COVID-19 Screening using Transfer learning model ResNet50

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Abstract- The presented people of the world faced a global pandemic for the first time since 2019, which killed and affected a very large population in a short period and continues. In the addition to RT-PCR method of testing the COVID-19 disease, the radiology images can also be very beneficial in the diagnosis of this disease with the involvement of Deep Learning support, which will help in providing fastresults with several advantages through X-ray images. In this paper, we have applied the transfer learning model – ResNet50 for the Chest X-rays images dataset of a total of 42000+ images divided into 3-categories. The outcome of our experiment results is 94.89% and 92.74% accuracy for training and testing respectively. Our model has given a better accuracy on such a large set of data images and reduces the data imbalance problem concerning existing work. In the future, we will mainly work on the enhancement and segmentation of the images and will evaluate the performance of our model on the processed data.
Keywords-COVID-19, Radiology image, Detection, Transfer learning, ResNet50

I. INTRODUCTION

The world came across COVID-19 in December 2019, which hasthreatened the lifestyle of people and the health sector completely. This is a highly adjoining disease, which gets spread to many people causing problems, especially in respiration, due to the reason of its transmission a very large number of populations of the world are affected and killed millions of patients in a very less time.

Different methods for the identification of the disease areout, among all RTPCR is a standard choice, but there are several disadvantages of it as high testing cost, a large number of hours for giving results, etc. it has been surveyed that 1 out of 3 tests of this testing method is a false result. As COVID-19 is a respiratory problem, the main suffering is in the chest area. The usage of radiology images can be very beneficial in the prediction of technological support.

Overthe last decade, the techniques hold up, giving a new direction to the medical field. The use of deep learning reduces the prediction problem and the diagnostic limitations for various types of images like CT-scan, X-rays, etc. So, applying the deep learning approach will give a true direction and accuracy in the detection of this pandemic, which will be very helpful in the timely treatment and precautions according to the requirement.

In this study, the model development is done with the support of the transfer learning approach, a part of deep learning. There are several networks for transfer learning among which, is the Residual Network variant, providing for the type of radiology image. The details of the work are explained as further in various sections of the paper presented as section 2 follows by related work, section 3 methodology, section 4 result & discussion, and the last section is the conclusion of our research work.

II. RELATED WORK

Halder et al. [1] proposed a framework KarNet that is based on deep learning with the involvement of VGG16, ResNet50V2, MobileNet, and DenseNet201 models. CT scan images are taken as a dataset for the experiment work among which 97% accuracy is the highest for the

DenseNet201 model. Albahli et al. [2] prepared a model, with the state of art models – InceptionNetV3, NASNetLarge, and Inception ResNetV2 for the prediction of the virusfrom the chest X-ray images of Chest of total 850 images of positive, 500 negative, 915 normals. The best result is obtained by the InceptionV3 model among all. The future work will be continued by them for a large set of data.Sitaula et al. [3] presented a model of deep learning attention-based with the support of VGG16, using three classes of dataset X-ray images and worked on the classification accuracy which is 79.58%. Also,used GAN and Convolution Autoencoder before training to improve the result.Bharati et al. [4] proposed a Residual Network(CO-ResNet) which is prepared using a hyperparameter tuning to ResNet101. A totalof 5939 datasetswere used in form of X-ray images. 92.08% and 91.32% are accuracy rates for CO-ResNet and ResNet101 simultaneously.Umair et al. [5] applied 4-models DenseNet121, ResNet50, VGG16, and MobileNet, for the dataset of Chest X-ray images of a total of 7232 where 96.49% was highest for the DenseNet121. The GRAD-CAM approach is also applied for creating Heatmap images for a feature highlighting.Alshehri et al. [6] worked on the 3 types of radiographic images – 746 CTscan and 852 X-ray images and experimented with 8- CNN based models, for the coronavirus prediction giving 84% and 69% accuracy for CT scan and X-ray images Respectively, the CT scan performance is observed as best.Dutta et al. [7] proposed a multi-layer CNN model, with the involvement of InceptionV3, and experimented on a CT scan dataset for 31 Epochs Consecutively and obtained 91.40% and 84.29% for training and validation accuracy.Taresh et al. [8] made use of the 8-models of transfer learning, among which the best result has been given by the VGG-16, with 98.71% accuracy for the dataset of X-ray images. The implementation work is performed in python using Keras Libraries.J Horry et al. [9] presented a semi-automated Deep learning framework. The 4-models- VGG, ResNet, Xception, and inception, Where VGG19 has gained the better precision 83% for the Chest X-ray images.Shadin et al. [10] proposedan efficient CovidNet model, with the approach of voting based, and worked on the CT scan images of 2 large publicly available datasets. The result gets improved from 56.16% to 87.68%.Arias-Garzon et al. [11] worked on U-Netand VGG16 to predict the positive and negative cases from X-rays. The accuracy obtained is 97% by the model. Total work is done on 9 images at various stages. Abdar et al. [12] developed a CNN model and operated it on 10000+ CT scans. The positive and healthy images are used and obtained with 90% accuracy. Shivani et al. [13] presented a CNN model and worked on 3 categories of images. 94% and 96% are the testing and training accuracy. S,Yadav, et al. [14] worked on the classification and prediction of pneumonia using 3-main techniques- Linear SVM, VGG16, and InceptionV3. Among theseCNN-based models have given the better outcome. Shrinjal et al. [15]prepared a CNN model and used open-source data from Chest X-ray images. The obtained accuracy of a model is 87%. Table I presented the summary of the related papers.

TABLE I. SUMMARY OF PAPERS

Techniques	References	Number of Dataset images
Simple CNN (Convolutional Neural Network)	Dutta et al. [7] Shadin et al. [10] Abdar et al. [12]	CT Scan
	Garzon et al. [11] Shivani et al. [13] Shrianjal et al. [15]	Chest X-ray
Transfer Learning	Halder et al. [1] Alsherhi et al. [6]	CT Scan

	Albabhi et al. [2] Sitaula et al. [3] Bharti et al. [4] Umair et al. [5] Garzon et al. [11] Taresh et al. [8] J Horry et al. [9]S.Yadav et al.[14]	Chest X-ray
Linear SVM (Support Vector Machine)	S.Yadav et al.[14]	Chest X-ray

III. METHODOLOGY

A. Dataset

In this work, the radiology images used as datasets are X-rays of the chest. These images are collected from open access source – Kaggle [17][18][19]. Total 40000+ images are applied to 3-different categories as follows COVID-19 positive patients, non-COVID infection (bacterial & viral pneumonia, Normal persons as presented below the data division for various classes "Fig. 1". For which the training and testing data images are divided into 29000+ and 12000+ i.e., 70:30 respectively. As illustrated in the diagram "Fig. 2"is the images for each class.

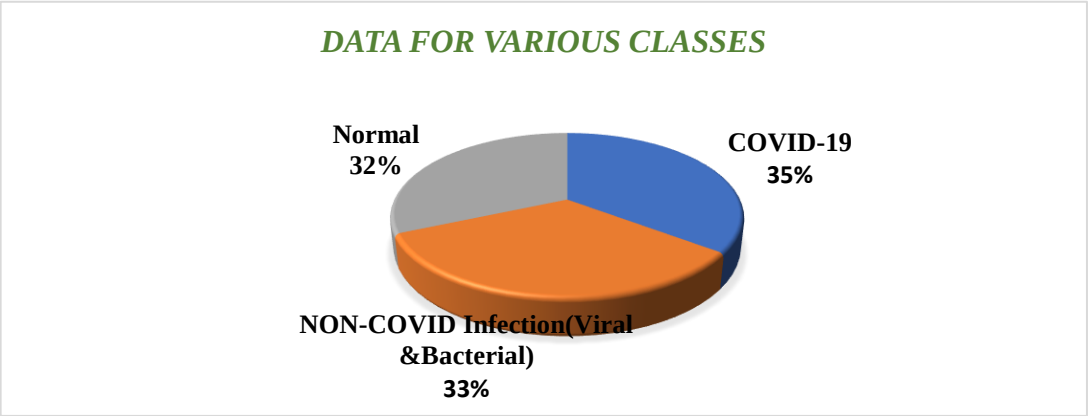
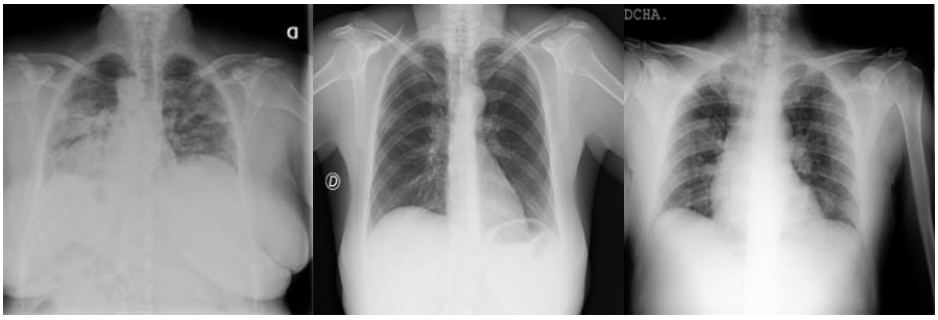


Fig. 1. Data for various Classes



i) COVOID-19 positive

ii) Non- COVID infection

iii) Normal

Fig. 2. Various categories X-ray images(Chest) presented – i), ii), iii)
[19]

B. WORKFLOW

As illustrated in the diagram of the proposed approach "Fig. 3". We have performed the work for COVID-19 screening for the X-ray images of the chest. The first step is that the dataset images are rescaled 224x224 and then further divided into training and testing. The transfer learning Techniqueis applied to perform the experiment in the prediction of the disease, using the ResNet50 model. Then the testing is done for the trained model, which is providing the best outcome with respect to the evaluated work in the same area for radiographic images. The applied technical way is detailed and explained below as follows.

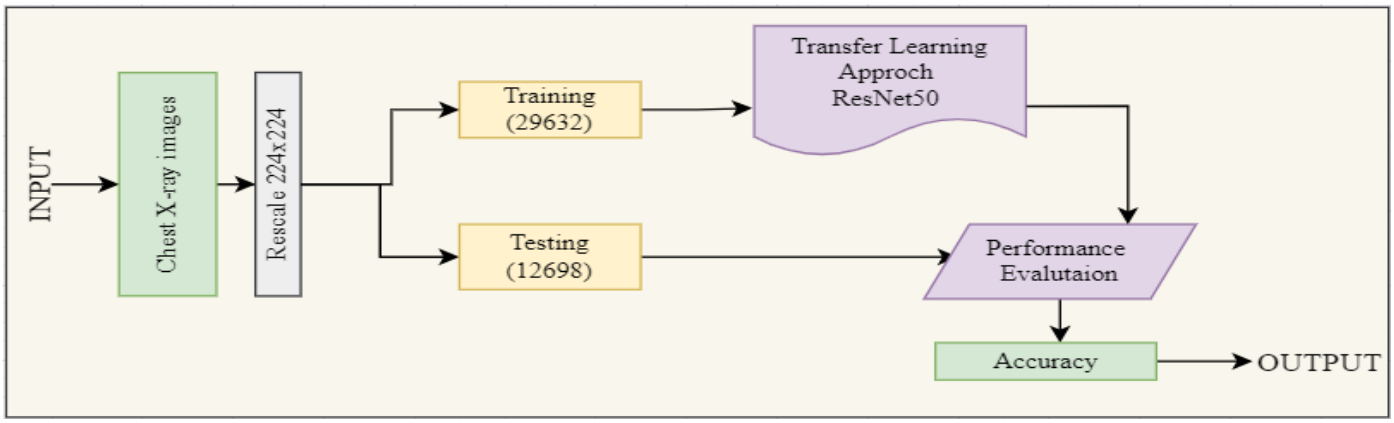


Fig. 3. Proposed Workflow

1. Transfer learning

Transfer learning is a way or process in the deep learning techniques, where it trains for one task, and reuses its learning or experience for a similar or another related task.

Deep learning can help in image classification with the CNN (Convolutional Neural Network). This is the major algorithm, that works for the images and its problem in identification. Every year ImageNet, held a competition for the CNN, which work on the learning of features without any human intervention from basic to the high level, a training of the network is done on a very large set of data images (in millions). The network which gives the best result is the one whose knowledge is used for similar related tasks or problem

to solve, which reduces the time and space usability and is helpful in giving better accuracy and result.

The Reuse of these Convolutional networks is referred as the transfer learning approach. As Illustrated in "Fig. 4" below. There are several networks also called pre-trained models as follows

VGG16/19, InceptionV3, NasNetLarge, ResNet, DenseNet, etc. Among these models, we have selected the ResNet50, to work more on its performance for the COVID-19 prediction from Chest X-ray images.

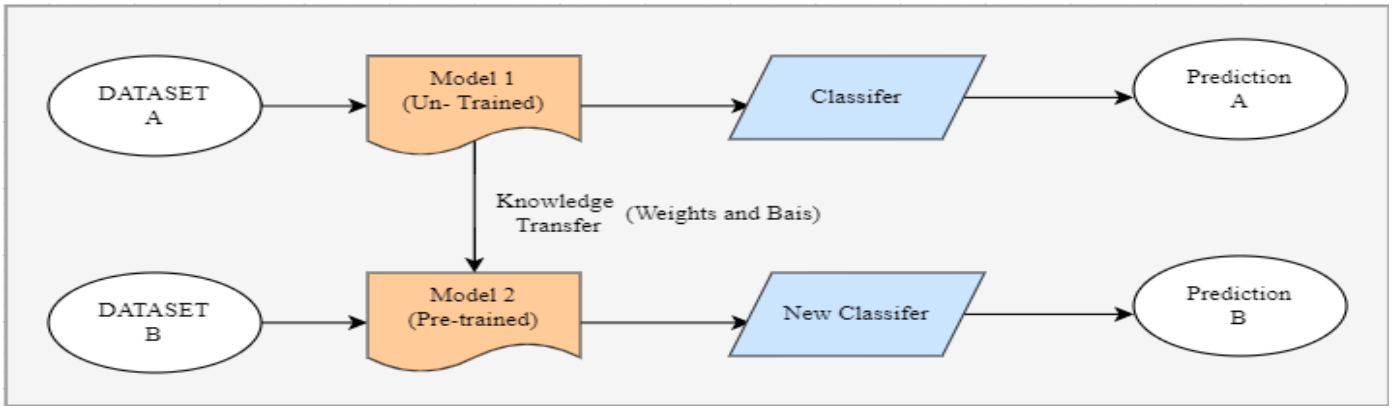


Fig. 4. Transfer learning approach

2. ResNet50

ResNet50 is the transfer learning model, a variant of Residual Network, with 50-deep layers has 48,1 and 1 as convolution layer, Max pooling, and average pooling layer respectively was developed in 2015, "Fig. 5" represents the architecture of the model. The major approach of its working is on skip connections, which is very helpful in avoiding the gradient problem and provides much better accuracy, as there are high chances of increasing the performance and decreasing the error rate because the vanishing gradient problem is reduced. As the model is worked on, first the weights are downloaded from ImageNet, and then freeze all the layers in which no change is required to make, this step is required so no loss can be done to the layers learning and the features, which will help in saving the time and the cost of computation. The changes are done in the final layer so that according to requirement and need the variation can be done and obtain the required result.

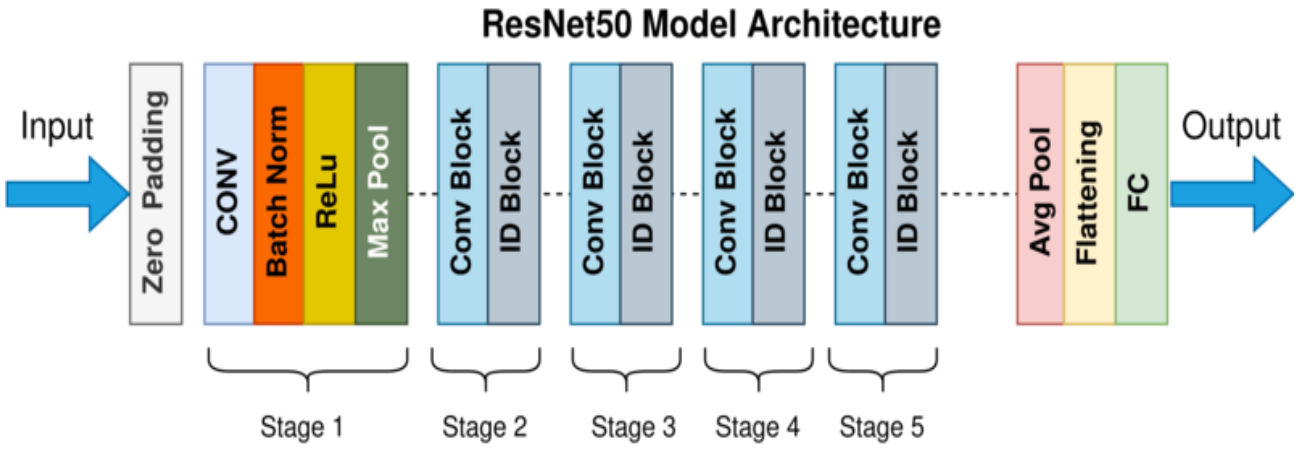


Fig. 5. ResNet50 Architecture[16]

C. Experimental Setup

Intel core i5 7th Gen with 16GB RAM is used. The implementation is carried out in python language using jyputer notebook on Kaggle.

IV. RESULT&DISCUSSION

As shown in Table II below, the outcome of our experimentation work on the ResNet50 model, which is performed for 10 consecutive epochs. Training and validation Values foreach epoch are presented in the table (see Table 3). The model has given the accuracy of 94.89% and 92.74% for training and testing respectively. Figure“Fig. 6”shows the graph for accuracy v/s epoch. Table III represents the value for each epoch from 1 to 10 for training and validation – accuracy and loss.

TABLE II. EXPERIMENT OUTCOME

Model	**Dataset**		**Accuracy**	
	Training	***Testing***	***Training***	***Testing***
ResNet50	29632	12698	94.89%	92.74%

TABLE III. VALUE FOR EACH EPOCH

Epochs	**Training**		**Validation**	
	Accuracy	***Loss***	***Accuracy***	***Loss***
1	0.6062	0.7616	0.3233	0.8779
2	0.4735	0.8161	0.2337	0.9220
3	0.4310	0.8405	0.2322	0.9220
4	0.4103	0.8403	0.2851	0.9083
5	0.3475	0.8665	0.2887	0.9185
6	0.2901	0.8914	0.2350	0.9209
7	0.2301	0.9127	0.2427	0.9264
8	0.1724	0.9377	0.2931	0.9198
9	0.2037	0.9264	0.2837	0.9192
10	0.1632	0.9489	0.2316	0.9274

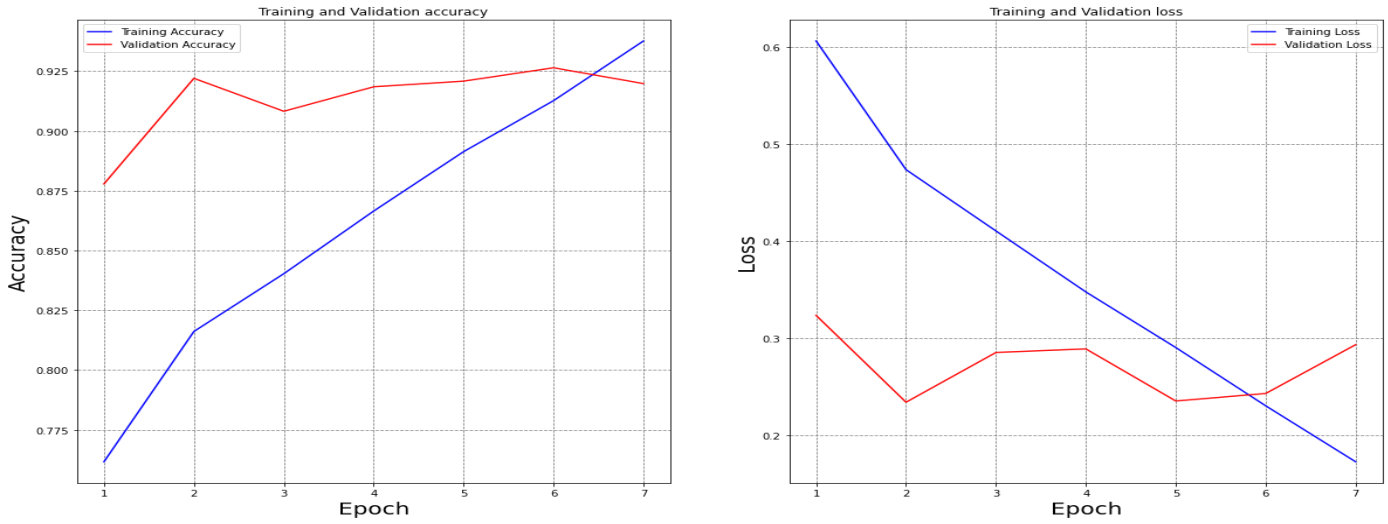


Fig. 6. Accuracy vs Epoch graph for model

In this paper, we have worked towards the screening of COVID-19 from the X-ray images of the chest for which the use of transfer learning model – ResNet50 is done, which is a variant of Residual Network. The publicly available data images of 3-categories are used. The size of these X-ray images isthe largest in number, which is taken for the experimentation work using the mentioned model. It has resulted that our model is giving the best accuracy for this largest dataset with respect to previous work, where they have used of maximum 10000 radiographic images dataset as CT scans, MRI, and Ultrasounds.

V. CONCLUSION

As we have discussed Billions of people are fighting against the suffering of COVID-19, due to its extremely spreading nature. The lungs are affected by infection badly which leads to death in many cases. So, in fighting against the disease in addition to other prediction methods. In this paper, we have developed and demonstrated the effectiveness of work done on the ResNet50 model for the COVID-19 prognosisfrom Chest X-ray images. The samples of the 3-categories images dataset are used from the open source- Kaggle repository. A total of 40000+ images are worked on, to look into the execution of the preferred model, where 70:30 images are divided i.e., 29000+ and 12000+ into training and testing respectively. The experimentation output obtained is94.89% and 92.74% for train and test data respectively. The obtained result is the best outcome on X-ray images used, which is largest in numbers in comparison to evaluated studies, which overcome the problem of the imbalanced dataset. In addition, we will apply the proposed model after enhancing and segmenting the images of the dataset and will work in direction of a larger number of images in the future.

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