Deeplearningapproachfor detection of multiple respiratory diseasesfrom chest X-rayanalysis:Asurvey

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Abstract

Deep learning approach for detecting various respiratory diseases hasbeen challenging and mostdemanding research area. Withrapidly increase in number of patients suffering from respiratory diseases quick method hasbecome necessary for classification and detection of respiratory diseases. This survey paper offers a comparative study of various deep learning techniques that can use chest X-raysfordetection of various thoracic diseases.There is possibility of severe respiratory failure in some thoracic diseases if they are not treated in initial stages. Many digital image processing techniques ,machine learning and deep learning models have been developed for this purpose[17]. Different forms of existing deep learning techniques including convolutional neural network (CNN), visual geometry group based neural network (VGG-16 and VGG-19) have been developed for respiratory disease prediction. But these all models have some limitations that they do not cover all respiratory diseases including Covid-19, Viral pneumonia and Tuberoculosis on single platform. Therefore, we propose our customized new deep learning model Clx-Net by using data augmentation technique to enlarge the area of available dataset[1][2] to make model more efficient with less time consumption per epoch and provide localization to identify infected region by examining chest X-ray images. Our focus is to develop a new unique deep learning based model Clx-Net which will be able to detect almost all major respiratorydiseases including Covid-19. It will simplify the detection of respiratory diseases and also find the location of infected chest area to make task easy for radiologists.

Keywords: *Deep learning Thoracic disease CNN GG Data augmentation.*
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Contents

1 Introduction

For detection of respiratory diseases,Chest X-ray imaging process is always preferred over CT imaging process because CT imaging process is time consuming and high quality CT scanner is not available inmanyrural and suburbanregions.X-ray imaging is mostcommonandwidely available diagnostic imaging technique.There are many regions acrosstheworldwherewe find shortage of expert healthcare practitioners and radiologistsfortimely diagnosis ofsuch diseases.Computer aided diagnosis using deep learningigenceis is best solution for this because this facility is availableto large populationat lowest cost,Another issue with these diseases is that many timesfeaturesthatdescribestheexistenceofdiseaseof tengetmixedwithotherdiseases.andradiologistsfindit difficultandchallengingtodiagnosethem.Deeplearnin gtechniquessolvethese problems with good accuracy and less time consumption.

In a pandemic situation like COVID-19, it was most demanding to search for accurate and rapid diagnosis methods inadditiontoavailable virus testingmodalities.Because X-ray machines are widely available all over including clinics ofunderdeveloped area, they canbe used for rapid detection ofpossibleCOVID-19lunginfections. X-rays are safe for children and pregnant woman as they use very small amount of radiationas compared to CT scanner. In this paper, we propose anefficient deeplearning-based chest radiograph classification architecture to distinguish covid-19 from other respiratory diseases.Furthermore, wejustify our customized CNN model by comparing itwith widely adopted CNN architectures for image classification such as VGG-16,,VGG-19,AlexNet, ResNet 50, and DenseNetwhich are well known for their performance and utility in field of healthcare..Thehighclassification and detection accuracy of our proposed model implies that it canefficiently detect COVID-19, pneumonia and oter lung diseases from radiograph images to provide a rapid and reliableevidence of existence of infection in the lungs. As the symptoms of respiratory diseases are almost similar,it can be difficult and time consuming for doctorsandradiologiststoddiagnose thelungdiseaseofpatient properly.Our customized model Clx-Net can solve these problems efficiently with good accuracy and less time consumption.

2 Materials and Methods

Literature survey

For literature survey papers are selectedusing a PubMed search. For methodical search and paper title we selected research papers presented in differentconferences likeMICCAI, ISBI,MIDL, SPIE and EMBC. Here we found multiple publication ofsame title. After listing yearwise, only the latest publicationswere included.This search methodresulted in around 120 listedpapers. After removing some duplicatepapers and papers whichwhich are not related to deep learning approach for chest X-rayanalysis ,afterexcluding publications which were not peer reviewd,Ourresearchfinallyreachedtolatest50resear chpapers.

DeepLearningApproach

Deeplearningisa part of artificial intelligence which proves milestone in the field of healthcare. Itisvery useful to data scientists who are working on collection ,analysis and interpretation of large

amount of data. By using concept of Deep learningthey can makethis process faster and easier.Thisapproach is final and most probable solution for for the literature reviewed in thiswork.Convolutionalneural-networks are provided in many other modalities as basic model for medical image analysis.Different networksmaybeconstructed with different types of layers included and worked as'architecture'.

ConvolutionalNeuralNetworks(CNN/Conv-Net)

CNNswerefirstdevelopedandused in initial period of 1980s (Fukushima and Miyake, 1982).TheCNN is a part of deep neural network and itrequiresalargeamountofdatafor training. It also requires a lot of computing resources.ThiswasadrawbackforCNNsatthattime.CNN specializes in processing data of image .Today theroleoftheConv-Netisto reducetheimagesintoaformthatiseasiertoprocess, without losing featureswhich are necessary forgettingagoodprediction.[3][4].

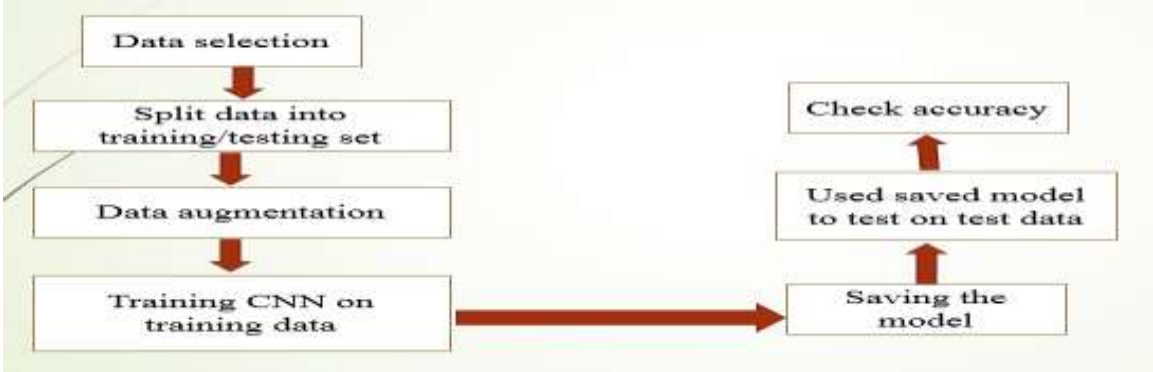
Transferlearningforimageclassification

In Transfer learning process the model is trained on one problem is used in some way on second related problem.We use the concept of transfer learning in Chest Xray analysis for pre-training of model. The network architecture is first trained on a large dataset to perform different task, and the trained weights are then used to perform taskforfine-tuning [16]. Depending on availability of data from the target domain, all layers can be re-trained or sometimes only the final fully connected layer can be re-trained.This concept of transfer learning is used in the research survey related to this work.[19],Localizationnetworks

Proposed Architecture

Localization is the term used for identificationof regionof interestwithin the image,It is generally indicated by abounding box technique or by a point location.The RCNN(RegionConvolutionalNeuralNetwork)wasintroduced in 2014[5],to identify regionsofinterestin the image.In this network CNNarchitecture is used to extract features of theseidentified regions. SVM (support vectormachine) was used to classify the regions based on feature extraction.This method passes through several stagesand isrelativelyveryslow.The performance of this method was later improved by fastRCNNwhichnedtheprocessingpipeline structure,which removes thenecessityof initialregionidentificationor SVM classification.Here speedand performance both are improved as compared to previous one.Another popular architecture for objectlocalizationisYOLO(YouOnlyLookOnce),which was firstintroduced in 2016 (Redmon et al., 2016) .It was single-stage objectdetection method and further improved in eventually versions in 2017and 2018 [18].Another popular localization network that used in medicalimaging field is RetinaNet [14]. Similar to YOLO, this is alsosinglestagedetector, works on theconceptofafocallossfunction,Most of the localization works used in reviewuseoneofthedescribed architectures. Deep learning depends on large amounts of annotated data.The quality of images available in public datasets is not good . This may decrease performance in deep learning systems. We are using dataset of chest X-ray image showing multiple respiratory diseases from Kagglerepository (https://www.kaggle.com>datasets)

Fig.2.Blockdiagramofproposedarchitecture



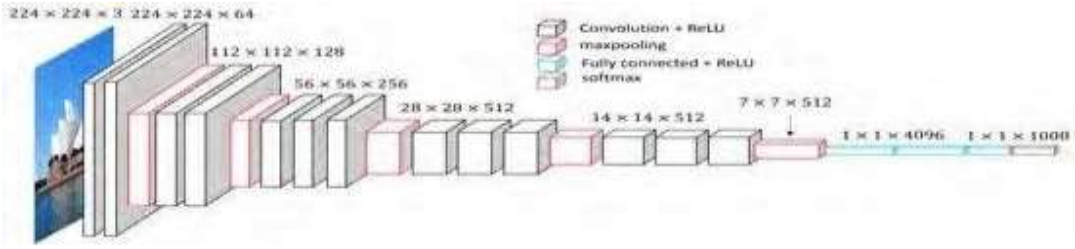


Fig.3.VGG16architecture

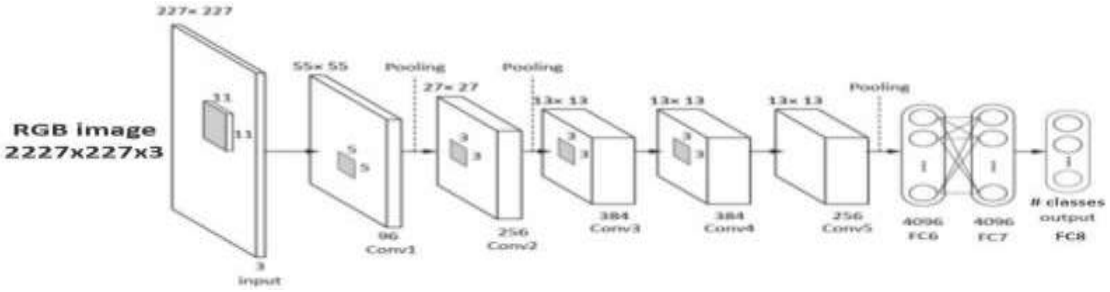


Fig. 4 AlexNet architecture

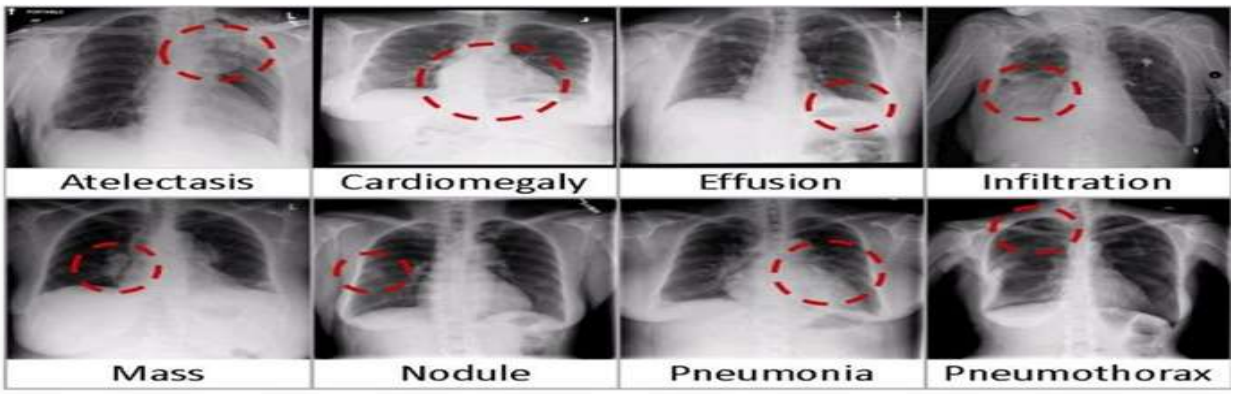


Fig. 5. Images of different respiratory diseases and location of infected region.

Comparison

VGG16/VGG-19 is **a** convolution neural network (CNN**)** architecture which isconsidered to be most popular and widely adopted excellent vision model architecture.It consists of fixed arrangement of convolution and maxpoollayersconsistentlythroughoutthewholearhitecture.It is trained on ImageNet dataset and applicable for more than 1000 classes for prediction.

Alex-Net is CNN based classic network architecture.It consists of convolutions layers , max pooling layers and dense layers as thebasic building blocks.The layer arrangement of Alex-Net is non uniform but no. of layers in architecture are less as compared to VGG-16 and VGG-19.

OurproposedmodelClx-Netwillbecomparableinperformance with VGG16,VGG-19, AlexNET and other widely adoptednetworksintermsofaccuracy,noofconvolutionlayers , maxpooling layers, no of dense layers,and run time perepoch.

3. Conclusion

After studying and comparing methods and techniques, I came to know that the research methodologies available to diagnose respiratory diseases are not sufficient to diagnose all the diseases caused due to chest infection with accuracy and less time consumption. My conclusion supported the statement that there is no research to differentiate pneumonia, covid-19, tuberculosis and other respiratory diseases on same platform.It is not mentioned clearly on which platform does the model was trained.What will be the result if we combined all the problems into one like classifying pneumonia, Tuberculosis and other respiratory diseases and localization of infected region as well. How big dataset we need if my research goes in this direction and what Type of evaluation metric we should use ifwork on this problem.If wecombined the problemsshallweget the balanceddatasetforall theclasses..If dataset is balanced, can we get location coordinates in theimagesforabnormalitydetection.Shallweneedexternalresourcestotrainourproposedmodel ClxNet.WhattypeofimplementationwecandowithCNNarchitecturetoimproveaccuracyofourmodelbyusingavailabledatafortrainingtestingandvalidationonsameplatform.

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