

## Identification of Pulmonary Disease with Chest X-ray data using CNN Architecture

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**Article History:** Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 23 May 2021

**Abstract :** Pneumonia is an infectious and fatal sickness in breathing that is caused by germs, fungi, or a virus that infects the human lung sacs with the load full of fluid or pus. The common method used to diagnose pneumonia are using chest x-rays and always needs a medical expert to assess the result of X-ray. This difficult technique of recognizing pneumonia results in a life loss due to improper diagnosis and treatment. This study intends to integrate deep learning methods to reduce the problem. Convolution Neural Network is optimized to perform the complicated task of detecting diseases like pneumonia from a group of chest X-ray images. This model is based on supervised learning, the output of this system is dependent on the dataset's quality. VGG16 Architecture which is a deep learning model is finely tuned using transfer learning to achieve higher accuracy. This model extracts attributes from chest X-ray dataset and categorize regardless if the man is affected with pneumonia or not. This model helps to reduce the sickness and describable challenges frequently faced with medical treatment.

**Keywords:** Chest X-Ray, Convolutional Neural Network (CNN), Pneumonia, Transfer learning

### 1. Introduction

The risk of pneumonia is immense for many. According to WHO, pneumonia is mainly affecting the children under the age group of 0-5 years. This problem is worse in backward areas as people do not have any medical facilities. People who are facing these problems due to lack of medical facilities and money, faster diagnosis means a lot to them. This system helps to treat people and can be done within no time and help the poor.

This project presents the treatment of pneumonia by medical physician using convolutional neural network models to accurately detect pneumonic lungs from a person's chest X-rays. These CNN models will be trained for classifying chest X-ray images into normal and pneumonia within seconds serving the purpose of early detection of pneumonia. To control this deadly infection a classification model is built using CNN to detect pneumonia from chest X-ray images. Accuracy of the model and the size of the dataset are directly correlated, thus improving the accuracy of the model by the usage of larger datasets, but direct correlation doesn't exist between the number of convolutional layers and accuracy of the model. A certain number of combinations of convolution layers, dense layers, dropouts and learning rates must be trained by evaluating the models after each execution, to obtain best results.

The existing system detects pneumonia based on their recall and F1 scores. Recall is often recommended in medical imaging cases over other performance evaluating criteria, as it gives a measure of false negatives in the results. To determine the performance of models the number of false negatives in the result is very important. If a model has higher accuracy but lower recall values, it is termed as underperforming, ineffective and even risky as higher false-negative values simply higher number of instances where the model predicts a patient as normal, but the person is diseased. Hence, it would risk the patient's life. To prevent this, our focus would be only on models with decent accuracies.

The existing deep learning models were experimented by medical specialist in hit-and-miss procedure, which requires immense time and wealth. Our model aims to carry out appropriate categorization task with deep learning model called VGG16 Architecture which is used for pneumonia dataset classification and improve the accuracy of the existing system.

The remainders of the paper are as follows: Section 2 surveys the related work. Section 3 describes about

the framework of deep learning models. Section 4 explains about the proposed methodology in detail, Section 5 exhibits the results. Finally, we draw conclusions in section 6 of the paper.

## 2. Related Work

As per our survey, there exist systems that can identify pneumonia using CNN Architecture and this can also be used for detecting other diseases. Each system has its unique features. The Following models describe the work performed by others:

Breast Cancer Classification using Deep Learning developed by Umit Ilhan, Kaan Uyar and Erkut Inan Iseri, [2] whose aim was to develop an efficient system to classify breast tumors as malignant and benign and achieved an accuracy of 98.42%. Hamdalla F. Al-Yasriy, Muayed S. AL-Husieny [3] developed Diagnosis of Lung Cancer based on CT Scans using CNN a Computer-aided system implemented for detecting lung cancer in a dataset collected from the Iraqi hospitals by using a convolutional neural network technique with AlexNet architecture and classifying whether it is normal, benign, or malignant and achieved an accuracy up to 93.548%. Sneha Grampurohit and VenkammaShalavadi [4] developed Brain Tumor Detection Using Deep Learning Models using Deep learning models like convolutional neural network (CNN) model and VGG-16 architecture (built from scratch) for detecting of brain tumor in the scanned brain images. Syed Muhammad Usman and Muhammad Haseeb Aslam [5] developed Epileptic Seizures Prediction Using Deep Learning Techniques, this system is applied 24 subjects of scalp EEG dataset which resulted in achieving an average accuracy sensitivity of 92.7%. Sarki R, Ahmed K., and Wang H developed Early detection of Diabetic Eye Disease from Fundus images with Deep Learning which mainly addresses the three research gaps, first is changes in eye anatomy, secondly large volume of fundus images puts strain on specialist resources, thus deep learning is used for early detection and they proposed a framework for early detection eye disease and fundus images.

## 3. Framework of Deep Learning Models

### 3.1 Convolutional Neural Network

CNNs are most used in analyzing optical analogue for image classification due to their improved performance. As shown in Fig 1, chest x-ray is given as input then it undergoes operations like convolution and pooling layer subsequently fully connected layers are connected. Softmax layer is used to achieve the output created on the operations performed.

Convolutional Neural Network comprises of a key in layer, invisible layers, and an outcome layer. In any perceptron neural network, all the center layers are known as invisible layers as their inputs and outcomes are disguised by nonlinearities and final convolution. In a CNN system the invisible layers include layers that perform convolutions, which extract characteristics from the dataset. Pooling is the method that subsamples the features from convolutional operation.

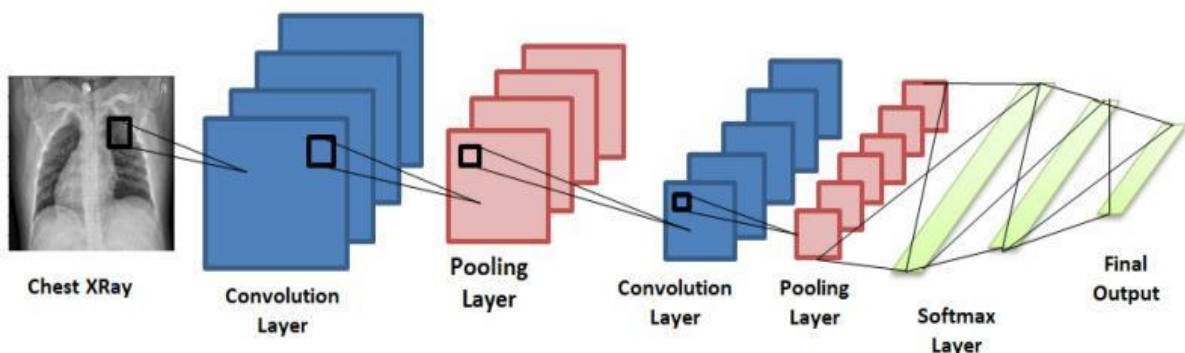


Fig 1: Convolutional Neural Network Architecture

### 3.2 Transfer Learning

CNNs can achieve a good throughput when the dataset is huge. Transfer learning is helpful in those cases where the dataset is not huge. Transfer learning basically concentrates on saving the understanding acquired while resolving one issue and using it to a different but linked issue, although formal relation between two issues are limited. Reutilizing or moving information with earlier learned tasks for the learning of new tasks has the

possibility to critically improve the efficiency. With the use of transfer learning, we do not need to develop our model from scratch which takes a longer training period. Thus, transfer learning helps us to store the basic model which in turn can be used to progress neural networks.

### 3.3 Pre-Trained CNN Model

In this paper, a familiar CNN model: VGG16 was used for identification of pneumonia. A short intro of the VGG16 Architecture is given below:

#### 3.3.1 VGG16

VGG16 is a Convolution Neural Network (CNN) architecture which will be used in ImageNet. It consists of convolution layers with 1 stride of 3\*3 filter and use same padding and maxpool layer of 2x2 filter with 2stride all the time. VGG16 has layered array of convolution and max pooling consistently all over the entire architecture. In the end it has 2 FC (fully connected layers) whose configuration is same in all the networks, followed by a SoftMax for output. VGG16 can be implemented from scratch using Keras. The following Fig 2 describes the VGG16 Architecture.

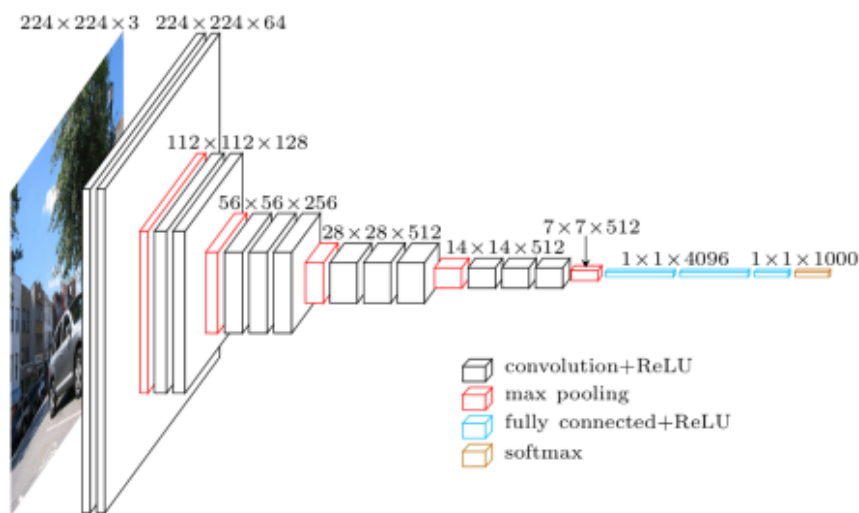


Fig 2: VGG16 Architecture

## 4. Proposed Methodology

This paper presents an ideal result for the identification of pneumonia from chest X-ray images. Preprocessing and Data augmentation were used to modify the dataset, and modern convolutional neural networks like VGG16 were very well modified for classification of pneumonia. The block diagram in Fig 3 represents the proposed methodology of the system.

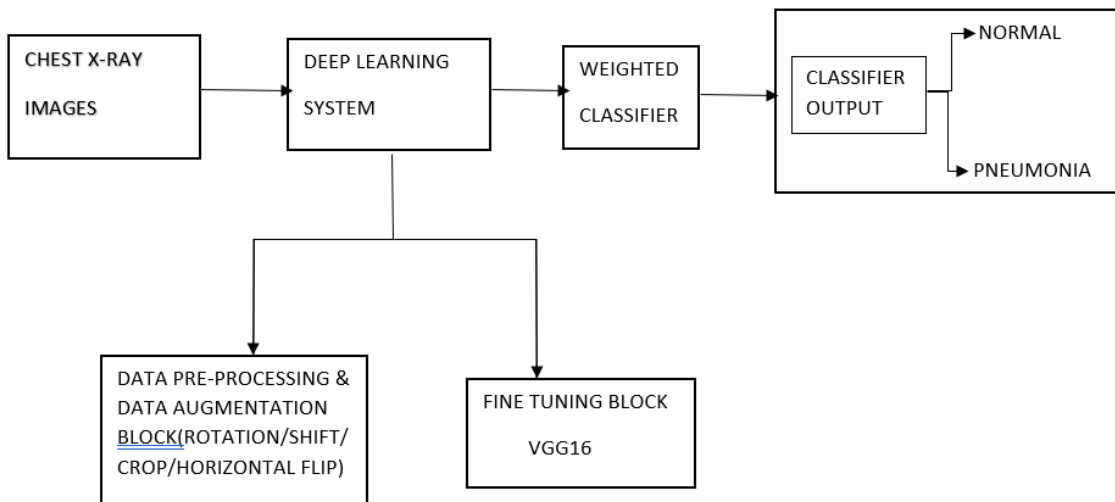


Fig 3: Block Diagram of Proposed Methodology

#### 4.1 DATASET

The actual dataset [9] comprises of two folders: train and test data folders which in turn comprises of chest X-ray image samples of a person affected with pneumonia and normal. The entire dataset is comprised of 1,250 chest X-ray images from the children of age group 0-5 years old. To stabilize the section of data allocated to the training and validation set, the actual data groups were altered. The complete data is repositioned into training and validation set and only validation set is used to improve validation accuracy.

#### 4.2 Preprocessing and Augmentation

The main procedure in the data preprocessing is to rescale the chest X-ray images into the size of the input image which is of 224\*224 pixels. VGG16 Architecture have standards, all the images will be changed into their standards. Deep learning models mainly consider the input image to be in a square shape, all the images are examined if it is a square shape, else they cut short the image appropriately.

Augmentation requires techniques to extend the measurements and standards of the dataset artificially. Augmentation helps in increasing the model’s ability to react to data and can make precise calculations for training data. This model avoids most of the undesired features in the dataset of a deep learning model. Rescaling, rotation, breadth and peak shift, magnification range, random resized crop, etc. come under this augmentation process.

The following percentage values were given for the dataset: Rotation range of 20 degrees which is helpful for rotation of images. A 0.1 percent was given to width shift, which is used horizontal transfer of images and height shift of 0.1 percent is given for the vertical transfer. 0.1 percent of shear range was used for clipping the image inanticlockwise direction and a zoom range of 0.2 percent was given respectively.

#### 4.3 Model Training

Transfer learning using VGG16/VGG19 architectures is done on ImageNet dataset. This transfer learning helps for Feature Extraction which will be later used on our chest X-ray image dataset. Transfer learning helps us avoid training the data from scratch, but we can transfer the learned models. Then we can add our own classifier for pre-trained model.

The classifier used is often called as dense layer. This classifier needs individual characteristics to carryout calculations like remaining classifiers. The output of characteristic extractor i.e., the convolutional neural network portion is changed into a single dimensional characteristic resultant for the classifiers. This procedure is called as levelling, which is used in last classification process, which gives the outcome of the convolution

performance and is levelled to create one lengthy characteristic resultant for dense layer. The classification layer contains a flatten layer and two dense layers.

### 5. Results

Techniques like preprocessing and data augmentation were used to aid in fitting the dataset into convolutional models' architecture. The acquired considerable results are shown in the below Fig 4. The results achieved are as follows: training loss = 3.1985, training accuracy = 0.9345, validation loss: 0.2914, and validation accuracy of 0.9688.

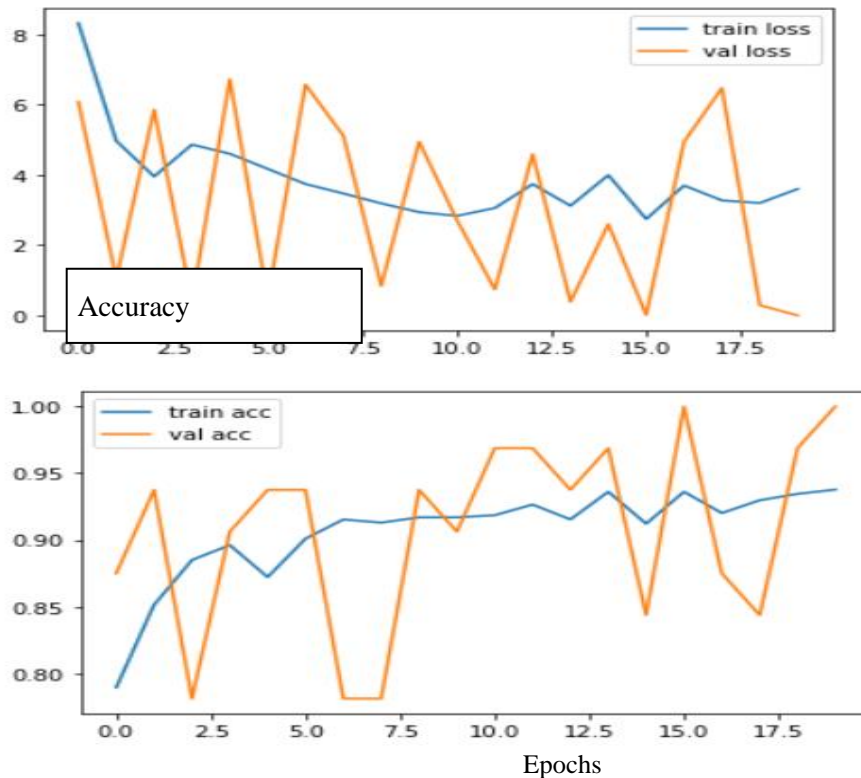


Fig 4: Performance of model for 20Epochs

**Table: Comparison with other works**

Approach	Accuracy
CheXnet	76.8%
Image Based Deep Learning	90.7%
SVM Based	88%
Efficient Deep Learning	93%

### 6. Conclusion

We have demonstrated how to classify if a person is affected with pneumonia or not from a collection of chest X-ray images data. We developed our CNN model from scratch, which can classify and thus detect pneumonic patients from their chest X-rays with high validation accuracy. This study detects whether a person is having pneumonia or not with a higher validation accuracy of 93%.

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