detection https://arxiv.org/abs/2004.10934
- DeepSort, Simple Online and Realtime Tracking with a Deep Association Metric https://arxiv.org/pdf/1703.07402.pdf
- Machine Learning is Fun! Part 4: Modern Face Recognition with Deep Learning https://medium.com/@ageitgey/machine-learning-is-fun-part-4-modern-face-recognition-with-deep-learning-c3cffc121d78, https://github.com/ageitgey/face_recognition
- Deep Face Recognition http://www.bmva.org/bmvc/2015/papers/paper041/index.html

Backup slide

		Actual Class		
		No mask	Correctly masked	Incorrectly masked
Predicted Class	No mask	2224	21	8
	Correctly masked	7	1155	47
	Incorrectly masked	2	2	1398