



Review on Deep Learning Based Automatic Detection of COVID-19 from Chest-X Ray Images

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The Global pandemic declared Corona Virus Disease (COVID 19) has affected severely to the health of human being over the globe. More than 15 crore around worldwide have been affected by the Novel Corona virus and it is progressing rapidly. Mainly in the health sector, the hospitals are not properly equipped with proper diagnosis system which can detect the disease accurately with less time consumption. The Chest X Ray image are taking less time and cost effective which can be used for detection of COVID 19 even the severity can also be determine form the CXR images. In the current research many researchers are focusing on implementation of Deep learning method for accurate and quick detection of COVID 19 which can help the radiologist for evaluation of the disease. In this review, proposed Deep learning methodology from the literature have been discussed with their experimental data set. This review could help to develop modified architecture which gives more improvement in the diagnosis in term of computational complexity and time consumption

Keywords: Covid 19; Deep Learning; Chest X-Ray.

1. INTRODUCTION

The World Health Organization (WHO) [1] on March 11, 2020, has declared the novel Coronavirus (COVID-19) outbreak a global pandemic. Worldwide around 18.7 Crore cases have reported till now. Most common symptoms include fever, dry cough, headache, chest pain etc. For diagnosis of the COVID-19 the most common practice is Reverse Transcription-Polymerase Chain Reaction (RT-PCR) [2,3]. The infection becomes more severe for the patients which are getting delay in recovery. Due to severe infection of lungs, chest X-ray and Computed Tomography (CT) based diagnosis are desirable for the detection of Covid 19 which give least contact with the patients. The evaluation of the disease done manually by a radiologist could be time consuming for a large number of cases. The conventional diagnosis process has become relatively faster but still causes a high exposure risk for medical staff who are performing the test. So the medical imaging techniques based screening are relatively safe, faster, and easily accessible. Compared to CT imaging, X-ray imaging has been extensively used for COVID-19 screening as it requires less imaging time, lower cost, and X-ray scanners are widely available even in rural areas. To meet these requirements automation system based on Artificial intelligence (AI) technologies has been developed. Most of the recent researches explored the Deep learning techniques for the diagnosis of Covid 19 using the chest x-ray images

2. LITERATURE

I.D Apostolopoulos et al. [4] have first proposed a study on automatic detection of corona virus disease with chest x-ray images of common bacterial pneumonia, confirmed Covid 19 disease and normal incident. The study was based on CNN architectures over recent years for medical image classification. The X-ray image data set collected from Cohen [5], RSNA, radiopaedia and SIRM websites [6]. Also some data for common bacterial-pneumonia were added for distinguish between Covid 19 and Common pneumonia. The experimental result suggested that VGG 19 and Mobile Net V2 achieve better accuracy over other CNN for binary classification for the first dataset. MobileNetV2 perform better in second set of data which classify Covid 19 and bacterial pneumonia with an accuracy rate of 96.78%.

T. Ozturk et al. [7] proposed a model for automatic COVID-19 detection using raw chest X-ray images. The authors have used DarkNet model for Deep learning. Darknet-19 consists of 19 convolutional layers and five Maxpooling layers. Adam optimizer was used for weight update, cross entropy function and selection of learning rate. The model was developed to provide accurate diagnostics for binary classification (COVID vs. No-Findings) and multi-class classification (COVID vs. No-Findings vs. Pneumonia). The model produced an accuracy of 98.08% for binary classes and 87.02% for multi-class cases.

Hemden et al. [8] have developed a model COVIDX-Net for automatic diagnosis of Covid 19 from x-ray image to assist the radiologist. The COVIDX-Net based on seven different architectures of Deep learning network namely VGG19, Dense Net 201, InceptionV3, ResNetV2, Inception Res Net V2, Xception. and Mobile Net V2. The proposed network includes three main steps including preprocessing, training-validation and classification. During the experiment they followed the public dataset provided by Dr. Joseph Cohen [5] and Dr. Adrian Rosebrock, which consist of 50 X-ray images divided as 25 normal and 25 COVID positive cases. All network was trained using Stochastic Gradient Descent (SGD) for its fast and good convergence. During execution of InceptionV3 was having 50% accuracy while VGG19 and DenseNet201 achieved about 90%, but MobileNetV2 showed average 60% accuracy. Mostly accuracy was high during positive Covid19 detection whereas performance was worst during normal case prediction.

Wang et al. [9] have investigated a deep learning model Covid-Net for automatic detection of Covid 19 using Chest X-Ray data set. Authors have introduced a COVIDX open access dataset comprises of 13,975 CXR images which is the largest number of publicly available data sets per the author. For the dataset generation, they have combined and modified five different publicly available data set five different publicly available data repositories. The proposed model used to classify normal, covid-19 affected and non-Covid Viral infection. The architecture was pre-trained on the ImageNet dataset and trained on COVIDX dataset using Adam Optimizer. The CovidNet achieved an accuracy rate of 93.3%.

Narin et al. [10] have proposed a automatic detection system as a quick alternative diagnosis

option to prevent COVID-19. In the proposed study, five pre-trained convolutional neural network based models (ResNet50, ResNet101, ResNet152, InceptionV3 and Inception-ResNetV2) have been evaluated for the detection of coronavirus and pneumonia infected patient using chest X-ray radiographs. Three different binary classification with four class (Covid-19, normal, viral pneumonia and bacterial pneumonia) has proposed with 5 fold cross validation. The experiment was based on three binary data sets. All the models were pre trained with random initialization weights by optimizing the cross-entropy function with ADAM optimizer. Considering the performance results obtained, the pre-trained ResNet50 model provided the highest classification performance with an average accuracy of 98.4%.

F. Ucer and korkmaz [11] have demonstrated AI based structure to outperform the existing study. They have proposed a SqueezeNet which tuned to Covid 19 diagnosis with Bayesian optimization. They had fine-tuned the hyper parameter and with augmented dataset able to make the model perform better than existing network. The Bayesian optimization algorithm was used to obtain the related hyperparameters which make the learning maximum. SqueezeNet structure was improved with Bayes optimization algorithm to build a robust and sustainable

learning model. The accuracy of the proposed method was achieved about 98.3% for 3 class of classification which was better than other state of the art methods with 100% correction.

M Farooq and A Hafeez [12] had contributed to build open source and open access dataset and developed an accurate CNN frame work for differentiating Covid 19 cases from other pneumonia cases. The presented work produced a three step technique to fine tune pre-trained ResNet architecture to improve model performance. Authors had used COVIDX dataset which consists of a total of 5,941 poster anterior chest radiography images with four classes namely normal, bacterial pneumonia, viral pneumonia and covid 19 case. Authors used modified dataset with 68 Covid radiograph from 45 Covid 19 patients. There was a total of 1203 patients with normal, 931 patients with bacterial pneumonia and 660 patients with non Covid viral pneumonia. Due to less number of dataset, data augmentation method was used to create newer data sets which improve the generalization of training model. The weights of ResNet50 were pre-trained with ImageNet dataset. The training of model done in 3 stages, for each stage input image resized to different dimension. During simulation they had achieved improvement in 13% from 83.5% to 96.23% in COVID-Net model in 41 epochs.

Table 1. Comparison between State of the Art Technique used for Covid 19 detection

Literature	Technique Used	Pneumonia	Normal	Covid19	2 Class-Accuracy (%)	3 Class-Accuracy (%)
ID Apostolopoulos et al. [4]	VGG19	700	504	224	98.7	93.4
	MobileNet v2				97.4	92.8
T. Ozturk et al. [7]	DarkCovidNet	500	500	125	98.08	87.02
E.E.E Hemden et al. [8]	COVIDX-Net	X	25	25	90	X
L. Wang et al. [9]	COVID Net	5538	8066	266	X	93.3
A Narin.et al. [10]	ResNet-50	X	2800	341	96.1	X
F. Uceret et al. [11]	Bayes-SqueezeNet	4290	1583	76	X	98.26
M Farooq et al. [12]	COVID-ResNet	1591	1203	68	X	96.23
M. Tagacar et al. [13]	SqueezeNet and Mobile Net (SMO and SVM)	98	65	295	X	98.25
T. Rahman et al. [14]	U-NET with CNN	6012	8851	3616	X	96.29
F.Mohanty et al. [15]	Optimized KELM	3418	1266	460	X	100

M. Tagacaret al. [13] has proposed a study for detection of coronavirus using Deep learning model MobileNetV2 and SqueezeNet. The extracted feature set was optimized using SocialMimic optimization method. The optimized features were combined and classified using Support Vector Machine. In the experimental analysis authors have used three class of dataset i.e., normal, pneumonia and covid19 chest x-ray images. The simulation reveals 84.56% accuracy for Squeeze Net with original dataset. Using Fuzzy color technique the accuracy improved to 95.58% and with the stack data set 97.06% accuracy has been achieved, whereas Mobile Net gave accuracy of 96.32% with original dataset and 97.05% with Fuzzy color technique data set and finally 97.06 with the stacked dataset. In the proposed technique, efficient feature set extracted using SMO algorithm, and with the efficient features the deep learning model perform 100% success in classification and 99.27% success was achieved in the classification of normal and pneumonia.

T. Rahman et al. [14] proposed different image enhancement technique that effect the detection performance. Authors have implemented six different CNN architectures (ResNet18, ResNet50, ResNet101, InceptionV3, DenseNet201, and ChexNet) while using a 22 layer CNN with a modified version of U-Net segmentation for lung area segmentation from Chest X-ray images. The simulation result gave an accuracy of maximum 95% using segmented lungs images. The data set repositories are getting updated, but still not sufficient to provide an unbiased result, as the Covid 19 chest X-ray image data is less in comparison to normal chest X-ray data. Many of the researchers have augmented the dataset for increasing the data set. But somehow still the features points are mostly remain unchanged.

In most Deep learning model the features are extracted automatically by the model, but Mohanty et al. [15] had proposed a classification method to classify chest X-ray images for Covid 19, Pneumonia and normal. The proposed method pre-processed the images using 2D singular spectrum analysis for image reconstruction which enhance the features inputs to the classifier. Block based GLCM method used for feature extraction. For optimal feature selection Kernel extreme learning machine has been proposed which produced an accuracy of 100%. The table below provides a comparative illustration of the existing techniques for chest x-

ray classification for COVID 19, Pneumonia and normal images.

3. CONCLUSION

In this study, some proposed deep learning based automatic Covid 19 detection have been discussed. The review of those models is focused on their architecture, dataset involved and accuracy rate obtained for each of the model. Bayesian optimization based Squeeze Net model performed better as compared to other deep learning model with an accuracy of 98.26%. Due to non availability of adequate amount of data set in most of the methods the authors have tried to regenerate the dataset through process of augmentation. Another proposed technique with conventional feature extraction with optimized KELM classification had been discussed which claimed 100% accuracy. This study could help further in developing a suitable algorithm which could overcome the biasing error and other limitations associated with existing techniques.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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