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Novel Deep Learning Architecture for Alveolus Ailments Detection

SadhaviThapa
Dept. of Data Science and Business Studies
S.R.M Institute of Science and Technology
KTR,Chennai, India
st8019@srmist.edu.in

Kanishka Gaur
Dept. of Data Science and Business Studies
S.R.M Institute of Science and Technology
KTR, Chennai
kg4571@srmist.edu.in

Dr. Arthi K
Dept. of Data Science and Business Studies
S.R.M Institute of Science and Technology
KTR, Chennai
arthik1@srmist.edu.in

***Abstract*—Apathological lesion to the alveoli distinguishes a group of ailments known as alveolar lung diseases (ALD) or alveolar illnesses. They are very common and a major cause of morbidity and mortality worldwide. Chronic obstructive pulmonary disease (COPD), pneumonia, pulmonary edema, asthma, TB, fibrosis, lung cancer, and other diseases fall under this category. According to WHO data Lung Disease Deaths inIndiareachedapprox.900,000 in 2020.This exhibits then ecessity of creating a new paradigm for a precise and earlydiagnosisofdisease,whichwouldgreatlyenhancepatients'outcomes. It is critical for processing massive amounts of data in the healthcare industry. Hence in this paper, we propose anoveldeeplearningdesignforalveolarailmentsdiscoveryutilizing VGG-16convolutionalneuralnetwork.Ourmodelusesa unique dataset of chest X-ray pictures to prepare theVGG-16torecognizedesignsrelatedwith different alveolarinfectionsandencouragehelpinillnessforecasts.Weevaluated our model on a separate test dataset and achieved anaccuracyof93.4%inidentifyingdifferenttypesof alveolarailmentsandavalidationaccuracyof91%.Ourtechniqueprovidesapotentialnewtoolforaccurateandtimelyidentificationofalveolarinfections,aswellasdisentanglesdisease location for specialists and clinicians as well as to surge the diagnostic abilities of experts, radiologists, and clinicians to accelerate the process and reduce time required for a correct diagnosis.**

Keywords—Alveolar Ailments, Convolutional Neural Network, Deep Learning, VGG-16, healthcare.

I. INTRODUCTION

Alveolus disorders are a kind of respiratory illness that affects the alveoli, which are microscopic air sacs within the lungs that may exchange gas. These ailments can range from mild to severe and can belief – threatening if left untreated. These incorporate chronic obstructive pneumonic infection, pneumonia, aspiratory edema, asthma, tuberculosis, fibrosis, etc. Alveolar lung disease fatalities in India totaled 879,732 According to the most recent WHO figures, 10.38% of all fatalities will occur in 2020. India ranks third in the world regarding the age- adjusted death rate (87.90 per 100,000 population) [1]. COPD (chronic obstructive pulmonary disease) is the third biggest cause of mortality in the world, accounting for 3.23 million deaths in2019.[2].

Several studies have been conducted to investigate the relationship between deep learning strategies for predicting diagnostic information from chest X-ray images. Because most government hospitals are overburdened, causing delays in providing appropriate treatment and diverting patients to more expensive private hospitals, this strategymayresultinlowermedicalexpendituresascomputerscienceforhealthandmedicalresearchprojectsgrows.

Machine Learning-based decision support systems can help clinicians make diagnostic decisions. The study looked into patients' respiratory problems, as well as Corona, Tuberculosis, Pneumonia, as well as Lung Cancer. Machine learning and deep learning are used to analyze data and build models for patient diagnosis [3]. Combining patient data with data from chest X-rays was one strategy used in this study to identify lung illnesses, as did CNN using the well-known pre-trained model and CNN for data. Deep learning was utilized to analyze and examine the data set to determine whether the patient had lung disease. The study uses binary classification, utilizing patient data from chest X-ray images as input and sickness diagnosis as output. The study's purpose is to investigate and diagnose alveolus lung diseases.

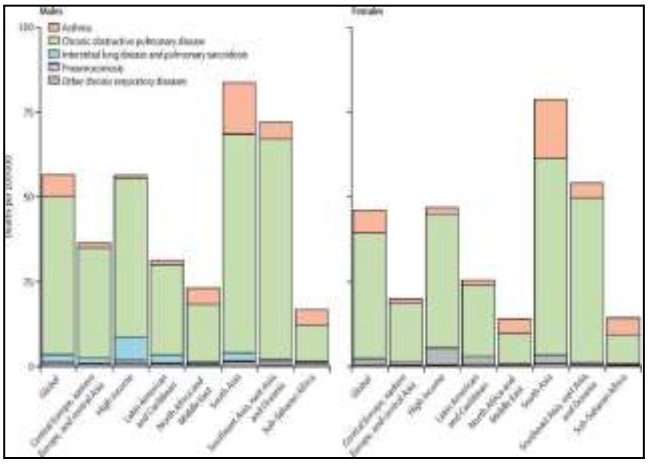

Fig1.Global Fatality Rate(LungDisease)

The basic version of CNN is insufficient. As a consequence, we present anovel deep learning system based on the VGG16 Architecture for forecasting alveolus diseases. The purpose of this study is to create a VGG16 architecture-based alveolus disease detection model. Early detection and diagnosis of alveolus disorders is critical in the medical industry since it makes managing patients' future clinical treatment easier. The sample and complete versions of the data set are considered. In terms of precision, recall, F1score, and validation accuracy, the VGG16 Architecture outperforms previous approaches for both entire and sample datasets. As a result, the suggested VGG16 Architecture will make detecting lung diseases simpler for both experts and physicians.

II. LITERATURE SURVEY

In [4], One of the most active topics of study, in order to enhance health and medical science, is the use of big data for predictive analysis in addition to machine learningordeeplearningtechniquesoralgorithms.PneumoniaPredictionUsingBigDataMachineLearningDeepLearning

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Approaches is demonstrated in this paper. CNN excels at this prediction, and pre-training of the CNN models for large datasets enhances the chance of correct classification. CNN models that have been pre-trained, in conjunction with an effective feature extraction approach and numerous classifiers, are thought to produce extremely accurate results.Anx-ray of the chestis essential to diagnose pneumonia, as is aprognosis specialist.

In [5], A variety of deep learning pre-trained models, including VGG, Inception, ResNet, and Efficient Net, were used in the development of a CNN-based computervisionAIsystem.Whencomparedtophotosofbothpneumoniapatientsandhealthypeople,thefinalDLH-COVID model had the greatest accuracy of 96%.Aweb application was also developed. This solution, when coupled, provides cutting-edge artificial intelligence-based technology and a simple application with the potential tobecomeaquickCOVID-19diagnosistoolsoon.

The[6]Research articled monstrates the application of Transfer learning methodologies. This study employed four pre-trained models - VGG-16, VGG-19, Inceptionv3, and Xception-on two separated at a sets. This article tackles issues that arise when utilizing pre-trained models in the actual world. These models also acquired great accuracy. Among four deep learning models, The VGG16modelachievedvalidationaccuracyof99.50%&classificationaccuracyof99.00%ondataset1andaccuracy of 96.41% & accuracy of 95.69% and validation on dataset 2, outperforming the other four models on both datasets.

The [7] application of multiple classifications is demonstrated in this research report. A CNN (ConvNet) was trained from scratch to identify tuberculosis (TB) on the chest radio graphs. ACNN-based transfer learning technique was also employed to distinguish between TB and normal patients using CXR images, with five separate pre-trained models used: Inception v3, ResNet50, Xception, VGG16&VGG19.ConvNet,thesuggestedCNNarchitecture,obtainedanAUCof87.0%,87.0%F1-score,88.0%precision, 87.0% sensitivity, and 87.0% accuracy, This was marginally lower than the pre-trained models.

III. Proposed Methodology

A. *Proposed System*

Today, we require a strong diagnosis to predict illness in the human body in order to diagnose or detect any ailment in humans.[8]. In general, we want to use X-Ray pictures to forecast lung disease. In medical imaging, improvements in deep learning artificial intelligence, andapproacheshavebenefitedintheidentificationandcategorizationoflungdisorders.Weprovideadeeplearning technique VGG16 Architecture in our suggested system that will be utilized to diagnose lung ailments. The major purpose of this effort is to research and detect different types of lung infections utilizing deep learning algorithms for early lung illness diagnosis.

The16-layer VGG convolutional network was trained using fixed-size pictures. A series of convolutional layers with small-size kernels and a 3x3 receptive field are used to process the input [9]. The smallest size that still allows us to distinguish between up, down, right, left, and centeris this one.

B. *System Methodology*

The dataset used, the preprocessing, the techniques for image enhancement, data augmentation, and the numerous algorithms are all covered in this section. A flow chart is used to show the suggested technique's work flow.

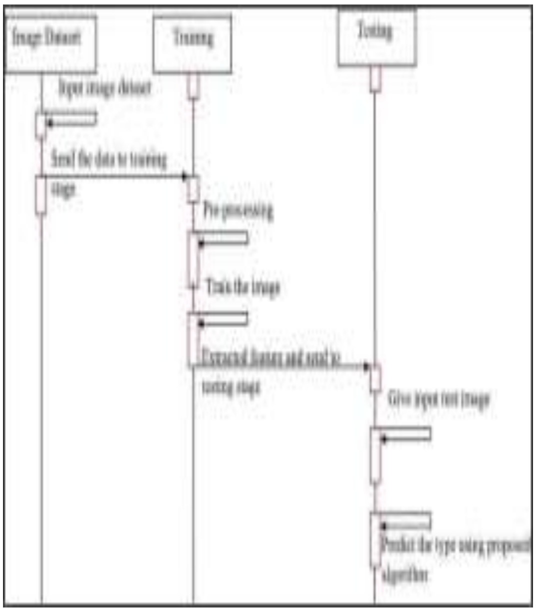

Fig2.SequencediagramUML

Fig 3. Data Flow Diagram

C. *Dataset*

In the first module, we develop the system to get the input dataset for the training, testing, and validation purpose. The dataset is formed from data retrieved from a

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few clinics, labs, and online sources. The dataset consists of approx 1100 chest X-ray images.

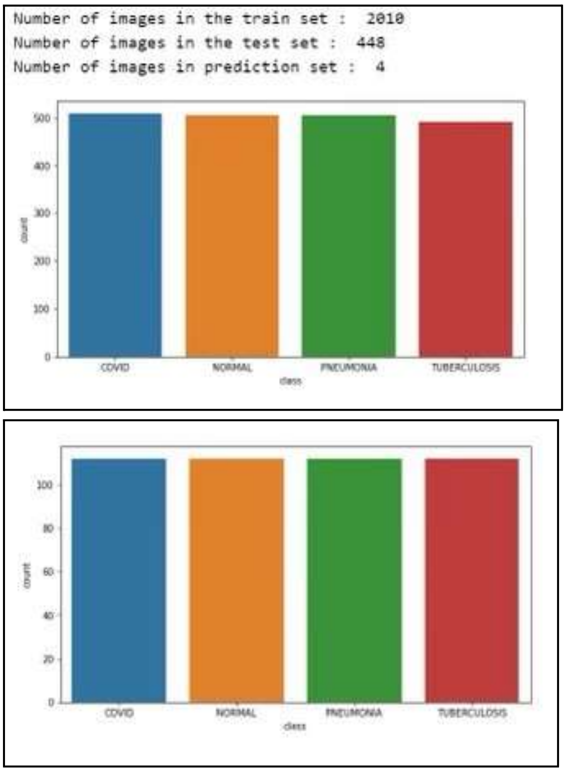

Fig 4. Images in Training and Test set

D. Data Pre-Processing

Feature Enhancement: A key component of the image analysis schema is the pre-processing stage. It can improve and drastically enhance the original image while lowering noise levels or extraneous information. In our research, we looked at 2 distinct pre-processing strategies.

Histogram equalization is a contrast correction method inimageprocessingthatusesthepicturehistogram[10].Basicall y used for Contrast Enhancement in medical imagesand satellite images and a tool for feature enhancement indetectiontasks.

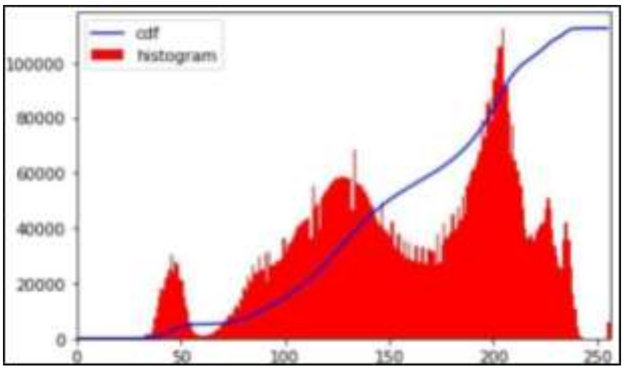

Fig5.NormalImageHistogramPlot

Adaptive Histogram Equalization (AHE): A method forenhancingvisualcontrast.Usefulforboostingtheclarityof edges and local contrast in each area of a picture [11].Though, It has the propensity to over-amplify noise in homogenous areas of an image.

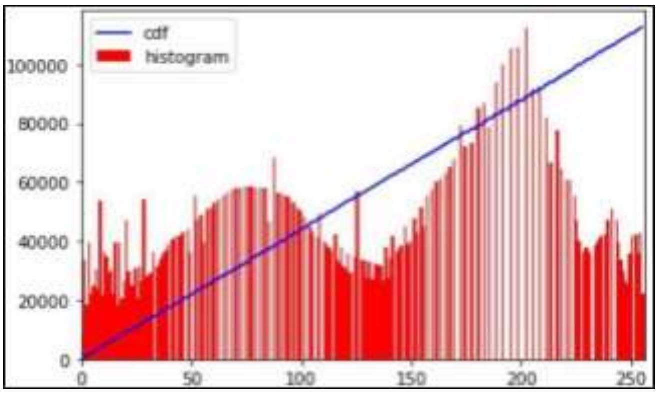

Fig6.AHEImageHistogramPlot

Contrast Limited AHE (CLAHE): AHE variant that reduces contrast amplification in order to decrease noise enhancement. It performs high-accuracy normalization in small sections or small tiles, as well as contrast limitation.

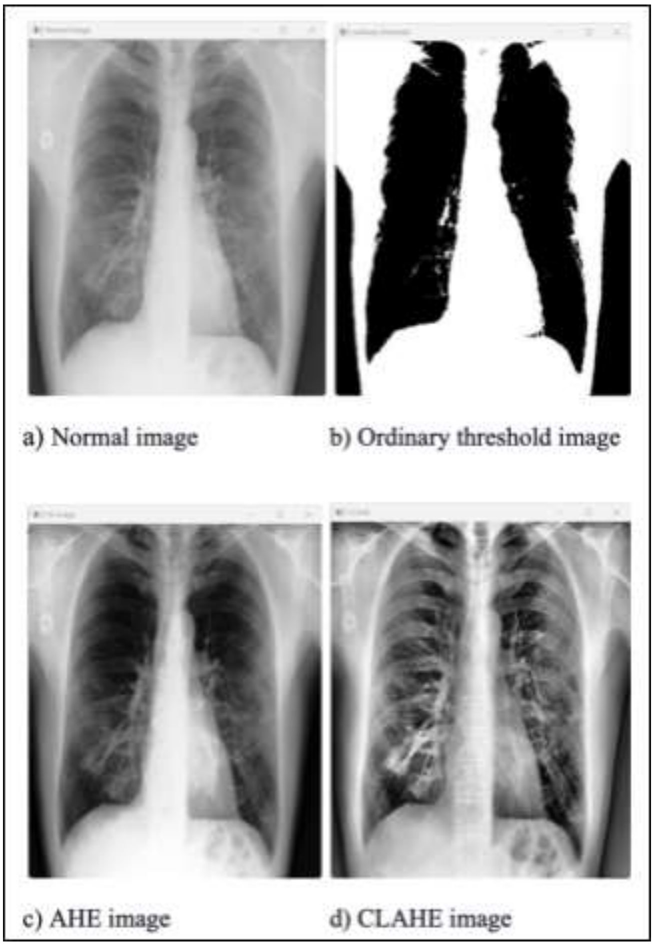

Fig 7. Preprocessed Image

E. Data Augmentation

It is a very frequent and well-liked support technique that, in essence, uses small modifications of a picture in each training session to dramatically enhance the volume of training data. The standard modifications utilized in data augmentation are horizontal flip, zoom, shear, rotation, and

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rescale. This method is crucial for obtaining high levels of accuracy because our deep learning model can be trained on a larger dataset in comparison to the original one.

F. Deep Learning Model

Deep learning is made up of a few layers of nonlinear nodes that combine input information with a set of weights to assign significance to inputs for the comparison task the computation is attempting to accomplish in guided and/or unsupervised behavior. The totality of these inputs and weights is transmitted through node actuation work. [12][13].The yield of each layer is encouraged concurrently with input to the subsequent layercommencing with the input layer [14]. Learning can take place at various levels of representation as opposed to different degrees of abstraction.

IV. Algorithm

Convolutional Neural Network: A CNN is a sort of deepneural network consisting of distinct hidden layers suchas the RELU layer, convolutional layer, fully connectednormalizedlayer,andpoolinglayer.CNNprovideswe ightsinsidetheconvolutionallayer, which reducesmemoryimprintandincreasesnetwork execution. The3Dvolumesofneurons, local connection, and sharedweightsarethekeyfeaturesofCNN.

*VGG16:*GroupforVisualGeometryVGG-16:Convolutional Networks with Extremely DeepLayers for Large-Scale Image Recognition.The VGG-16modelcomprises16weightedlayers,5convolutionblocks,and 3 fully connected layers. The default size oftheinputimageis224x224butwasresizedto180x180.We actualized a classic VGG16 base model thatincludesthefirst5convolutionblocks.

The latter layer we are convolving, the more high-levelfeaturesarebeingsearched.Betweendescribedlayers,there arealsopooling(sub-sampling)operationsthatreduce the dimensions of resulting frames. For the Fullyconnectedlayers,ratherthanusingtheaggregatearchitectureofthepre-trainedmodel,weimportedapre-traineddisplayVGG16and"cutoff"theFully-Connected layer - which is referred to as the "top"model.

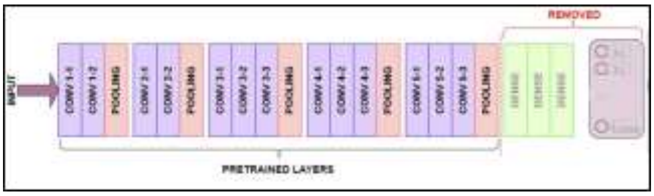

Fig8.VGG16Basemodel+Bootstrapped“top”model

Theimageaboveshowsthemodel's"top"pieceremoved.Themodelcombinesthepre-trainedoutputlayers,resultingina3Dstackoffeaturemaps.So,followingthebasemodelflatten()layerisadded,followed by 3 dense layers and 2 dropout layers. The firstdense layer takes input from the flatten layer, this layerconsists of 256 neuron’s, then comes the first dropoutlayer.Followingthisdropout layer is the second dense layer which consists of128 neuron’s which passes the input to the last denselayerhaving4units(numberofclasses)onbasesofourtargetdatasetconsistingoffourforecastclasses-Typical,Tuberculosis,Pneumonia,andcovid-19.

Fig9.Freezingthepre-trainedlayers

Theabovegraphicshowsfreezingpre-trainedconvolutionallayers&whichmovesallthelayer'sweights from trainable to non-trainable. Rectified linearunit - an activation function is present in the first andsecond dense layers. The last dense layer used a softmaxactivation function with four output classes. We utilizedthe Adamax optimizer to update the model in response tothe loss function output as it provided better results thanAdamoptimizer.Finally,thefinishedmodelwasassembled andcompiled.

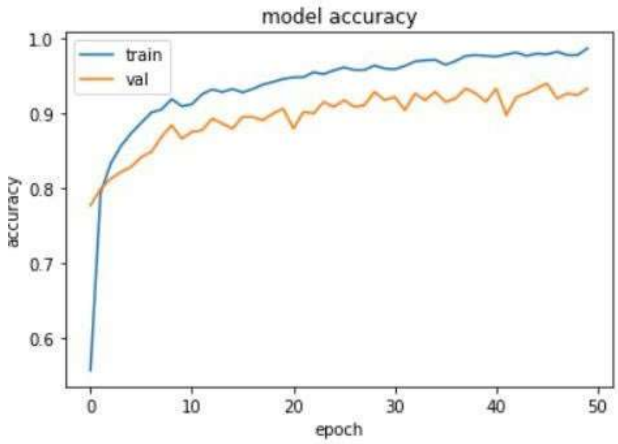

Fig11.ModelAccuracyGraph

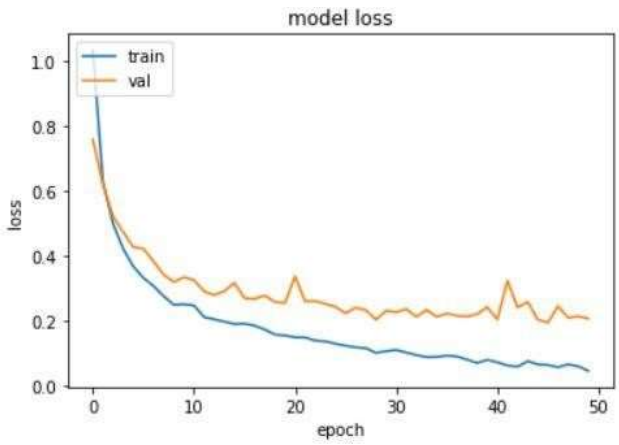

Fig12.Model Loss Graph

V. Result

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The last layer's soft max activation function allows the neural network to output the likelihood that An image falls into one of four categories. The concluding output is determined by the network, selecting the most probable category.

Model Accuracy 0.9385714285714286

	precision	recall	f1-score	support
COVID	0.87	0.92	0.89	112
NORMAL	0.94	0.82	0.88	112
PNEUMONIA	0.92	0.99	0.95	112
TUBERCULOSIS	1.00	0.98	0.99	112
accuracy			0.93	448
macro avg	0.93	0.93	0.93	448
weighted avg	0.93	0.93	0.93	448

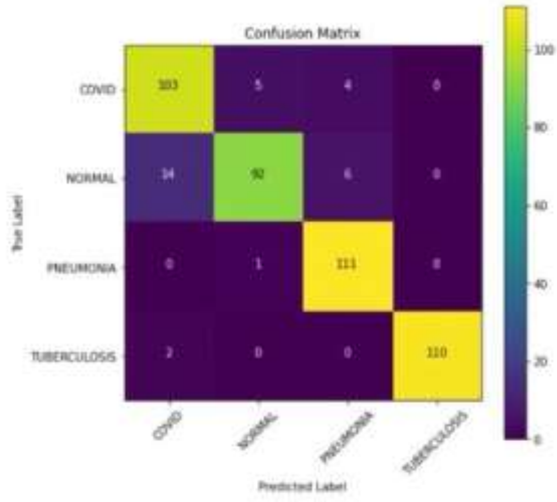

Fig13.Confusion Matrix

The data set was split into three distinct subsets: training(75%), validating (10%), and testing (10%). The suggested method can detect the presence or absence of the list edalveolus disease with a model accuracy of around 93.8%.The training accuracy of the model was 96.78% and thevalidationaccuracywas92.8%.TheproposedVGG16convolutionalneuralnetwork-basedtechniqueperformedrelativelybetterthantheexistingmodelpresentinconsiderationofthedatasetsize.

VI. Conclusion

Numerous researchers thoroughly discuss the influence of a modern patient's Alveolus (lungs) on various researchers and the damage to the lung in this study. According to several studies, because these lung ailments have been healed, detecting this condition has become critical. One of the primary goals of this study is to find and choose appropriate data set sand techniques for analyzing lung illnesses. Based on the comparisons and comments in this book, the chest X-ray was chosen. Following that, because the chest X-ray may contain a large amount of useless data, an appropriate feature extraction approach was designed. This pick was based on the benefits and drawbacks of numerous standard algorithms. Eventually, a classification technique based on their distinguishing characteristics was discussed. Short-term studies revealed that VGG16 Architecture provided extra benefits for predicting lung ailments in advance with improved out comes. Finally, lung disease can be identified.

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