Mask On – Face Mask Detection

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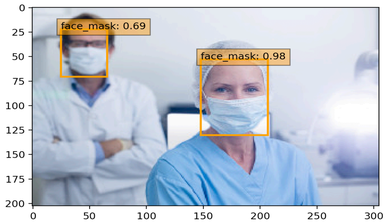
Problem Statement

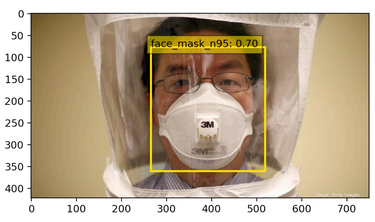
The COVID-19 pandemic is spreading virally and affecting people's daily life greatly. Wearing a mask in public will help prevent people from spreading the virus.

Our project detects whether a person in the image is **wearing a face mask or not** and recognizes the **mask type** (N95 or non-N95) if the image subject is wearing a mask.

By implementing our project, local governments can easily detect the mask rate from CCTV footage and be prepared for potential outbreak. Automated public services, such as parking lots, can better control any risks.

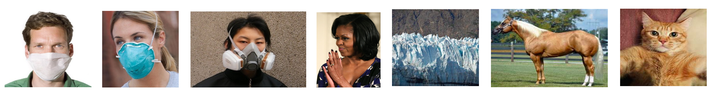
Since the current research related to COVID-19 has been mainly focused on predicting the spread of the pandemic, there is only a limited number of work on face mask detection. The existing projects on this topic took the approach of Single-Shot Detector (SSD) to identify faces and mask-on status.





Dataset

- All images were obtained from four online open resources:
  - *MAFA [for masked human faces]*
  - *WIDER FACE [for not-masked human faces]*
  - *Kaggle [for natural scenes]*
  - *Kaggle [for animal images]*
  - *Online scraping [for N95 images]*
- The dataset comprises 4-class images: no human face, human face without mask, human face with mask, human face with N95 mask.
- The data is split to 6182:2041 for training and testing.
- All images were transformed into the same size (64*64) and normalized based on RGB scales



Technical Approach

Step 1
VGG16 Network to classify no face, face with mask and face without mask

Step 2
Use LabelImg to label images of N95 and regular mask with both the type and the location of the face mask

Step 3
SSD with VGG16 as backbone to detect instances of mask-wearer and N95 wearer in images

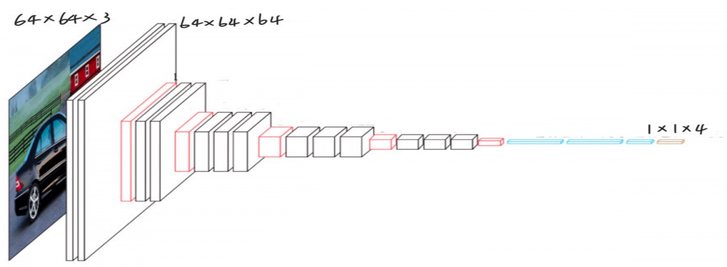
Step 4
Create demo and output images with detected bounding boxes

VGG Model Settings:

- 5 VGG blocks
- Enable transfer learning up to layer 2
- Size of fully connected (FC) layers = 128
- 1 FC layers

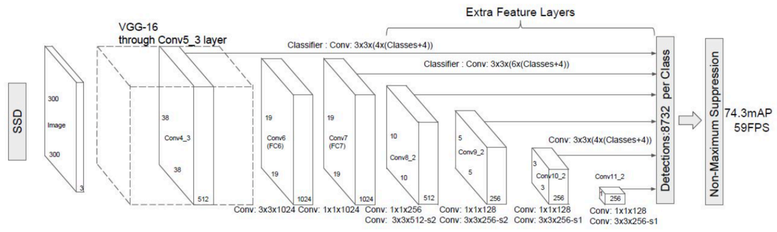
VGG Optimizer Settings:

- optimizer = Adam()
- Batch size = 32
- Number of epoch = 196
- Batch normalization



SSD (Single Shot MultiBox Detector)

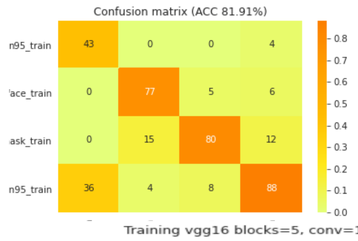
- Using pre-trained VGG16 (structure modified, excluding FC layers) as its backbone to extract features
- SSD used VGG16 without FC layers allows for input images of different sizes
  - **3 Object Classes** (Face, Face_Mask, N95) and **1 Background Class**
  - Outputting **(Xmin, Xmax, Ymin, Ymax)** as bounding boxes based on feature map dimensions

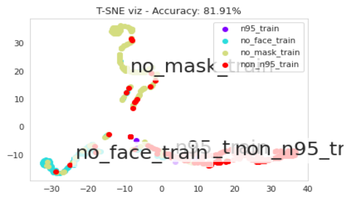


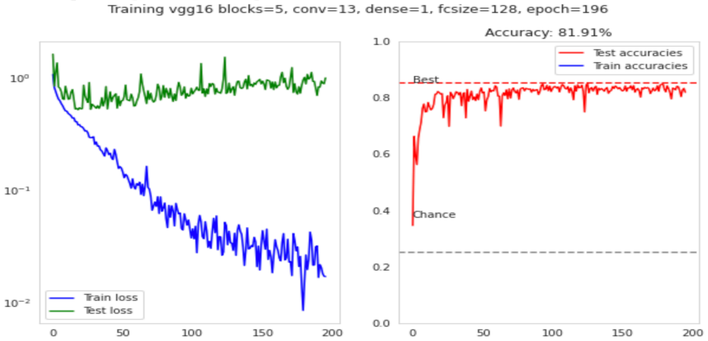
•. The SSD Network discretizes the output space of bounding boxes into a set of default boxes over different aspect ratios and scales per feature map location; it also combines predictions from multiple feature maps with different resolutions to naturally handle objects of various sizes.

•. In the context of our project, to achieve real-time detection, we not only need to perform classification but also want to detect the count of people wearing masks versus people who are not.

Results







	AP for *Face*	AP for *Face Mask*	AP for *N95 Face Mask*	MAP
SSD (*Mask / No Mask*)	0.249	0.821	N/A	0.535
SSD (*Mask / N95 / No Mask*)	0.285	0.811	0.7385	0.612

Conclusion

The model has a decent accuracy for detecting mask and can detect multiple faces in a picture. It has excellent classification power differentiating face/no face, mask/no mask (especially when background is not too noisy).

Limitations of approach:

- Low accuracy on detecting human faces/masks for faces not directly facing the camera
- Low accuracy on differentiating between regular surgical and N95 mask

Potential improvements:

- Train the network on more images of human faces/masks facing different directions
- Increase the number of images of the N95 mask in training data
- Increase model complexity
- Add features on taking streaming input data in addition to static images and making real time detection

References and Related Work

FaceMaskDetection by AIZOOTech
https://github.com/AIZOOTech/FaceMaskDetection
Detecting Masked Faces in the Wild with LLE-CNNs
http://www.escience.cn/people/geshiming/mafa.html