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Real Time Face Mask Detection using Google Cloud ML and Flutter

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Real Time Face Mask Detection using Google Cloud ML and Flutter

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Abstract. Coronavirus (Covid-19) pandemic has impacted the whole world and has forced health emergencies internationally. The contact of this pandemic has been fallen over almost all the development sectors. A lot of precautionary measures have been taken to control the Covid-19 spread, where wearing a face mask is an essential precaution. Wearing a face mask correctly has been essential in controlling the Covid-19 transmission. Moreover, this research aims to detect the face mask with fine-grained wearing states: face with the correct mask and face without mask. Our work has two challenging tasks due to two main reasons firstly the presence of augmented data set available in the online market and the training of large datasets. This paper represents a mobile application for face mask detection. The fully automated Machine Learning Cloud service known as Google Cloud ML API is used for training the model in TensorFlow file format. This paper highlights the efficiency of the ML model. Additionally, this paper examines the advancement of the cloud technology used for machine learning over the traditional coding methods.

1. Introduction

Covid-19 has had a huge impact on the mankind. The Covid-19 pandemic affected billions of lives and lead to the loss of millions [1]. As suggested by World Health Organization (WHO), 171 million people were infected, as well as 3.5 million people died due to this Covid-19 as per the May 2021 [2]. WHO declares some of the major symptoms for the novel virus, such as loss of smell and taste, fever, tiredness, dry cough and diarrhea. It affects almost all the economy, commercial establishment [3], religion, tourism, transport, employment, food security, education and other industries also. Many preventive measures have been taken against COVID-19 such as maintaining social distancing (minimum 1.2m), sanitizing hands, avoid touching eyes, mouth and nose are the main and most important while wearing a good mask. While it is important for people to understand that a mask is very important from prevention of Covid-19. This paper highlights a model for the detection of face mask technique [4]. This model classifies a face with a mask. This paper demonstrates Machine Learning (ML) model in the TensorFlow format. ML marks an exceptional role in the detection of objects [5]. Firstly, the camera captures the real-time image of faces in public places. This image is converted and then analyzed through the TensorFlow file; these images are analyzed on multiple layers of automated CNN built using Google Cloud.

The major contributions of this research paper are presented below:

A. This paper presents masked faces dataset which is utilized for additional training for the development of the new face detectors.
B. This paper proposes Automated CNN, used for mask detection. This algorithm outperforms the traditional six face detectors which detects the faces with the mask.
C. This paper researches on the target of key challenges present in face mask detection. This paper suggests new ways for developing the new face detectors.

This paper is well ordered as follows: Section 2 discussed the linked face mask detection. This paper examines different researches done in the industry and also this paper also suggests drawbacks.

Section 3 represents the methodology for expanding this model. Section 4 highlights the working of the model. The results of the model are demonstrated in section 5. Section 6 demonstrates the conclusion of this paper followed by future works in Section 7.

2. Related Work

Recently, the ML field has obtained a huge distribution of observation. Table 1 describes the method used in different paper for preparation of face mask detection. This table also discusses different contribution made by different paper with respect to the algorithms used by the authors and the benefits attached to them.

Table 1: Comparison of Associated Papers with the Current Paper

Study	Year	Method	Contributions
Qin et al. [6]	2020	SCR Net	1. Performs well on low-quality pictures. 2. Prediction is not accurate due to low quality datasets images. 3. Complicated training process.
Jiang et al. [7]	2020	Retina Mask	1. High ability to extract the robust feature. 2. Highly complicated due to the hyperparameter. 3. More training time.
Militante et al. [8]	2020	RTFR	1. It has a lot of errors due to the local features. 2. It is not end to end. 3. Highly dependent on pre-processing.
Din et al. [9]	2020	GAN-based Network	1.Representative of state-of-art approaches both quantitatively and qualitatively. 2. Generates perceptually and structurally plausible facial images. 3. Achieved the effect of coarse-to-fine image completion.
Taha et al. [10]	2021	ResNet-YOLOv2	1. High number of anchor boxes. 2. Predicted results are not correct 3. Low efficiency and medium performance in model
Zhang et al. [11]	2021	R-CNN	1. Average prediction on practical dataset. 2. Highly capable of extraction of distinct feature maps. 3. Complex due to high number of anchor boxes.
Loey et al. [12]	2021	Hybrid Model	1. Used different kinds of classifiers for better performance. 2. Training process is relatively low. 3. Images cover faces and are restricted for single person per image.
Liu et al. [13]	2021	3D Presentation Attack Detection (PAD)	1. It detects the type of masks. 2. High detection rated due to special camera features like 150° motion and dim light sensor 3. Uses multi-channel time-frequency analysis scheme.
Sohit et al. (Current Paper)	2021	Automated CNN	1. Uses Bucket Classification for the datasets. 2. Detect face mask with occlusion. 3. Machine learning file is then combined with flutter for mobile application development.

3. Methodology

3.1. Background

Our paper recognizes the proper state, as if a person is wearing a mask or not and it also checks whether the mask has been worn correctly, which will result in the reduction of the Covid-19 spread. Firstly, a large amount of dataset was not available on the online platform. Secondly, the presence of original images with people wearing mask data set was not available on the online platform. To overcome this challenge, this paper first shown a practical as well as clean data set of conditions of wearing face-mask. Based on this, this paper evolves the detection framework with the help of Google Cloud AI/ML API, which uses Convolution Neural Network (CNN) and Machine Learning (ML), which could attain detection of high-quality performance by capturing different images from different angles [14].

3.2. Construction of Data

First step would be to collect the data set available for the mask and no mask from the internet sources like Kaggle. In that processes, "occlusion, cover, face and mask" were utilized to recover 4500 images with faces from social nets such as Flickr as well as image search engines such as Safari, Bing and Google. This paper depicts the images with minimum of 90 pixels. After this, the images which contains faces without occlusion were removed manually. Finally, this paper obtains with 1,026 total images in which 513 images of masked face and 513 of non-masked face. This paper depicts nine subjects manually to annotate all the faces available in the dataset, all the image is annotated on the two major subjects and cross-training mostly by third subjects [15]. This paper states the six attributes that must be manually for each face:

- **Face Location:** Each face location illustrated by square. If it was difficult to detect because of blurring of images. In the major cases the image is then rejected for the model training.
- **Eyes Location:** In each face, eye coordinates center is marked manually.
- **Mask Location:** All mask location and/or glasses in face are illustrated by rectangles.
- **Orientation of Face:** This paper defines five orientations such as front, left, right, right-front and left-front. In the illustration, the face orientation was adopted by three subjects.
- **Occlusion degree:** This paper separates the face into four areas, such as nose, eyes, chins and mouth. According to number of areas occluded by glasses and/or masks, this paper explains three occlusion degrees, consisting: Heavy Occlusion (four areas), Medium Occlusion (three areas) and Weak Occlusion (one or two areas).
- **Type of Mask:** This paper explains four classes of mask that could be found frequently in web/internet images, such as: Human Body Mask (covered of face by hair, hand etc.), Hybrid Mask (combination of at least two masks), Complex Mask (synthetic objects with complex logos or textures) and Simple Mask (pure color synthetic objects) [16].

3.3. Statistics of Dataset

This paper consists of 513 mask and 513 without mask faces with minimal size of 30*30. The coverage of an average face mask is around 145*145 pixels This paper explains that most of the faces are front faces, while few are right or left faces. In this way, face detector relies on exact determination of eyes, as well as in demanding cases like right-front and left-front faces could be utilized. Furthermore, most of the faces were medium occlusion. In addition, this detector consists multiple types of masks such as hybrid, complex, simple etc. As discussed above, all these attributes specifies that this dataset for detection of face, could give equitable contrast in distinct standard face detectors.

3.4. Traditional Algorithm

The algorithm proposed for detection of face mask comprises three steps: preprocessing, detection of face and mask detection as shown in figure 1. The first step is data preprocessing in which it enhances input image quality by utilizing edge enhancement as well as auto white balance using unsharp filters. The auto white balance is to check consistency of color of input image with different ranges of color temperature. Then, the unsharp filter enhance the edges of images. In second step, the detection of face is placed where enhances the detection of face region. Viola-Jones proposed Haar cascade classifier to detect face region [17]. This executes Haar cascade classifier to extract features with 25*25 window size, utilizing AdaBoost to detach unnecessary features as well as apply it to detect objects. The Haar Cascade classifier obtains the result by dividing the sum of black pixels by the sum of white pixels. Then, detected face regions is put into input data of YOLOv3 algorithm to recognize regions of masked face. In last step, model identifies whether person is wearing a mask or not by utilizing YOLOv3 algorithm. This paper forms the predicting process at three scales: 14*14, 25*25 and 50*50. The first detection carried out by 82nd layer with the size 14*14*26 followed by second detection carried out by 94th layer with size 25*25*26 followed by last detection carried out by 106th layer with the size 50*50*26.

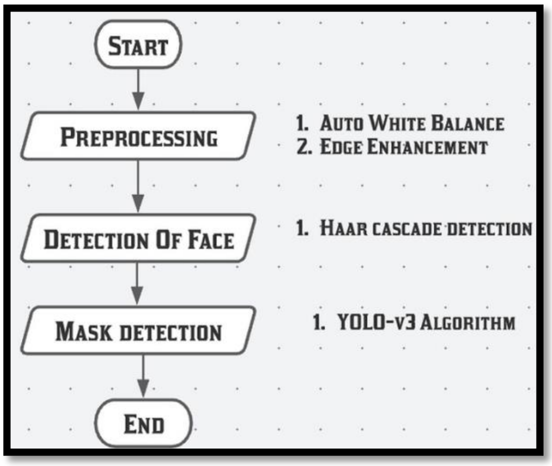


Figure 1. Flowchart of the traditional algorithm.

4. Working

The working of our model is shown in figure 2. This model is developed with Google Cloud Auto AI/ML. In which Auto AI/ML API allows to train the model with the given dataset. Auto AI/ML API utilizes Neural Architecture Search (NAS) to search the best way to train the model. It works more perfectly with the good quality dataset, it also results in high accuracy of the model. Exponentially, it reduces effort of writing code to train the model from scratch. After collection of data is done, the data collected of masked and non-masked faces is then zipped up and imported in Google cloud platform (GCP). Then these Data is segregated into different classified buckets according to the training hours required. Then the buckets are trained with the classification as TensorFlow file [18]. As flutter is compatible with only TensorFlow lite file with Yolov3 library only. After exporting this model, it can be integrated with the camera modules to run this ML model. However, we have combined this TensorFlow file with the flutter by using the Dart language. In this way, anyone can detect the masked and non-masked faces by using the android and iOS application.

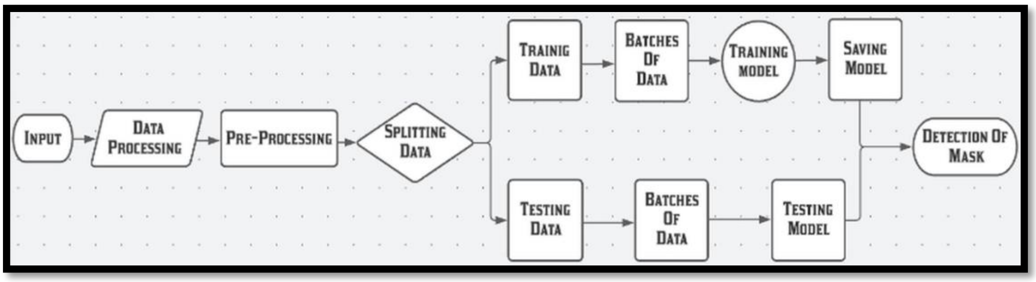


Figure 2. Working of the model

5. Experimental Results

5.1. Dataset

The paper utilizes the face mask detection model dataset in which 1,026 images with minimal size of 30*30. However, at the initial stages 4,500 images were selected for this model but most of them have to ruled out as the face mask were not worn properly. In this dataset, faces have their distinct occlusion degree and orientations. Then, this paper at final selects 1,026 images.

5.2. Training

In this model, the dataset is inserted into the GCP bucket and the training of algorithm is done based on the images. In this, the inserted images are reconfigured and further converted into the array format. Then the training of this model is done by utilizing TensorFlow. This paper presents the graph of the recall and confidence of our face mask detection training model which has been trained by Google cloud ML. In figure. 3, it represents precision rate of our model. We have taken in account of about 1026 images datasets in which 513 images have been taken for mask images and no mask images respectively. The confidence graph also tells us about the performance of our model with the current dataset taken in the account. In figure 4, our paper demonstrated the precision rate of the machine learning model at various quantity of the dataset available. At the starting stage precision rate was less than 75%, then it gradually increased. However, from the different result fourth dataset of 1026 images was found out to be the most ideal dataset for the training as it achieved the most stable precision after which there was no significant increasing change in the precision rate.

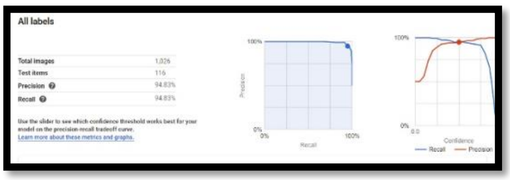


Figure 3. Training of the model

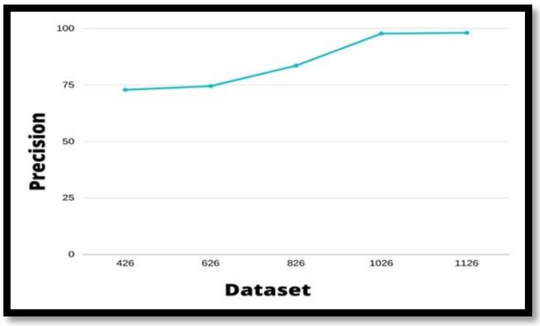


Figure 4. Flowchart of Dataset with its Precision

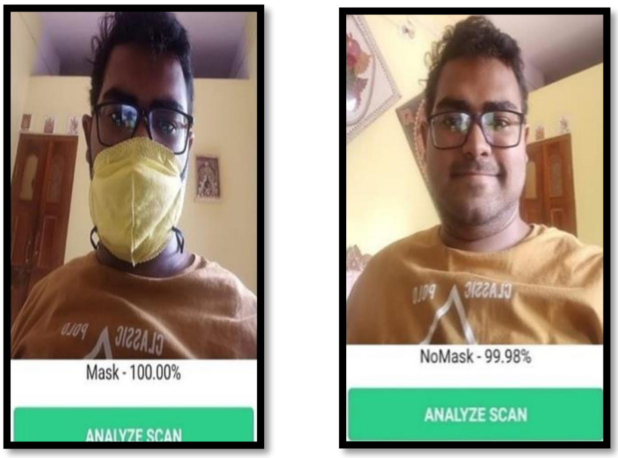
5.3. Performance

True Label \ Predicted Label	Mask	No Mask
Mask	100%	-
No Mask	10%	90%

Figure 5. Performance of the model

In this paper, figure 5 demonstrates the performance table for the face mask detection model. Our model has two true labels which are Mask and No Mask. Figure 5 also depicts two predicted labels for Mask and No Mask respectively. Our performance models show 100% efficiency of the predicted label of a mask with a person wearing mask. However, our model showed a 10% deflection in the No mask section of the true label. This figure also states that our model was showing highest efficiency with the person wearing mask.

5.4. Demonstration



(a) Precision with mask (b) Precision without mask

Figure 6. Results with Masked Face

Through both the representation of figure 6 we can see that when the real-world data was pushed in the mobile application. Our model has performed exceptionally well with the given input. When a person was wearing a mask, it showed 100% efficiency however according to another sample where a person was not wearing a mask, our model showed 99.98% efficiency. Through this we can say that our model has performed exceptionally well according to the data available in the training model in figure 3. However, any machine learning model which involves the data capturing through has a lot of exceptions like camera module quality, lighting conditions and temperature etc. All of these factors are highly responsible for the efficiency of the model. If these conditions are not kept in mind, then these might affect the efficiency in a larger way.

6. Conclusion

This paper suggests a model for the nation to control the coronavirus spreading by informing authorities about the importance of wearing of face mask properly that is most important precautionary measures for Covid-19. The objective of this paper is-to aware the people who disobey the laws or rule which are suggested by WHO or government to stop the Covid-19 spread. Due to Covid-19 pandemic, this model is highly applicable on the public areas where the mask is mandatory and it is difficult for the officials to keep an eye on all the people. To make people more aware of the mask use in the public areas, this model can be deployed or integrated with different channels such as flutter application which are now highly compatible with different kind of devices. This model can be used at all the distinct places such as schools, offices, railway stations and airports. This model will not only help the officials but would serve as a great advantage for the nation to recover from the pandemic of Covid-19. This model will be responsible for generating the awareness in the society for the people to wear the mask at all time. This model is also responsible for detecting the face mask on the people and companies could use it as tool to grant the entry access. It will only detect the face mask when you have properly worn it on your face.

7. Future Works

There are a lot of cases in which this model could be merged for the public safety. Firstly, by identifying what type of mask is the person wearing. Secondly by detection of sneezing and coughing. Thirdly temperature Screening. Fourthly by identifying a person is doing crime by wearing face mask.

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