International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

Deep Learning Model Covid 19 Detection and Progress Stage Classification

Ms. Jyoti Chandrakant Patil, Mr. A. V. Shah
Electronics & Telecommunication DKTES's
TEI Ichalkaranji Ichalkaranji,India

***Abstract*—Chest X-ray image processing can assist to doctors for faster detection of Covid-19 infection. The large number of patients and their chest X-ray observation is huge task during pandemic situation which shows need of automatic Covid-19 detection technology to assist doctors. This paper contributes in terms of a convolutional neural network (CNN) model for Covid-19 detection by processing Chest X-ray (CXR) image. The model is composed of convolutional layers and dense layers to classify input image into true or false that is Covid-19 positive or normal. The performance is evaluated by considering parameters accuracy, sensitivity and specificity which show satisfactory results.**

***Keywords: Covid-19, Chest X-ray, deep learning, Convolutional Neural Network, Classification, performance*.**

I. INTRODUCTION

Corona is infected in viral form attacks directly on respiratory system which also called as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS CoV-2) [1-3]. The pandemic situation has shown dangerous situation to humankind in the entire world. The origination of this virus was from Wuhan city of China [4]. More than crore people are infected due to this virus [5-7] and many of them have died. The population affected by this disease have shown geographic segmentations in [8]. For the test of Covid 19 infection Polymerase Chain Reaction (PCR) technique is used as a primary pathologic test. After the positive tests are identified, there is the test followed by optical imaging methods in which computer aided diagnosis is performed. This includes Chest X-ray observation and computed tomography analysis. The people who are sensitive to X-rays are brought under CT image analysis category on the other hand due to large number of patients, X-ray is the right choice in terms of easy availability of X-ray machines and also cost of investments is higher for CT machines [12, 13]. Due to pandemic situation, the personnel who are not expert in this field of radiology are also volunteering the work which again show that it is prone to miscalculations in the actual estimates. The Chest X-Ray (CXR) based technique is comparatively less costly than CT imaging and shows more information compared to pathological tests. There are variety of methods available for chest disease infection and also recently various methods are developed using these techniques [9, 13–15]. Most of the classical methods involve the hand crafted rules and hence are prone to missed judgments and hence neural network based methods show better performance in computer vision methods [16]..

II. RELATED WORK

The features obtained using deep learning methods give more detailed features and hence more accuracy of detection. Hence using deep learning methods for CXR analysis is right choice in all. The Covid 19 detection from CXR images also show better performance when variety of methods available from literature are studied. The machine learning methods when compared to deep learning, then in ML based techniques there is inclusion of different methods for preprocessing feature extraction and based on features quality which are purely from hand crafted rules the performance of classifier is estimated. As far as preprocessing work is concerned, in CXR images the segmentation of lung region and then classification using deep learning shows better performance. This implies that, there is need to focus purely in lung region during feature extraction. The segmentation for large number of images in the dataset may become complex task and hence the alternative approach is required to be considered. Also, on the other side there is limited set of X-ray images considered by some researchers which show better accuracy and when these methods are applied on large datasets they show degradation in performance. In [17], author has shown the use of VGG16 model for Covid-19 detection with transfer learning method and its performance is shown. The normal VGG16 model shows considerably less performance and hence in [18] other choice of convolutional neural network (CNN) model is shown. The max pooling and average pooling layers in this case are seen to extract more information from CXR images with more accuracy compared to normal model and hence this combination is preferable [19]. Kumar et al. [19] have shown variations in infection detection capabilities from CXR images. This way it shows that there is no need to segment the lung region and automatically infection region features are extracted. The spatial features required for the detection of Covid 19 detection which has particular pattern of infection is seen to get identified with the use of attention layer composed of average pooling and max pooling layer. Hence the attention layer is used in the work shown in this paper. The detection of Covid 19 is performed on public dataset and performance is compared with non-attention layer architecture as explained in upcoming sections. The infected region is shown in sample image in figure 1.

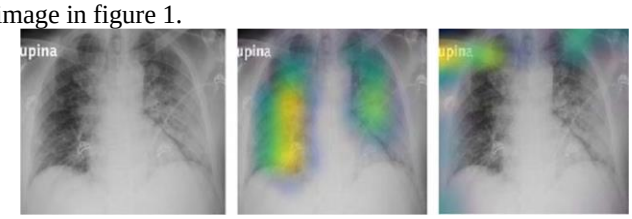

Fig. 1. ROI of CXR images for COVID19 detection

III. PROPOSED WORK

The number of trainable parameters of CNN model is the direct complexity of the CNN and hence minimum number of

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

parameters is right choice. The proposed model shows less number of trainable parameters due to inclusion of attention layer in the model. Also, 4th pooling layer is removed from the model compared to basic VGG16 model which minimizes the trainable parameters count. The main characteristics of the proposed model for Covid 19 detection from CXR images are: The local and global features extraction is easily achieved due to inclusion of attention layer in modified VGG16 model. Important characteristic features are extracted rom CXR images for Covid 19 detection. The attention layer is capable of extracting characteristic features of ROIs compared to other regions. The trainable parameters required are less in count compared to VGG16 model due to inclusion of pooling layer. The training and testing classification does not require separate processing as it is less complex model and also, no preprocessing tasks are required.

The performance of the proposed model is evaluated using CXR dataset which consist of few Covid 19 infected patients images and non covid infected images. The results are validated by comparing the prediction to that of with expert opinions. We assess our model on COVID-19 CXR datasets.

Compared to artificial neural network (ANN), deep neural network models for deep learning are having more number of hidden layers. The classification for multiple classes is possible with better accuracy by using deep learning models [9] which also identifies healthy and infected images from medical image processing. The dataset preparation is crucial step in deep learning methods which may effect on deep models in terms of over fitting problems. The performance evaluation of deep models is done normally on public datasets and hence VGG16 as it is proven for 1000 classes' classification problem in terms of challenge. There are supervised and unsupervised learning approaches in which unsupervised learning is prone to over fitting. Hence, the supervised learning requires the preparation of dataset.

The spatial features are required to be extracted to identify the Covid-19 infection. The use of max pooling and average pooling suggested by Woo et al. [18] is used in our model which is responsible to extract more detailed features from infected ROI. We modify the fourth pooling layer by inserting attention layer which boosts the features and also minimizes the trainable parameters. The sigmoid activated max pooling layer is capable of providing features with 7X7 sized windows which has more features from infected region. The proposed CNN model with inclusion of attention layer is shown in figure 2. The convolution output and attention layer output is merged and convoluted further which boosts the infected region features. The layers from fourth layer are similar to that of VGG16 which constitutes two convolutional layers followed by max pooling layer. The extracted features are classified using dense layers in which input is required to be one dimensional. Hence flatten layer plays the role of converting 2D features to 1D features. The fully connected dense layers are used. Three fully connected dense layers are capable of catching the features from previous input layers and finally binary class output is given in which covid or non covid is indicated by 1 or 0 respectively. Last dense layer is softmax activated which focuses on number of classes that are to be given as output and operates in the specific region. The activation function softmax plays important role of tuning the model for better accuracy. The dataset required for estimating the performance is composed of combination of three publicly available datasets. Covid 19 CXR images dataset consist of large number of covid infected and non covid images thereby which shows performance that is considerably better. The proposed model is implemented using keras tools and python programming language. During the training step pretrained weights from Imagenet are used and further training is performed which shows better results and more tuning of the model for CXR images. The results are considerably higher compared to basic VGG16 model. The performance evaluation is done by splitting the entire dataset in training and testing parts. The 80-20 strategy is used in which 80% part is used for training and 20% part is used for testing and validation of results of prediction..

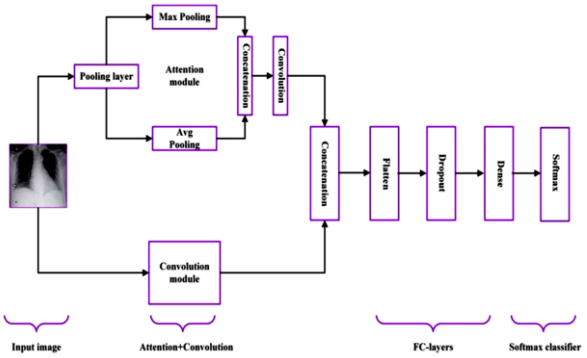

Fig. 2. Proposed model with addition of attention layer in VGG16

The attention layer used in the VGG16 modified version minimizes the trainable parameters and also boosts the features when merged with convolutional layer output. The reaming layers are similar to VGG16 where last layer is modified for 2 class classification output.

Multiclass Progress Stage classification:

The covid-19 disease progress stage classification is performed using proposed model. the class label is considered as 0 for progress up to 20%, 1 for progress up to 40%, 2 for progress up to 60%, 3 for progress up to 80% and 4 for progress up to 100%. The progress stages are nothing but number of lung segments that are occupied by infection. Out of 40 score the infection ratio is considered to decide the percentile score of the infection.

IV. RESULTS AND ANALYSIS

The performance is evaluated with implementation using python programming and keras platform.

a. Performance Analysis

The performance is evaluated for the experimental configuration as detailed in table I. The formulae shown in table 2 are used for estimation of parameters.

TABLE I. EXPERIMENTATION DETAILS

Number of test Images	36
TP	18
TN	5
FP	2
FN	11
Accuracy	0.81
Sensitivity	0.62
Specificity	0.71

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

b. Formulae:

TABLE II. FORMULAE FOR PARAMETERS

Accuracy	(TP+FN)/(TP+TN+FP+FN)
Specificity	TN/(TN+FP)
Sensitivity	TP/(TP+FN)

TP=True Positive= Input Covid and detected as Covid
TN=True Negative = Input Covid and detected as Non-Covid
FP=True Positive= Input Non-Covid and detected as Covid
FN=False Negative= Input Non-Covid and detected as Non-Covid

The loss rate analysis is observed for proposed model as shown in figure 2. The result shows the stability after some epochs.

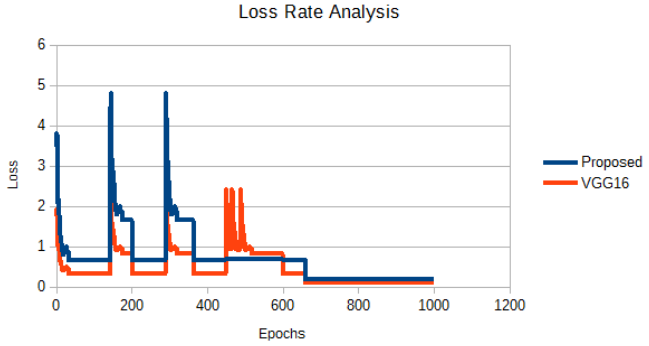

Fig. 3. Loss rate analysis

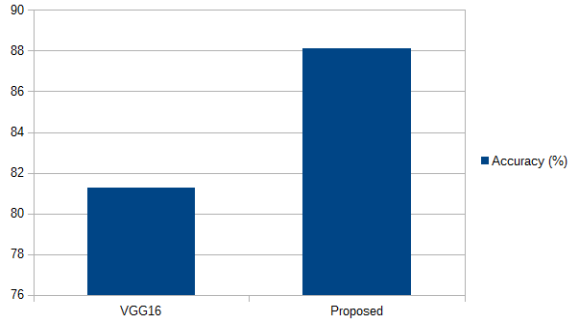

Fig. 4. Accuracy Analysis

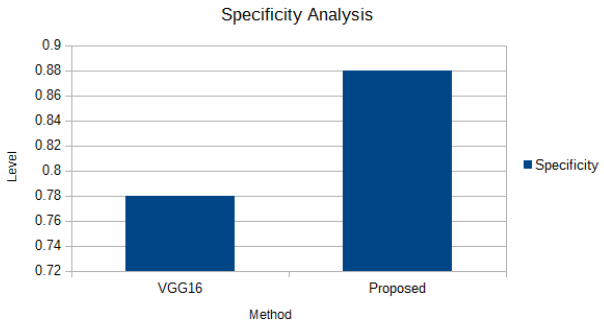

Fig. 5. Specificity Analysis

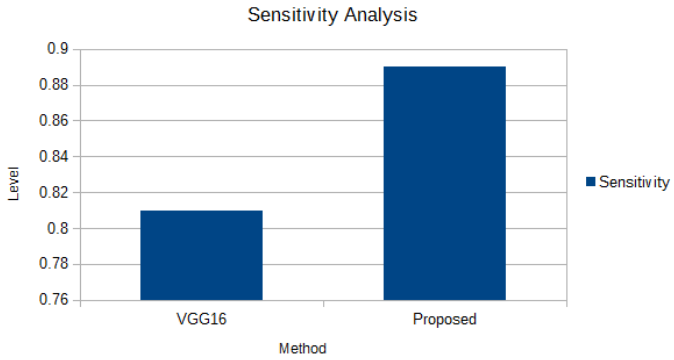

Fig. 6. Sensitivity analysis

Figure 3 to 5 show the graphs for the performance of parameters observed for different images and calculated as per the formulae in table 2.

Progress stage classification results:

The infection progress images are used to retrain the same model for classification of images in 5 classes. The accuracy, specificity and sensitivity parameters are evaluated using formulae as shown in table 2. The results are plot in figure 7.

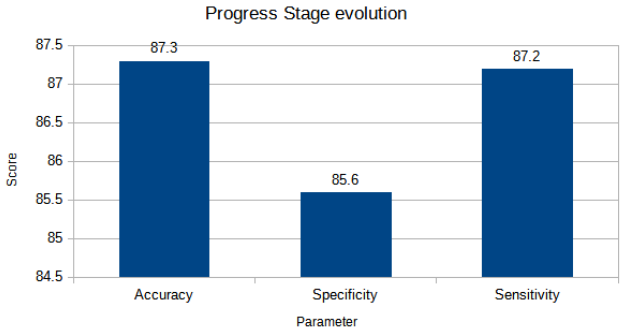

Fig. 7. Performance Parameters of progress stage

V. CONCLUSION

The chest X-ray processing supports identifying the infection in lungs. The covid-19 infection has its own pattern and density. The feature extraction becomes powerful tool when VGG16 network is used. The features are then classified using dense network in the work presented in this paper. This paper contributes the method for detection of Covid-19 using modified VGG16 model. The performance is evaluated and shows that it outperforms the results over VGg16 model. The performance with accuracy of 88% is satisfactory over VGG16 model. The model will be useful for the assistive technology to the doctors. The progress stage evaluation is also possible using the same model. The second stage training on progress stage images is also evaluated which shows accuracy of up to 87.3%. The model performance is satisfactory for 5 class classification task.

REFERENCES

[1] Lai C-C, Shih T-P, Ko W-C, Tang H-J, Hsueh P-R (2020) Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (COVID-19): the epidemic and the challenges. Int J Antimicrob Agents 55:105924

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

[2] Li J, Li JJ, Xie X, Cai X, Huang J, Tian X, Zhu H (2020) Game consumption and the 2019 novel coronavirus. Lancet Infect Dis 20(3):275–276
[3] Sharfstein JM, Becker SJ, Mello MM (2020) Diagnostic testing for the novel coronavirus. JAMA 323(15):1437–1438
[4] Singhal T (2020) A review of coronavirus disease-2019 (COVID-19). Indian J Pediatr 87:1–6
[5] Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, Spitters C, Ericson K, Wilkerson S, Tural A et al (2020) First Attention-based VGG-16 model for COVID-19 chest X-ray image classification case of 2019 novel coronavirus in the united states. New Engl J Med. 929–936
[6] Giovanetti M, Benvenuto D, Angeletti S, Ciccozzi M (2020) The first two cases of 2019-ncov in Italy: where they come from? J Med Virol 92(5):518–521
[7] Bastola A, Sah R, Rodriguez-Morales AJ, Lal BK, Jha R, Ojha HC, Shrestha B, Chu DK, Poon LL, Costello A et al (2020) The first 2019 novel coronavirus case in nepal. Lancet Infect Dis 20(3):279–280
[8] Hernandez-Matamoros A, Fujita H, Hayashi T, Perez-Meana H (2020) Forecasting of covid19 per regions using arima models and polynomial functions. Appl Soft Comput 96:106,610
[9] Khan AI, Shah JL, Bhat MM (2020) Coronet: a deep neural network for detection and diagnosis of COVID-19 from chest X-ray ages. Comput Methods Progr Biomed 196:105581
[10] Ozturk T, Talo M, Yildirim EA, Baloglu UB, Yildirim O, Acharya UR (2020) Automated detection of COVID-19 cases using deep neural networks with X -ray images. Comput Biol Med 121:103792
[11] Loey M, Smarandache F, M Khalifa NE (2020) Within the lack of chest covid-19 x-ray dataset: a novel detection model based on gan and deep transfer learning. Symmetry 12(4):651
[12] Singh D, Kumar V, Kaur M (2020) Classification of COVID-19 patients from chest CT images using multi-objective differential evolution–based convolutional neural networks. Eur J Clin Microbiol Infect Dis 39:1379–1389
[13] Ko H, Chung H, Kang WS, Kim KW, Shin Y, Kang SJ, Lee JH, Kim YJ, Kim NY, Jung H et al (2020) Covid-19 pneumonia diagnosis using a simple 2d deep learning framework with a single chest ct image: model development and validation. J Med Internet Res 22(6):e19,569
[14] Luz E, Silva PL, Silva R, Moreira G (2020) Towards an efficient deep learning model for covid-19 patterns detection in x-ray images. arXiv:200405717
[15] Panwar H, Gupta P, Siddiqui MK, Morales-Menendez R, Singh V (2020) Application of deep learning for fast detection of covid-19 in x-rays using ncovnet. Chaos Solitons Fractals 88:109944
[16] Qin C, Yao D, Shi Y, Song Z (2018) Computer-aided detection in chest radiography based on artificial intelligence: a survey. Biomed Eng Online 17(1):113
[17] Simonyan K, Zisserman A (2014) Very deep convolutional networks for large-scale image recognition. arXiv:14091556
[18] Woo S, Park J, Lee JY, So Kweon I (2018) Cbam: convolutional block attention module. In: European conference on computer vision (ECCV), pp 3–19
[19] Kumar N, Sukavanam N (2017) Deep network architecture for large scale visua detection and recognition issues. J Inf Assur Secur 12(6):201–208