Automatic Detection of COVID 19 Infection Using Deep Learning Models from X-Ray Images

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Abstract. In worldwide millions of people are infected due to COVID-19 virus and even that is increasing exponentially. The medical researchers are using RT-PCR test to distinguish between COVID (+) and COVID (-). The growth of virus is exponential that’s lead to an outbreak, and to break this we have to conduct test as many as possible. RT PCR test is costly and not available in remote areas this is big challenge that developing countries is facing. The second big challenge whole world facing is the availability of doctors and radiologists. So, we need an automated system based on AI and Machine learning (ML) for detection of COVID (+) cases. In literature AI, ML and Deep Learning (DL) played an important role in designing automated system in medical field by achieving good accuracy. In this paper, we have applied DL models ResNet 34 and ResNet 50 on X-ray images, achieved accuracy 96.4% with ResNet 34. And compared their result on the basis of various quantitative analysis parameter MCC, F1 Score, Precision, Recall and others to solve both challenges.

1. Introduction

The 2019 coronavirus pandemic also known as COVID-19, which started from China, has now spread in almost all of the parts of the world [1][2][3]. This pandemic has taken innumerable lives and has also caused extensive respiratory diseases in numerous people [4]. This virus is termed as SARS-CoV-2 and it’s cases has now reached to approximately 23,041,433 cases worldwide according to the statistics of WHO. However, since the cases are increasing rapidly around the world there are a scanty number of RT-PCR kits which are readily available in hospitals for the detection of COVID-19. Radiologists have a significant role in detection of COVID-19 cases due to their expertise in this area, further and automated system based on ML DL and AI technologies in radiology can be helpful and beneficial in obtaining even more accurate diagnosis [5][6][7][8][9]. Therefore, it has become important and necessary to develop an automated detection system based on Artificial Intelligence as an alternate diagnosis option to detect COVID-19 at the earliest and also so that it can be prevented from spreading further among people.

The aim of this research is to assess the efficacy of the pre-trained CNN models in accurately diagnosing the COVID-19 patient. In this paper, we have proposed two Residual Neural Network based models (ResNet34 and ResNet50) for the detection of COVID-19 pneumonia infected patients from the chest X-ray radiographs. And to achieve this we used an aggregation of 2481 X-ray radiographs of the chest to train and validate our models. From the results obtained, it is observed that the pre-trained model ResNet50 provided with a higher accuracy and showed better performance than
ResNet34 with an accuracy of 96.4% whereas pre-trained model ResNet34 showed an accuracy of 94.3%. The organization of the papers is followed as in Section 2 Literature Review is given. In section Implementation of model is performed and results obtained are discussed on the basis of various quantitative analysis parameter. Further, in Section 4 conclusion were drawn.

2. Literature Review
It was in December, 2019 when a virus named COVID-19 started to spread in China followed by which it rapidly spread amongst almost all the parts of the world [6,7]. Therefore, the early detection of this virus might prove to be helpful in reducing COVID-19’s spread [8]. Deep learning is one such AI technique that might be beneficial in detecting COVID-19 virus using the medical images (eg-X-rays), especially if provided with a smaller dataset [6][8].

Initial researchers have also used deep learning for the COVID-19 detection using the X-ray images of the chest. Minaee et al [6] created a dataset of chest x-rays which consisted of 5071 images. It had 5000 non-COVID-19 and 71 images of Covid-19. He selected 3000 non COVID-19 images and 40 images of COVID-19 for the testing set and 2000 non COVID-19 and 31(496 after augmentation) COVID-19 images for the training set. Then 4 Neural Network models (deep learning models) SqueezeNet, DenseNet-121,ResNet50, ResNet18 were trained on the above dataset for detecting the COVID-19 virus. The highest sensitivity and specificity rate achieved by the best model was 97.5% and 95% respectively [6].

Ozturk et al [10] suggested the DarkCovidNet model for the diagnosis of COVID-19 from the X-ray images of the chest. He evaluated his model using a dataset of 127 chest X-ray images of COVID-19, 500 chest X-ray images of a healthy person and 500 chest X-ray images of people suffering with pneumonia [10]. The proposed model gave an accuracy of 98.08% in case of binary classes ( Healthy vs COVID-19 ) and an accuracy of 87.02% in case of multi-class ( Pneumonia vs. Healthy vs COVID-19 ) [10].

3. Implementation and Results
In this section we have applied DL models ResNet34 and ResNet 50. For the training our deep learning models: ResNet34 and ResNet50 we have used a dataset of 2481 images and divided the dataset in the ratio of 80:20 for training and testing respectively. The methodology of implementation is given in Figure 1.

![Figure 1. Flow Chart of Methodology](image-url)
To measure the performance of both the models, the training loss curve is drawn for ResNet 34 and ResNet 50 see Figure 2.

![Figure 2. Training Loss Curve](image)

**Figure 2.** Training Loss Curve
a) ResNet 34  b) ResNet 50

Fig. 2-a is showing the training loss of the deep learning model ResNet34 and figure-b is showing the training loss of ResNet50. In the following plots Y-axis is showing the loss whereas the X-axis is showing the no. of iterations. From the following plots of ResNet 34 and ResNet50 we can observe that the training loss of ResNet34 is less than that of ResNet 50, since the loss curve of ResNet34 is decreasing more consistently in comparison to ResNet50.

Further, to measure the performance of the model the learning rate curve is drawn for both deep learning models ResNet 34 and ResNet 50 see Figure 3. From Figure 3 it has been observed that learning rate curve of ResNet 34 is smoother than ResNet 50.

![Figure 3. a) Learning Plot of ResNet34 and b) Learning Plot of ResNet50.](image)

**Figure 3.** a) Learning Plot of ResNet34 and b) Learning Plot of ResNet50.

The confusion Matrix (CM) will give the pictorial representation of False (+/-) and True (+/-) cases. For the DL model ResNet 34 and ResNet 50 we have drawn CM on test cases. The confusion matrix for both the models ResNet34 and ResNet50 is built on the test data i.e., 496 images. The positive class is ‘COVID’ and the negative class is ‘non-COVID’ as shown in figure 4.
Fig. 4-a is the confusion matrix of ResNet34 showing that the value of TP (True Positive) = 228, TN (True Negative) = 240, FN (False Negative) = 10 and FP (False Positive) = 18. Figure-b is the confusion matrix of ResNet50 showing that the value of TP (True Positive) = 234, TN (True Negative) = 242, FN (False Negative) = 6 and FP (False Positive) = 12. From the predicted values of TP, TN, FN and FP by the deep learning models - ResNet34 and ResNet50, it is observed that ResNet50 has more number of True Positives and True Negatives and less number of False Positives and False Negatives compared to the ResNet34. Therefore, it can be concluded that ResNet50 classified the images more accurately than the ResNet34 model.

Performance metrics play a vital role in finding the best classifier for solving the particular approach. In this paper we have measured our DL models on various quantitative parameter analysis to observe the performance of classifier.

From the results in the table 1 we observed that ResNet50 has a higher accuracy than the ResNet34 model therefore, proving to be a better training model for Covid Detection. Also, the other parameters such as Precision, Recall, F1_Measure, Sensitivity, Specificity, MCC etc used to compare the two training models also show that ResNet50 is a better training model than ResNet34 since all the values of ResNet50 of the above parameters are better than ResNet34. MCC for resnet50 is 0.92 whereas for ResNet34 it is 0.88 and thus, this proves again that ResNet50 is a better training model since nearer the value of MCC is to 1 more accurate prediction does the classifier give.
Table 1. Quantitative Parameter Analysis of ResNet 34 and ResNet 50

|               | ResNet34                  | ResNet50                  |
|---------------|---------------------------|---------------------------|
| Accuracy      | 0.9435483870967742        | 0.9635627530364372        |
| Precision     | 0.926829268292683         | 0.9512195121951219        |
| Recall        | 0.957983193277311         | 0.975                     |
| F1 Measure    | 0.9421487603305786        | 0.9629629629629629        |
| Sensitivity   | 0.957983193277311         | 0.975                     |
| Specificity   | 0.9302325581395349        | 0.952755905511811         |
| FPR           | 0.06976744186046512       | 0.0472440944881889        |
| FNR           | 0.04201680672268908       | 0.025                     |
| NPV           | 0.96                      | 0.9758064516129032        |
| FDR           | 0.07317073170731707       | 0.04878048780487805       |
| MCC           | 0.8875222391101176        | 0.9273908628435336        |

4. Conclusion

Millions of people are already infected through COVID 19 and cases are growing exponentially. Throughout the world researchers of various fields are working to break this outbreak. AI, ML and DL in literature is used to design the automated system in various areas like Medical, agriculture, management and others. In this paper we have designed an automated detection system using DL models ResNet34 and ResNet50 and measured their performance on the basis of various quantitative analysis parameters. It has been observed that the pre-trained model ResNet50 provided with a higher accuracy and showed better performance than ResNet34 with an accuracy of 96.4% whereas pre-trained model ResNet34 showed an accuracy of 94.3%.

5. References

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