International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July - 2021 ISSN: 2582-3930

DETECTION OF PNEUMONIA FROM CHEST X-RAY IMAGES USING CNN

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Abstract - One of the infectious disease which affects one or both lungs in humans due to the bacteria called Streptococcus pneumoniae. Thus for detecting pneumonia automatically would be more beneficial for treating the disease without any delay especially in remote areas. Using deep learning algorithms for analyzing medical images, Convolution Neural Networks(CNNs) have gained much attention for disease classification. We proposed a CNN model which is trained from scratch for classifying and detecting the presence of pneumonia from a collection of chest X-ray images. For extracting the features of pneumonia from a chest X-ray image and classify it to determine whether a person is effected with pneumonia, we constructed a convolutional neural network from scratch. Comparing with other deep learning classification models with sufficient image repository, and it is difficult to obtain a huge amount of pneumonia dataset for this classification; therefore to improve the validation and model accuracy of the CNN model we deployed several data augmentation algorithm and achieved exceptional validation accuracy.

***Key Words*:** pneumonia detection, chest X-ray images, Convolution neural networks, sigmoid function

1.INTRODUCTION

Pneumonia is a lung inflammation often caused by pathogenic microorganisms, factors of physical and chemical, immunologic injury. It is approximately 17% of the millions death, killing more children in 2016. Due to this the most children less than two years are affected. The major factor in attacking the pneumonia is air pollution. Not only this but also due to lack of nutritional food, lack of sanitation and moreover shortage of safe drinking water. People who get effected with pneumonia have cough, fever, moreover shortness of breath and during deep breaths there is a sharp chest pain. In elderly people, confusion may the most common factor. The symptoms in children under five years are fever, cough, and fast or difficult breathing.

The neural network architecture was specifically designed for pneumonia image classification tasks. The proposed technique is based on the CNN algorithm, to utilize a set of neurons to convolve on a given chest X-ray image and extract relevant features from them. The efficiency of the proposed method with the minimization of the cost as the focal point was conducted and compared with the exiting pneumonia classification networks. U-Net, DenseNet, and AlexNet are the most used architectures for medical image analysis. However, these techniques are cost effective, low processing power. For an alternative, our study proposed a conceptually simple yet efficient network model to handle the pneumonia classification problem.

2. METHODOLOGY

EXISITNG METHOD:

Some of the existing methods for the detection of pneumonia by analyzing through the

a) Needle of biopsy
b) CT image of lungs
c) MRI of the chest
d) Ultra sound of the chest
e) PCR method
f) Chest X-ray of the lungs

Due to these existing methods for the detection it requires more computational cost and also a time taking procedure. And also in the remote areas, it is difficult to undergo through these methods.

However, even for very professional and experienced doctors, the diagnosis of pneumonia through seeing the any of the method is still a tremendous factor because of X-ray images have similar region information for different diseases, such as various lung diseases. Therefore, it is a time-consumed and energy-consuming for diagnosing pneumonia through these traditional methods and it quite impossible to analyze whether a patient suffers pneumonia through a standardized process.

PROPOSED METHOD:

The flow chart of the proposed method is as follows,

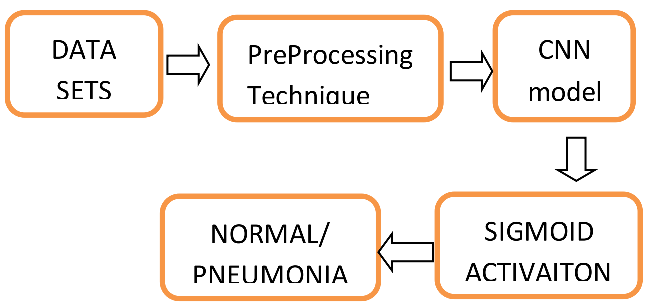

Figure 1: Flow chart

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The chest X-ray datasets which extracted are preprocessed and train by the model for the feature extraction and the classifier that is the sigmoid activation function which is at the end of the model classifies whether the patient is affected with Pneumonia or not. And this is the automatic process for detecting of pneumonia which doesn't require a specialized radiologist for treating and can also be used in remote areas.

3.MODELING AND ANALYSIS

To test the effectiveness of the proposed model we present the detailed experiments and evaluation steps. To build and train the convolution neural network we deployed keras open source deep learning frame work with tensorflow as backend.

Dataset:

The dataset which we used in this work is taken from Kaggle. It consists of 5856 images of chest X-ray. The dataset is split into three portions namely training dataset, validation dataset and testing dataset with two folders containing Pneumonia[P] and Normal[N]. The details of number of images under each part is shown in Table 1.

Dataset	**Number of normal images**	**Number of pneumonia images**
Training dataset	1341	3875
Testing dataset	234	390
Validation dataset	8	8

Table 1: Dataset Information

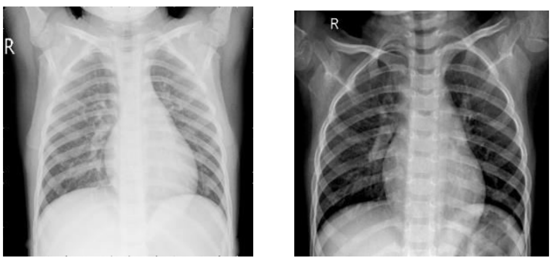

Figure 2: Chest X-ray's without pneumonia

Figure 3: Chest X-ray's with pneumonia

Preprocessing:

The primary goal to use the preprocessing step is to reduce the complexity of the model which is likely to increase if the input are images. So to downsized the X-ray images we use the resize technique for image size reduction, and to reduce the blurred portion because of noise we used median filter and a histogram equalization to keep the saturation and contrast same in all the images which has taken.

Figure : 4 Original image vs Preprocessed Image

CNN Model:

CNNs are a class of Deep Neural Networks which can recognize and classify particular features from images which we taken and are widely used for analyzation of images. There are two main parts to a CNN architecture, a convolution layer which identifies the various features of an image for analysis in a process called as Feature Extraction. A fully connected layer which utilizes the output from the convolution layer and predicts the class of the image based on the features extracted in previous stages.

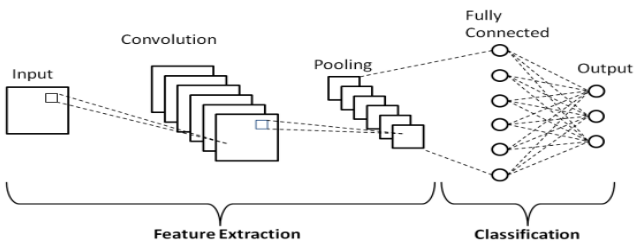

Figure: 5 Basic CNN model Architecture

We proposed CNN model to extract features of chest X-ray images and use those features to detect if a patient is suffering from pneumonia. The overall architecture of the proposed CNN model which consists of two major parts: the feature extraction and a classifier (sigmoid activation function). Here, we present CNN architecture with a dropout layer. This CNN consist of convolution layer, max pooling and a classification layer. This model consists of six layers where 3 layers are given for convolution whose strides are 2 and the activation function is ReLU. After convolution layer these are employed as max pooling operation to retain maximum of each sub region which split according to the stride and the remaining randomly fit zero to improve the proposed model performance. The two densely fully-connected layers followed by Sigmoid function are utilized to take full advantage of the features extracted through previous layers.

Sigmoid activation function:

It is a mathematical function which will take any real value and map it to between 0 to 1 shaped like the letter "S". And the another name is a logistic function.

$$Y = 1 / 1+e^{-z}$$

So, if the value of z goes to positive infinity then the predicted value of Y will became 1 and if it goes to negative infinity then the predicted value of Y will became 0. And if the output of the sigmoid function is more than 0.5 then we classify that label as class 1 or positive class i.e., person affected with Pneumonia and if it is less than 0.5 then we can classify it to negative class or label as class 0 i.e., person with normal condition. Sigmoid Function acts as an activation function in deep learning which is used to add non-linearity in a deep learning model, in simple words it decide which value to pass as output and what not to pass.

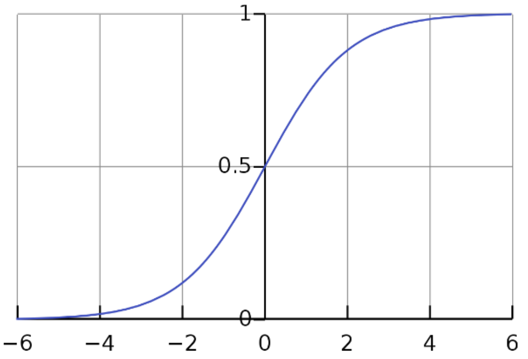

Figure: 6 Graphical plot of Sigmoid function

4. RESULTS AND DISCUSSION

The performance of proposed CNN architecture, to access the consequences of data we trained the CNN with the original dataset. Therefore, the model is trained for 20 epochs with Adam optimizer and learning rate is set to 0.0001 and the batch size is taken as 32. During training and validation, model loss is calculated using binary cross-entropy error as given in (1). Training and validation accuracy is calculated using below formula given in (2)

$$\text{Loss} = -\frac{1}{N}\sum_{j=1}^{N}(y^{j} \log y^{\wedge j} + (1-y^{j})\log(1-y^{\wedge j}))\_ \ (1)$$

Where y^{j} and $y^{\wedge j}$ are the target and the output values respectively of i^{th} sample of training or validation datasets and N represents the total X-ray images present in the training and validation dataset.

Therefore by using the above proposed method we calculated the accuracy, precision, recall values by the help of confusion matrix. To observe more information about the model performance confusion matrix is used. The 4 elements of the matrix represent the four metrics which count the number of correct and incorrect predictions which the model made and it is shown below. Accuracy is calculated by using (2), Precision value is calculated by (3), and Recall is calculated by using (4) as mentioned below

Accuracy = (TP+TN)/(TP+TN+FP+FN) __________(2)

Precision = TP/(TP+FP) ________________________(3)

Recall = TP/(TP+FN)____________________________(4)

Where TP is True Positive, TN is True Negative, FP is False Positive, FN is False Negative values.

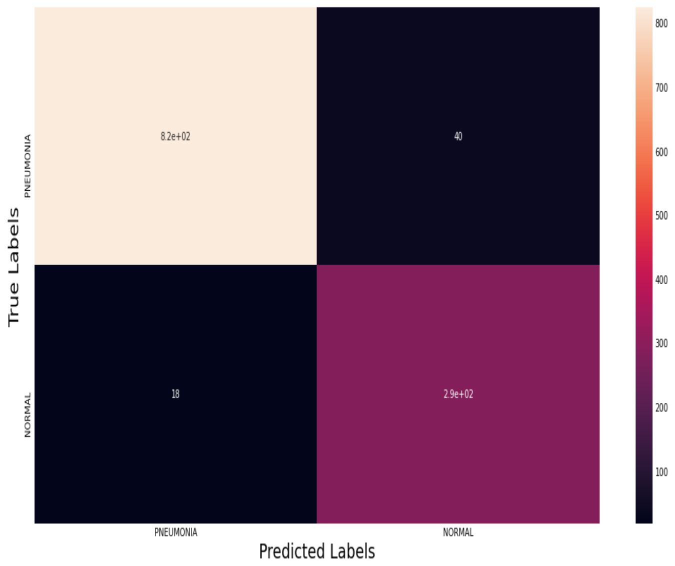

Figure : 7 Confusion matrix

The final results obtained with an accuracy = 0.9505, precision = 0.8784, recall = 0.9413. The plot of accuracy of the proposed model on the training set as well as the validation set over the training epochs are shown below

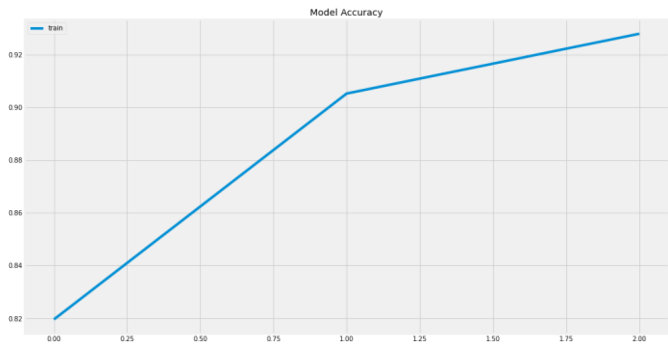

Figure :8 Plot of Training Accuracy

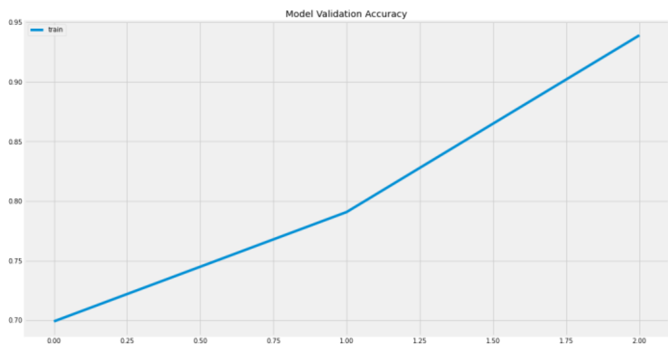

Figure : 9 Plot of Validation Accuracy

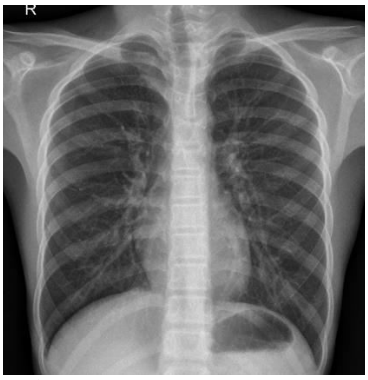

Figure : 10 Without Pneumonia

Figure : 11 With Pneumonia

5. CONCLUSIONS

In this paper we proposed CNN architecture that are designed from scratch to detect the pneumonia from chest X-ray images. And we demonstrate how to classify the positive and negative pneumonia from the collection of X-ray images. To avoid overfitting data augmentation techniques are used and achieved good accuracy to replace the existing method. In the future we tackle the problem of detect and classifying the lung cancer using the X-ray images.

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