Deep Learning for Detection of COVID-19 from Chest X-ray Image

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***Abstract*— Since December 2019, the world has entered a new phase, where the health sector and lifestyle of people has threatened worldwide due to global pandemic COVID-19. Because of this infectious disease, approximately 6 million people have died worldwide, and still, it is increasing. RT-PCR (Reverse Transcription-Polymerase Chain Reaction) is the prime method of testing covid- 19 now, but its pricey cost, lengthy testing result, and several other factors reduce the quality of prediction accurately within the time. In this paper, a deep learning approach is used to detect the Covid-19 disease using a dataset of chest X-ray images. A total 21165 chest X-ray images of 4-categories are taken and applied on the deep learning model ResNet50. The experiments show that it has better accuracy of 97.17% as compared to the existing models. In addition, the data set is also applied to Convolutional Neural Network model which has given the accuracy of 96.68%.**

Keywords*— *COVID-19, Chest X-ray, Deep Learning, Detection

I. Introduction

The unknown virus in 2019 December identified, which has emerged from SARS and MERS – named as Coronavirus, that has shaken the whole world in various aspects – Economically, Socially, Health sector, where the healthcare systems seemed helpless as its outburst on a very large scale [20]. Later, World Health Organization announced it a pandemic and is named as a disease called COVID-19. Its first case was identified in China and rapidly spread all around, due to which multiple variants have emerged till date, also its capacity of growing is very extortionate. The vital impact is on the people already suffering from some other serious illness. Its most serious symptoms can be noted down as Breath shortness.

COVID-19 timely detection and medication is a very major part on behalf of the public health and welfare of the society. For this, several approaches are used among which RT-PCR is the main mode in the predication but sometimes the result provided is false as it cannot identify it from the chest part and testing cost is high, also the time taken to provide result is around 18-20 hours minimum, which is very dangerous from point of the positive detected patient. The work is being done on finding the alternative method of RT-PCR which can give optimal results in less time and less cost. According to studies, the vaccination also has its impact for around a year, again gets high chance of getting the worst condition as its rapid spread give birth to in which some are very dangerous. Inspiring from recent research work, on the diagnosis of this disease from radiographic images and performed our work in the direction.

Over the past few years, Radiology Imaging has been a widely used clinical tool to diagnose abnormalities in the cardiothoracic portion and predict and monitor various lung diseases such as cancer, chronic bronchitis emphysema, pulmonary fibrosis, Pneumonia [15]. So, in the prediction of COVID-19 also this radiographic approach can be used where the images like Chest X-rays, CT-scan, Ultrasound, MRI, etc. can be scanned to check the presence and symptoms of the disease. As AI has been playing an encouraging role in the medical field to support the health care system with technology help to reduce their efforts.

Based on previous research work, Deep learning methods such as CNN and Transfer Learning approach is applied to give the best accuracy of their work on the data mostly available on open-source platforms like Kaggle, GitHub, Hospitals and medical institutes of several categories like covid-19 infected, Pneumonia, Healthy, and other Lung problems. Our work has focused on the CNN and Transfer Learning Model-ResNet50. The remaining paper is as follows- Section 2 focuses on reviewing research work their models, result, and dataset. Section 3 explains the details of datasets and methodology followed in this finding. Section 4 presents the result analysis and discussion of our work. Section 5 has given the summary of the proposed work of our research.

II. Related Work

Iraji et al. 2021 [1] a presented method, formed on a hybrid approach of deep CNN. Applied Metaheuristic algorithm for valuable selection of features and SVM classifier. They have made use of 11 CNN layers and a total of 1092 X-rays images are used of 3 categories. Tool preferred is Matlab and obtain 99.43% accuracy. The model prepared is useful for various other medical applications also. Yang et al. 2021 [2] worked on a publicly available dataset of X-ray and CT scan images. Applied 4-pre-trained CNN models – VGG16, ResNet50, ResNet152, DenseNet121 and proposed fast AI ResNet framework for better accuracy, which obtained up to 96% from CT scan and VGG16 has given 99% using X-Ray. Lafraxo et al. 2020 [3] proposed a CoviNet, which is built by histogram equalization, adaptive mean filter, and CNN. The dataset used is from Kaggle and given accuracy 98.62% and 95.77% for binary and multi-class respectively by using python and Keras library. Sevi et al. 2020 [4] has taken a total of 657 chest X-rays and used 4- deep learning methods – VGG16, VGG19, CNN, Inception v3 in which the most successful result is given by VGG19 95% and most unsuccessful by Inception v3. Hasan Jahid et al. 2021 [5] has prepared an ensemble model based on DenseNet121, EfficientNet B0, VGG19, and a DenseNet, which is based on U-Net architecture, applied amazon saga maker ground truth tool for training the U-Net segmentation model. Total 6571 X-rays images are taken and obtain validation accuracy is 99.2%. here two techniques are applied GRAD-CAM visualization

Technique and weight initialization Technique. Musleh et al. 2020 [6] have worked on Pneumonia prediction and detected COVID-19 by applying the CheXNet algorithm, which is a 121-layer condensed model. Total 556 X-rays images are used from Kaggle and divided data for 2 experiments. One is giving accuracy 84% and the other given 89.7%. Basu et al. 2020 [7] have proposed the DELT Concept with pre-trained deep learning models and taken 4 categories of data, which is collected from open source and given overall accuracy of 90.13%. the concept of GRAD-CAM is applied for more focus on the detected region of an image. Taresh et al. 2021 [8] aimed at evaluating pre-trained deep learning models. 8-models are used for the Kaggle dataset in X-ray forms. Among them, VGG16 and MobileNet have given the best accuracy 98.28%. Diaz-Escobar et al. 2021 [9] used the POCUS dataset of lung ultrasound images and applied VGG19, Resnet50, Xception, and Inception V3 models. 2-experiments are performed in which average and balanced accuracy achieved is 89.1% and 89.3% respectively. Sekeroglu et al. 2020 [10] has given 98.50% best accuracy after performing 38 experiments using CNN, 10 experiments using machine learning models, and 14 using pre-trained models. The dataset used is taken from GitHub in form of chest X-rays. Nur-a-alam et al. 2021 [11] used a machine vision approach to proposed a future fusion technique. Histogram equalization and CNN are involved for feature extraction. The MADF technique is also used for edge preservation and reducing noise and a watershed segmentation algorithm is applied as well. 98.36% is the best accuracy achieved using k- the fold Technique. The CNN provided better results than ANN, KNN, and SVM Techniques. Berrimi et al. 2021 [12] by pre-trained DL models approach, proposed a method. Two forms of images – Chest X-ray and CT scan are taken and worked on Inception V3 and DenseNet model for comparison, where the developed approach has given the better accuracy 94%. Zhao et al. 2021 [13] made use of transfer learning where CT scan is taken as a dataset. The proposed approach for diagnosis is compared to the neural architecture search model and given 99.2% accuracy. Das et al. 2021 [14] proposed a weighted average-base ensemble technique work based on state-of-the-arts CNN models- ResNet50V2, InceptionV3, and DenseNet201. Total 1006 X-rays of positive and negative cases are taken and given the best accuracy 91.62% higher than the individual result of models. Along with this, a GUI-Based application is developed that can be used on any system to check the result of COVID-19 inpatient. Moura de et al. 2020 [15] proposed an automatic way for classification using portable devices for 3-categories – Covid-19, normal and pathological. The presented approach is prepared from 3-complementary deep learning approaches and provides 79.62%, 90.27%, and 79.86% accuracy respectively. The dataset is from the radiology services of complex hospital Arian university.

III. METHODOLOGY

A. Dataset

The dataset taken is Chest X-rays images over other radiographic images due to their reasonable cost factor and availability. Total 21165 images are used from Kaggle, which are divided into 4-classes as follows – 3616 COVID-19 infected, 10912 Normal, 6012 Lung-opacity, 1345 Viral Pneumonia [16][17]. The collection of these images is prepared by researchers' group from the University of Doha and Qatar University in collaboration with medical doctors. 70:30 dataset is taken for training and testing respectively. Given below "Fig. 1" represents the different classes of X-ray images A) Covid-19 B) Lung Opacity C) Viral Pneumonia D) Normal.

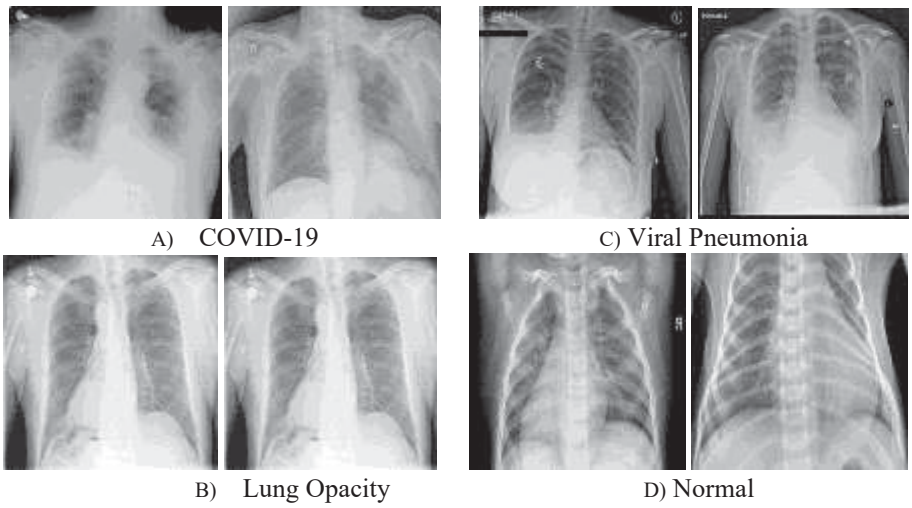

Fig. 1. Different Classes X-ray images of Chest A, B, C, D [16][17]

B. Proposed Approach

As the proposed work is presented for the identification of Coronavirus from the X-ray images of the Chest by the involvement of technology. So, great support can be provided to the healthcare system, improve work speed and reduce burden manually. The Deep Learning approach applied is i.e., Convolutional Neural Network and ResNet50 model. CNN is used to create the base-line model and ResNet50 is preferred on the large dataset. It is also observed that ResNet50 work is mostly performed on CT (Computed Tomography) scan, where these images provide high-level details and clarity, but in comparison, to the X-rays, its cost is high and not affordable, especially in remote areas and for people deals with financial problems. So, the major focus is kept on the work to be done on X-ray images. Pre-processing and

classification are major tasks involved in the experiment. Below "Fig. 2" has represented the proposed approach.

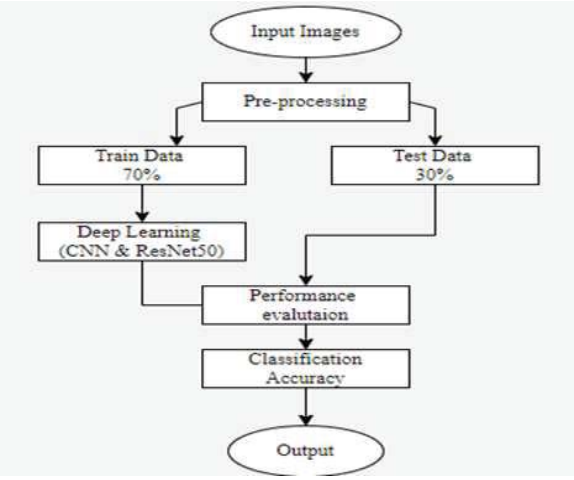

Fig. 2. Proposed Approach

C. Pre-processing and Classification

All the categorical labelled data images have been prepared from various sources such as online, published papers, German medical school, SIRM (Society of Medical and Interventional Radiology), podcast Dataset with different size and acquisition conditions. So, the performance of the created model can be affected due to variability of data. Here, pre-processing plays a major role in direction of creating a model with a better result. Major steps in the processes are- first Converted all the images to 224x224 pixels in grayscale and Normalization is done for changing the value of pixel intensity. The classification task is based on distinguishing the images provided in the dataset representing to which category the input refers as COVID-19, Normal, Lung-Opacity, Viral Pneumonia. The use of CNN and ResNet50 models are made for giving the expected result. As, shown below "Fig. 3" the classification of different images.

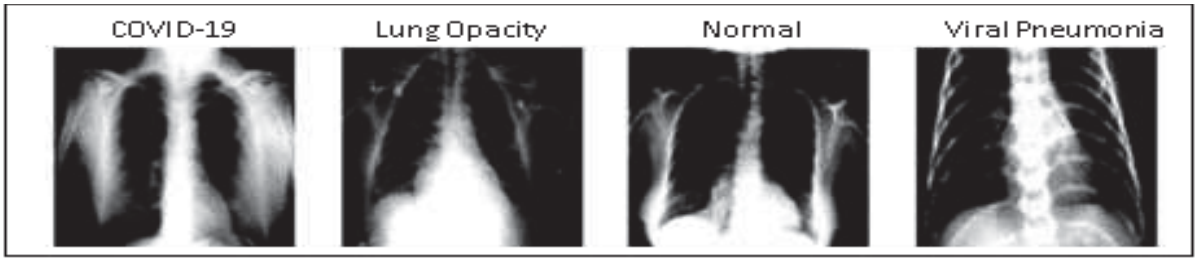

Fig. 3. Classification of the X-ray image classes

- **ResNet50** – is a pre-trained model uses transfer learning technique, in which the weights are already trained for the ImageNet dataset on millions of images. So later, the model prepared can be used for the small set of data and give faster and better performance by taking the advantage of already learned features. This model is a modification of the ResNet model "Fig. 4" and is 5-layers deep, works on skip connection and has around 23 million parameters. It has been observed in previous work [14][19] that the model is giving less accuracy for the X-ray images as compare to CT scan images. So, our work focused mainly to improve the classification performance for images of chest X-ray.

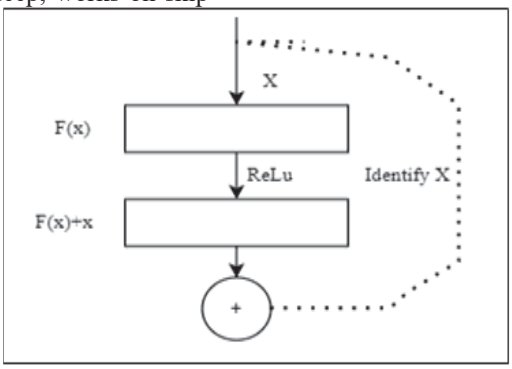

Fig. 4. Residual Network (ResNet) Architecture [18]

- **CNN**- CNN is the most popular algorithm of deep learning, which is specially designed for Image Recognition and Classification. There are several layers based on which the process "Fig. 5" follows such as Input, Convolution layers, pooling layers, flatten, fully-connected layers. With the help of these layers, the model prepared using a total of 5 layers. Hyperparameter used 3x3 feature detector is preferred, as it's a standard choice for convolution layers, activation function (ReLu) is used to maintain non- linearity next to every convolution layer. Max pooling 2x2 kernel size used and then dropout layer is given 0.2, this helps to check and prevent the model from overfitting. Next, flatten layer representing in the vector form and dense layers connected deeply process the given input and the output is presented for classification.

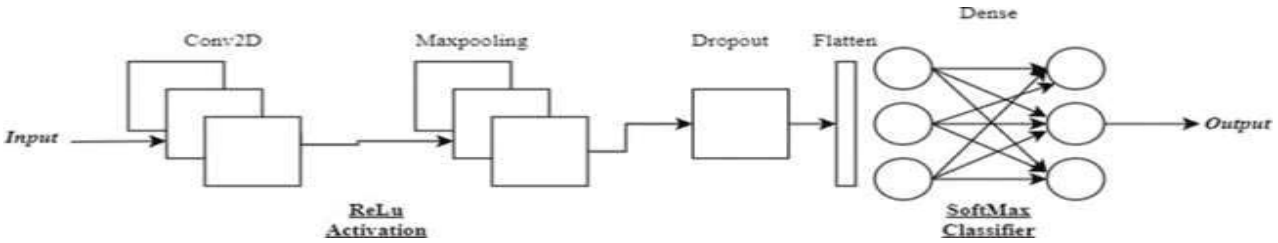

Fig. 5. Applied CNN layer

D. Tools

This paper performs implementation in Python Programming Language (3.7) using Keras libraries and TensorFlow (2.2.0). All the work has been done on the Cloud platform Kaggle using Jupyter Notebook.

IV. RESULT

Table I. represents an output of the models applied. In the experiment work, ResNet50 and CNN classification accuracy results for the categorical data images (COVID-19, Normal, Lung Opacity, Viral Pneumonia) in the prediction of COVID-19. The training and testing accuracy is 96.68% and 88.39% for the CNN whereas in terms of ResNet50 model accuracy is 97.17% and 92.78% for training and testing respectively as presented in the following Table 1. 14820 training and 6349 are used as testing images. The epoch size is 20 and 10 for CNN and ResNet50 sequentially. Below "Fig. 6" and "Fig. 7" represents the plot of the accuracy of the models. Here, the best result is obtained by the Transfer Learning model i.e., ResNet50.

TABLE I. EXPERIMENT RESULT

Models	Accuracy	
	Training	*Testing*
CNN	96.68	88.39
ResNet50	97.17	92.78

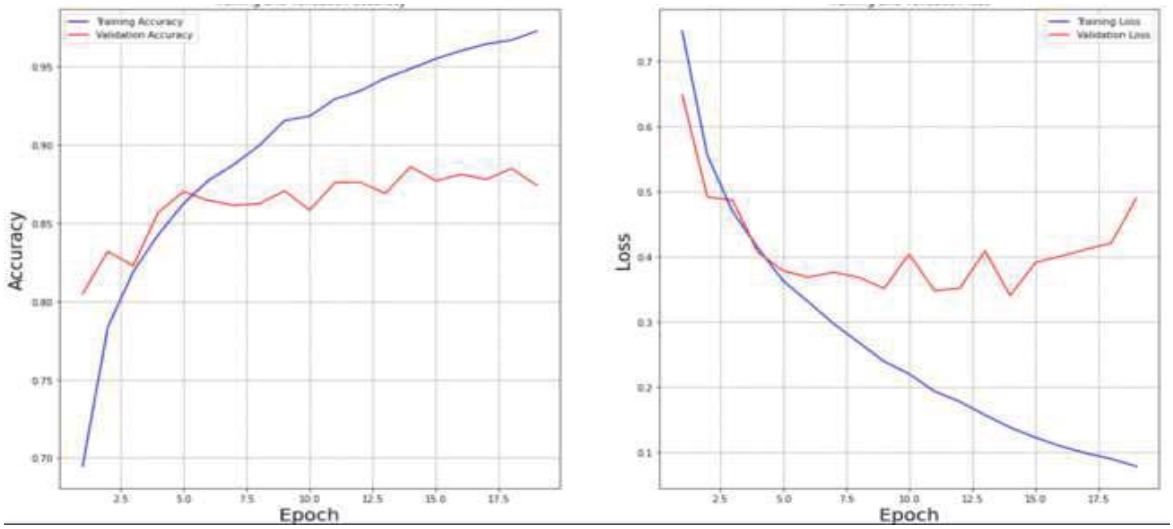

Fig. 6. Plot for CNN of Training and validation accuracy

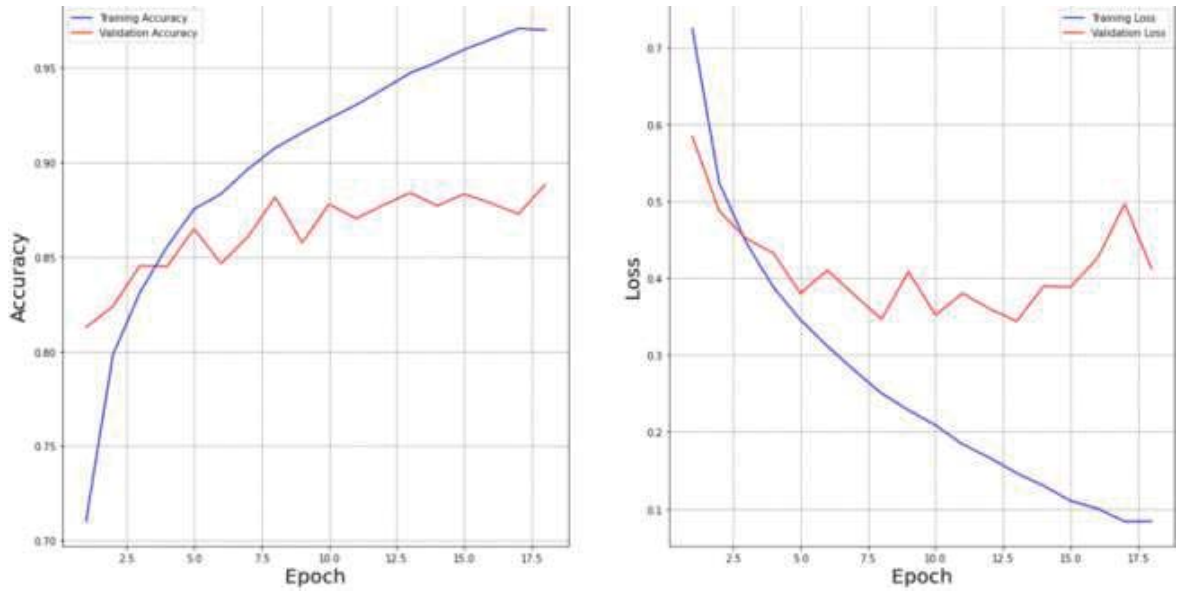

Fig. 7. Plot for ResNet50 of Training and Validation Accuracy

In this work, the classification of 4-categorical data is performed, to diagnose the Covid-19 from other types of infection and viruses from Medical Image - X-rays of the chest. The experiment is performed using Transfers learning model-ResNet50 and CNN. The proposed process involved the pre-processing of dataset images and then the classification is carried out on the basis of experiment performed on dataset based on training and testing result. The applied model (ResNet50) has given the better accuracy and also, the additional work is performed on CNN which provide the better result, on a large dataset applied in this work in comparison to evaluated previous studies.

V. Conclusion

After inspiring by the research in direction of radiographic images to detect the COVID-19, which is an ongoing pandemic. This approach can fill out the gap caused by the RT-PCR test, which is widely preferred and considered valid in the identification of this disease. The proposed work is an effort to provide technological support for the healthcare system, with the help of a deep learning approach using CNN and ResNet50. The models are applied for the classification of the virus using multi-classes images (Covid-19 infected, Viral-Pneumonia, Lung-Opacity, Normal). The better result obtained is 97.17% accuracy given by the ResNet50 model whereas CNN has given 96.68%. The presented work also focused on the diagnosis that can be done at an affordable price in less time at small hospitals by applying the X-rays dataset as its machine are easily available in rural areas in comparison to other approaches of detection, which are costly and not frequently available. For further, we want to work on the dataset that will be collected from the rural hospitals on the large scale and work on the effectiveness of the proposed work, also the segmentation task will be continued for further work.

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