Detection and Analysis of covid-19 using chest x-ray images

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Abstract: Covid-19 is a rapidly spreading viral disease that infects not only humans, but also animals are infected because of this disease. The daily life of human beings and their health and the economy of the country are affected due to this viral disease. X-ray imaging is a tool which is easily accessible and that can be an excellent alternative in COVID-19 diagnosis. The accuracy, sensitivity, specificity for this analysis was 97%, 96.3%, 97.6% respectively. This would be extremely useful in this pandemic and need for preventive measures are at odds with available resources. The aim of this paper is to propose automatic detection of covid-19 from digital chest X-ray images by applying deep-learning algorithms.

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1. Introduction

Covid-19 is a severe disease where a large number of people lose their lives every day. This disease affects not only a single country, and even the whole world suffered because of this disease. In the past decade, several kinds of viruses (like SARS, MERS, Flu, etc.) came into the picture, but they stand for only a few days. Many scientists are working on these kinds of viruses, and few are diagnosed due to the availability of vaccines prepared by them (i.e., Scientists or researchers). In the present time, the whole world is affected by Covid-19 disease, and the most important thing is no single country scientists can prepare a vaccine for the same.

In March 2020, X-ray images of healthy people and Covid-19 infected peoples were available in different repositories such as Github, Kaggle for analysis. Covid-19 is a disease that threatens humans at a global level and turned into a pandemic. To diagnose covid-19 patients with healthy patients is a critical task. The dialysis of Covid-19 infected patients needs more precaution and must be cured under strict procedures to reduce the risk of patients unaffected with covid-19.

As per literature review, after analyzing the potentials of computer tomography (CT) scans and X-ray images in detecting COVID-19. There have been several studies [5]-[7] trying to develop COVID-19 classification models, with an overall accuracy of 86.7%. Consequently, There are two or three regions which are randomly selected images from the dataset. Finally, features are extracted from CNN and fed to ensemble of classifiers for COVID-19 prediction of accuracy 88%. CT scans are also used in reference [8] to identify positive COVID-19 cases, where all images are separately fed to the model and outputs are aggregated using operation of sensitivity of 90%.

Deep convolutional neural networks perform better with a larger dataset than a smaller one. Transfer learning can be used in the training of deep CNN.

Large number of COVID-19 patients infected worldwide, the images of chest X-ray available in online are small and scattered. So, In this work we have reported a comparatively large dataset of COVID-19 positive chest X-ray images and unaffected person chest X-Ray images are used for this study. The collected dataset consists of 3000 total chest X-ray images.

2. Proposed Methodology

2.1 Data-Base Description

In this study, posterior-to-anterior (AP)/anterior-to-posterior (PA) images of chest X-ray were used by radiologist in clinical diagnosis. Different sub-databases are used to create one database. Normal and Pneumonia databases were collected from different websites. The methodology was explained by using block diagram as shown in fig.2.b.

2.1.1 COVID-19 positive Chest X-ray images from different articles

More than 1000 covid affected images were collected from different website and kept into a database. The radiography images were compared to other publicly available datasets to avoid duplication.

2.1.2 Pneumonia Detection

In this database, Normal chest X-ray with no lung infection and non-COVID person images as shown in fig.2.a were available.

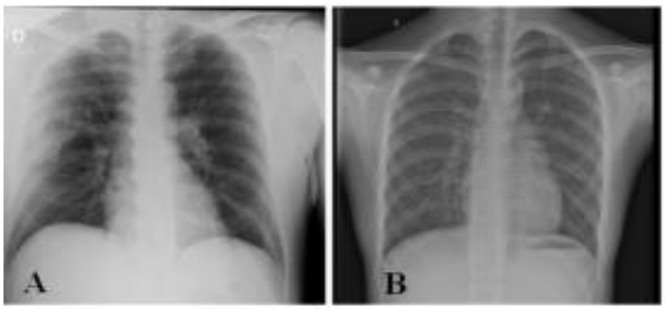


Fig.2.a

(A) Covid affected person X-ray image
(B) Normal person X-ray image

2.1.3. Block diagram

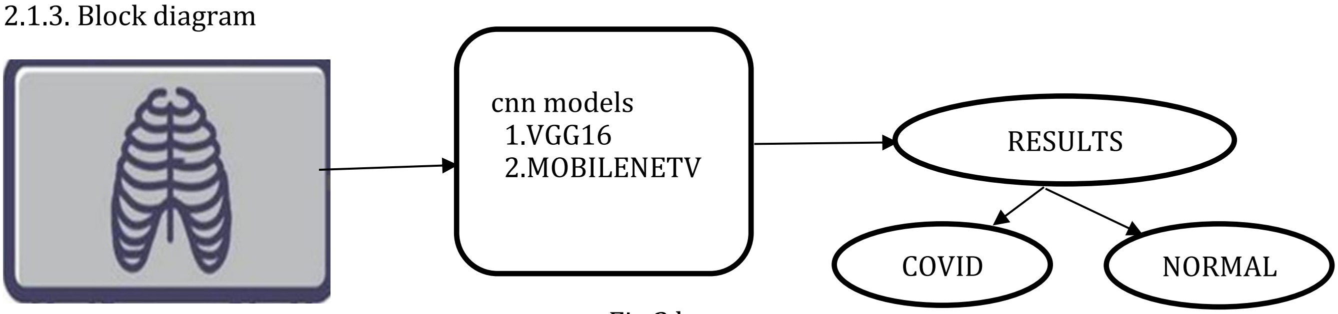


Fig.2.b

3.. Architecture of VGG16

It was proposed by simmonyan and Zisserman in 2014 and the block diagram of VGG16 architecture is shown in fig.3.a. This framework has been trained on Image Net dataset that consists of 14million images and attains accuracy of 92.7%.

Most of the parameters are used in fully connected layers. It has total memory of 96 MB image for only forward propagations.

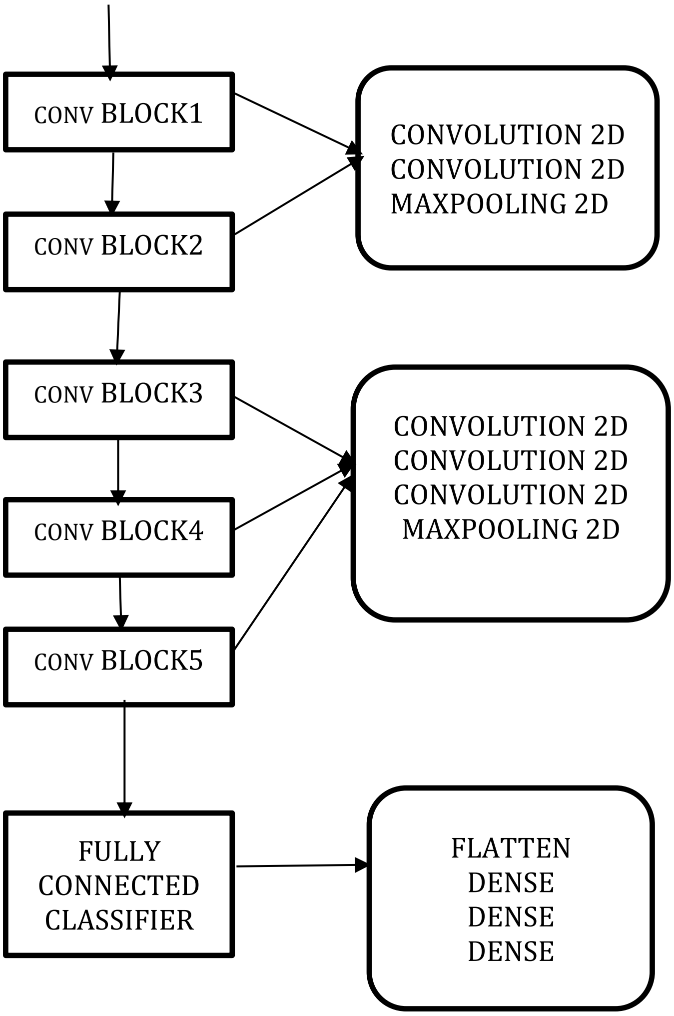


Fig.3.a.Architecture of VGG16

4. MobileNetV2 Architectre

MobileNetV2 is issued as a component of tensor flow slim image classification library. MobileNetV2 is a convolutional neural network builds upon the ideas from MobileNetV1. The architecture of MobileNetV2 consists of 54 layers that takes as input. The main feature of this architecture is that it utilizes depth wise seperable convolution.

The MobileNetV2 consists of two types of blocks. One block is residual block and other block is used for downsizing. Both the block consists of three layers. Those blocks are shown in fig.4.a. Each layer in the mobilenetV2 is represented as series of one or more identical layers that are repeated for n number of times. The Number of output channels is same in all the layers that have the same series.

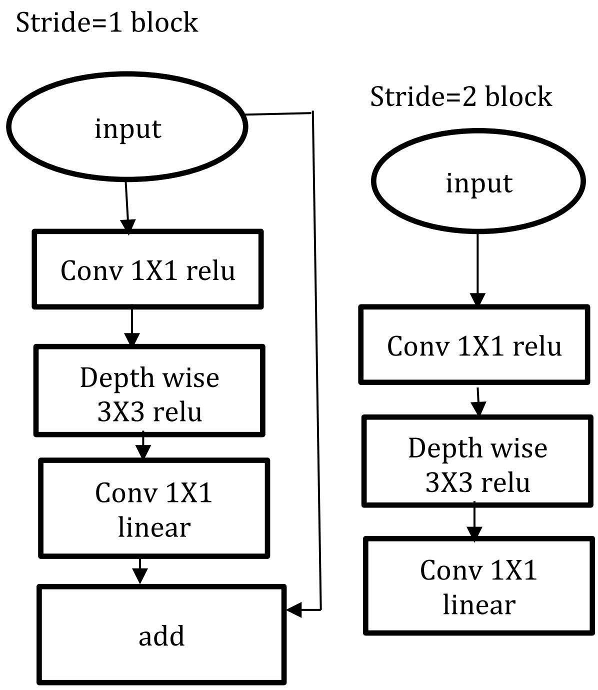


Fig.4.a.convolution of MobileNetV2

MobileNetV2 is an extractor for detecting the object and segmentation. It is based on an inverted residual structure where the residual connections are between the layers.

The whole architecture of MobileNetv2 contains fully convolutional layer with 32 filters follwed by 19 residual layers.

5.Data Preprocessing

To enhance this process, the images are preprocessed utilizing various preprocessing methods. The main reason for preprocessing the images is to enhance the visual capacity of input image by increasing contrast, by deleting low or high frequencies in the image and by reducing the noise present in original image. In this paper, we applied image resizing and image normalizing techniques for enhancing the quality of image.

5.1 Image Resizing

The dimensions of the image in the dataset are of different ranges. Therefore, to achieve dimensions of all images, original images are resized to the size of pixels to fit to the image in VGG16 and MobileNetV2 pretrained models.

5.2 Image Normalization

In this paper, we have applied the intensity normalization as preprocessing technique which is widely used in image processing applications. The intensity of the image is from 0 to 225 are normalized to the basic normal distribution by utilizing the min-max normalization and is shown in eq(1).

$$Xnorm = \frac{\mathrm{X-Xmin}}{Xmax-Xmin} \text{ -------->eq(1)}$$

Where,
X=pixel intensity
X_{min} and X_{max} = minimum and maximum intensity values of input images.

5.Accuracy

Accuracy is the measurement tool which is used to determine which model is perfect at identifying patterns between variables in dataset based on input and data. The formula of accuracy is given in eq(2).

$$Accuracy = \frac{\mathrm{TP+TN}}{\mathrm{TP+FP+TN+FN}} \text{ ----------->eq(2)}$$

6.Specificity

Specificity is the proportion of true negatives that are correctly represented by the model as given in eq(3) and eq(4).

$$Specificity = \frac{\mathrm{TN}}{\mathrm{FP+TN}} \text{ --------------->eq(3)}$$

Where,

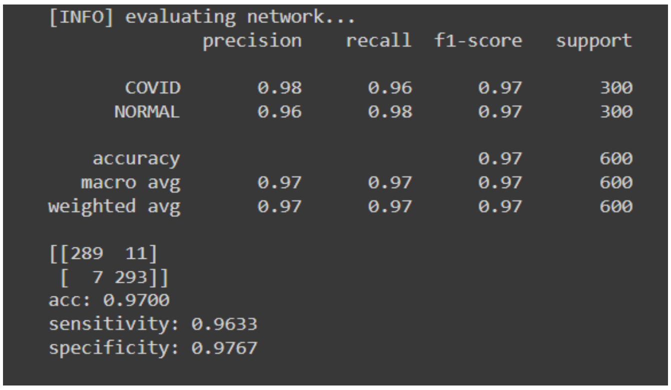
$$Fallout = \frac{\mathrm{FP}}{\mathrm{FP+TN}} \text{ -------->eq(4)}$$

6.Result and Conclusion

We validated our proposed model on COVID-19 normal chest X-Ray images and affected person chest X-ray images using VGG16 and ADAM optimizers.

It is also significant that these machine learning techniques have been used in the training process improves the ability of the work.

On comparing with other models our work approaches the better accuracy that is 97.7%. as shown in fig.7.a.



```
[INFO] evaluating network...
              precision    recall  f1-score   support

       COVID       0.98      0.96      0.97       300
      NORMAL       0.96      0.98      0.97       300

    accuracy                           0.97       600
   macro avg       0.97      0.97      0.97       600
weighted avg       0.97      0.97      0.97       600

[[289  11]
 [  7 293]]
acc: 0.9700
sensitivity: 0.9633
specificity: 0.9767
```

Fig.6.a

7.References

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