YOLOMask: DEEP LEARNING BASED FACEMASK DETECTOR

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Abstract

Wearing facemasks has become a social norm due to the COVID-19 pandemic. According to CDC, the use of facemask helps reduce the infection rate of COVID-19. Therefore, it is important to monitor the utilization of facemasks during indoor or group activities and encourage people to practice wearing masks. Motivated by this cause, we designed a deep learning based (convolutional neural networks) automated face mask detection model. We used the YOLOv4 architecture which is a single pass algorithm to detect objects. YOLOv4 measures the accuracy through the comparison of the intersection between the original bounding box of a person's face, wearing mask, with the predicted bounding box, the more these areas intersect, the higher the accuracy. When running our model, it shows that the model detects whether a person is wearing a mask "properly" or not, with around 90% accuracy.

Introduction

Masks have been an obvious lifestyle change since the pandemic. Many institutions and businesses require masks in order to carry out daily tasks for a good reason. On March 11, 2021, the WHO declared COVID-19 as a pandemic, and as of April 23, 2021, COVID-19 has a national death toll of 553,092 lives. In order to enforce CDC guidelines of wearing a mask, facemask detection platforms have seen an increase in popularity. In this project we experiment facemask detection using the region based convolutional neural network architecture YOLOv4. This project explores the realm of machine learning and convoluted neural networks, applying these concepts towards facemask detection. Previous researchers have used the deep neural network SSDMV2 for real time face mask detection. SSD uses a single shot multi-box detector in order to detect the faces, and MobilenetV2 as the object classifier for the mask. However, SSDMV2 is slower in performance and yields lower accuracy in comparison to YOLOv4[1]. Similarly, other research work have implemented a revised model of Resnet-50 and YOLOV2 for facemask detection. These kind of studies implements a two step-stage detector, which is much slower, in comparison to single-shot detector like YOLOv4.

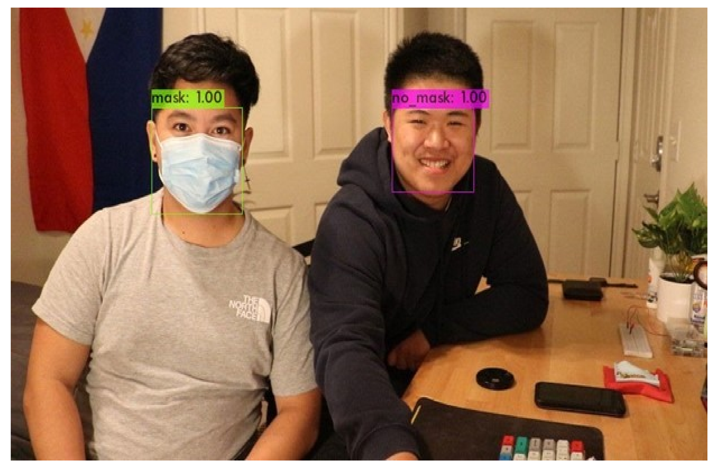

Figure 1: YOLOv4 detector detecting Don-Joshua Argomido (left) wearing mask and Eric Chien (right) without mask.

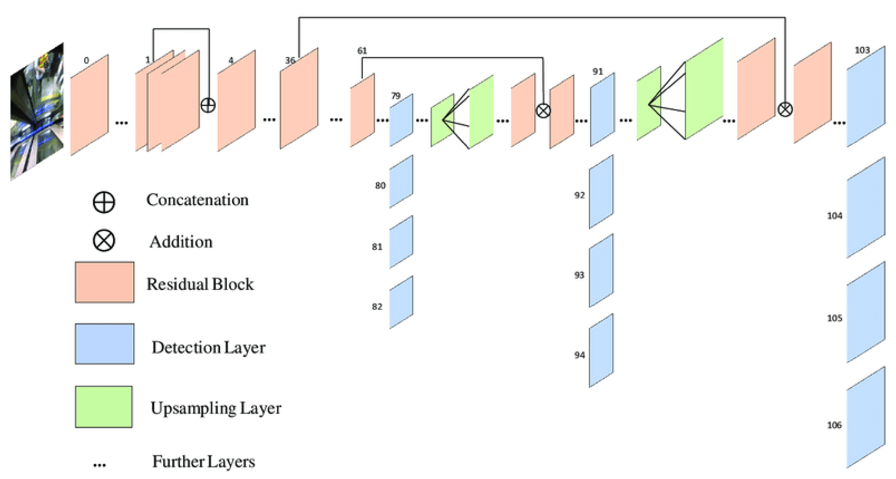

Figure 2: YOLOv4 model architecture

Data

To train the YOLOv4 model, we used raw Kaggle annotated datasets with labels. We further cleaned the datasets to feed into our model. To test our model, we created a custom dataset (Table 1) that consists of SFA students to test our YOLOv4 model.

Table 1: The dataset that was used for the project.

	Datasets	Images w/ mask	Images w/o mask	w/annotations
Kaggle Datasets	Dataset 1	0	0	853
	Dataset 2	329	131	0
	Dataset 3	656	956	0
	Dataset 4	5883	5909	0
	Dataset 5	3725	3828	0
SFA Dataset	Dataset 6	0	0	81

Model Design

Our first objective was to see the effectiveness of convolutional neural networks in classifying images with masks or without masks (without any feature of localizing where the mask is present in the image, or image localization). Therefore, we used multiple deep learning models for image classification tasks such as ResNet, Inception, MobileVnet etc. The entire framework followed various steps, specifically, we first cleaned the data and preprocessed it. We then trained the model based on this data, and evaluated the model.

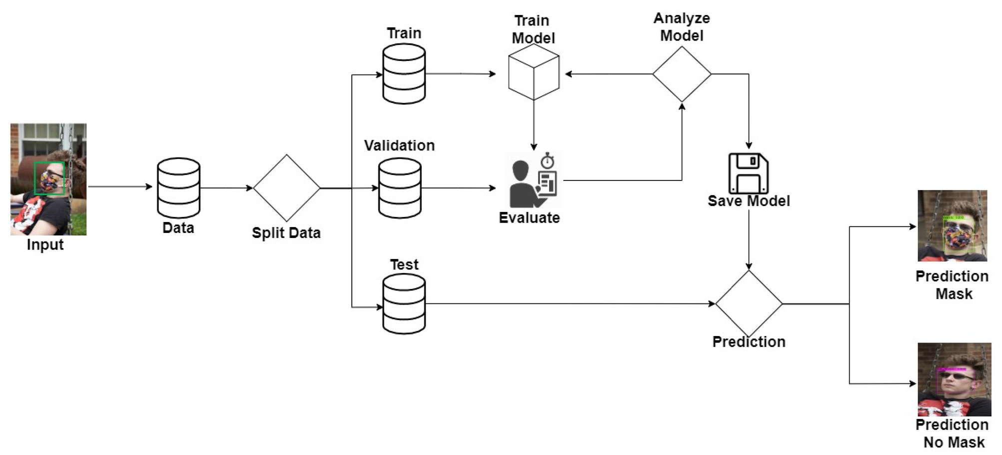

Figure 1: Facemask Detection pipeline.

As we can see in Fig 3, almost all of them showed a very good result. Encouraged by this outcome, we planned to use a more sophisticated model (YOLOv4) for image classification as well as object localization. The model uses mAP(mean average precision) to measure the accuracy. AP (Average precision) is a popular metric in measuring the accuracy of object detectors like Faster R-CNN, SSD, etc. The model also then uses IoU which is the Intersection of Union, to measure the effectiveness of the object localization. IOU is used to measure how much our predicted boundary overlaps with the ground truth (the real object boundary).

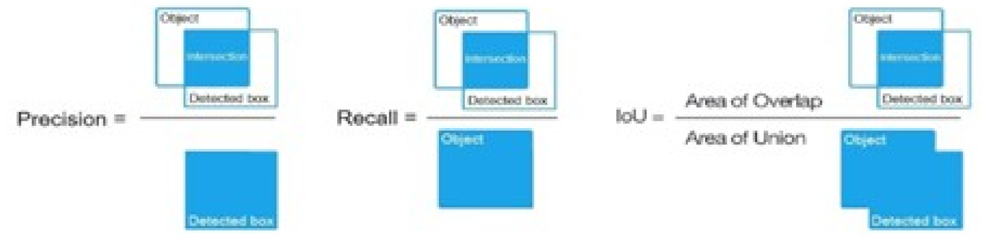

Figure 2: Performance Metric: mAP

Object Recognition

As a first step, after grabbing our dataset, we began using convolutional neural networks such as Inception, ResNet, MobileNet for object classification to measure the effectiveness of these models in such tasks. We trained these model based on Dataset 2 to 5, considering both with and without transfer learning (TL). Encouraged by the results (as shown in Fig 3), we proceeded with the task of object localization. It involves identifying an object and drawing a box around each face in the image and then classifying the box if it has mask or not.

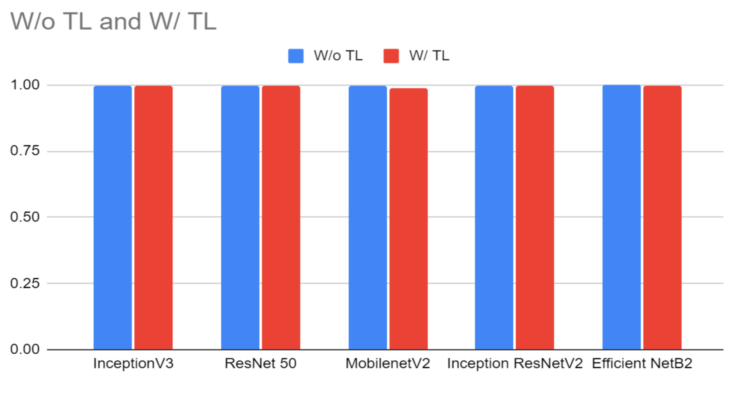

Figure 3: The accuracy of models we test w/TL and w/o TL.

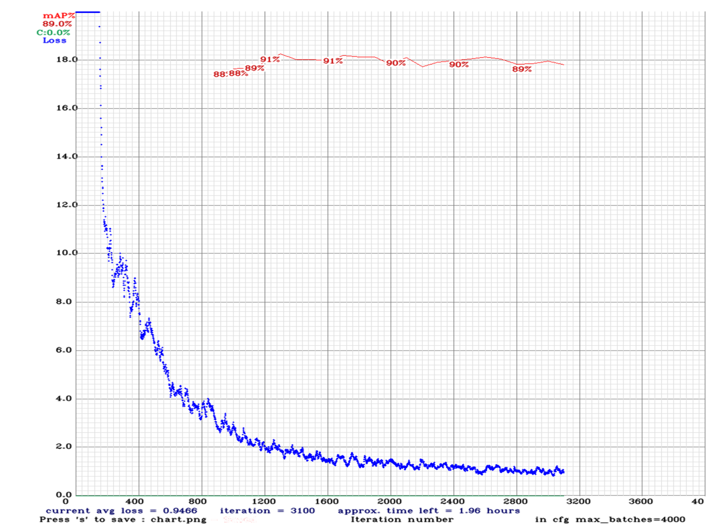

Figure 4: YOLOv4 model's mAP.

We considered YOLOv4 for the object detection task on Dataset 1 since it contained the bounding box annotations. In Fig 4, the YOLOv4 model ran from around 3,000 epochs and at the beginning we can see the loss of the graph was all the way on top and slowly began to decrease. Around 2800 we can see the graph beginning to plateau showing that the model is already training at its best, indicating to end training. As we look at the top of the chart it displays the mAP with a prediction of starting at 88% it slowly went up to its best at 91% in accuracy. As the model continues to train, the accuracy ranges between 89-90% accuracy. The weights with the highest accuracy are then used and applied for the face mask detection.

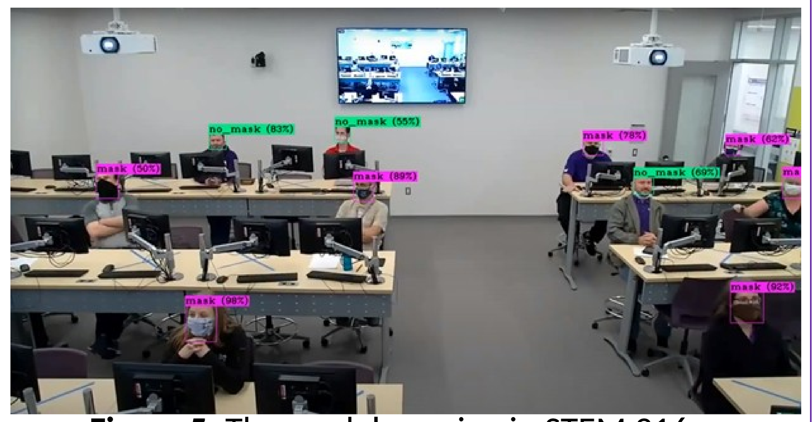

Figure 5: The model running in STEM 316 classroom. (pink: mask; green: no mask)

Finally, we tested the model by running it in a classroom setting with CS professors that wore masks and without masks (Fig 5). When running the model, the model performed with minimum errors and high prediction accuracy.

Conclusion/Future work

YOLOv4 is a powerful model that could complete both object classification and localization in a single pass. In our case, we used the model to detect whether someone was wearing a mask or not. It can also be implemented with live video feed. For our future work, we would also like to implement these technologies into the medical field such as detecting abnormality (such as tumor cells) in medical images. This will help medical professionals to identify if a cell is malignant or benign tumor cells.

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