Pneumonia detection using deep learning

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***Abstract*—This is an implemented project.The main idea is to detect the pneumonia using deep learning.Developed an algorithm that can detect pneumonia from chest X-rays at a level exceeding practicing radiologists. large number of children die due to pneumonia every year worldwide. An estimated 1.2 million episodes of pneumonia were reported in children up to 5 years of age, of which 880,000 died in 2016. Hence, pneumonia is a major cause of death amongst children, with high prevalence rate in South Asia and Sub-Saharan Africa. Even in a developed country like the United States, pneumonia is among the top 10 causes of deaths. Early detection and treatment of pneumonia can reduce mortality rates among children significantly in countries having a high prevalence. Hence,I used vgg-16 model to perform the task.**

***Index Terms*—Vgg16,Chest Xray, Pneumonia**

I. Introduction

1) Accuracy of the model is directly correlated with the size of the dataset that is, use of large datasets help improve the accuracy of the model, but there is no direct correlation between the depth of the model and the accuracy of the model.
2) CNN is good for image classification as less number of parameters and connections are required in such networks. This makes the training of such neural networks (CNNs) far easier compared to other neural networks. Artificial Neural Networks, on the other hand, have difficulty in computing image data in view of a high degree of computational complexity involved networks are trained and tested on different datasets. The knowledge acquired by the network can then be applied to train and test new datasets.This process is known as Transfer Learning
3) VGG16, VGG19, ResNet50, and Inception-v3 are transfer learning models consisting of many layers . One of the biggest problems faced when developing deep networks is vanishing gradient. In vanishing gradient problem, during back propagation, the gradients become infinitesimally small,leading to loss of integral information[1]. Due to this, the accuracy of the network saturates and then starts degrading. Different techniques have been employed by the models used in this paper to overcome the vanishing gradient problem. Training deep networks have certain restrictions viz.the dataset should be large, a large number of computational resources are used to achieve high performance, and the process of fine-tuning each parameter and hyper-parameter to achieve the optimum results is quite mundane.

II. Related Work

- This project is based on deep learning models for analysing medical images.In Image processing part I have implemented data augmentation and contrast enhancement techniques.In data augmentation I have considered flipping,rotating and added Gaussian noise. Due to the characteristics of low brightness and low contrast of the chest X-ray image, to better detect the target area of pneumonia and improve the detection accuracy, the chest X-ray image can be prepossessed. In X-ray images, normal lungs will not absorb X-rays[2], so it will appear black. The location of the pneumonia is a gray dashed shadow or a cloudy area. To improve the recognition rate, contrast and brightness enhancement operations can be performed on X-ray images.

III. Method

- **Image Preprocessing :** I have implemented two different methods like data augmentation and adaptive contrast enhancement.
- **Data augmentation :** The initial dataset values are as shown below. Data before augmentation

Type of data	Normal	Pneumonia
Test	234	390
Train	1341	3875
Validation	8	8

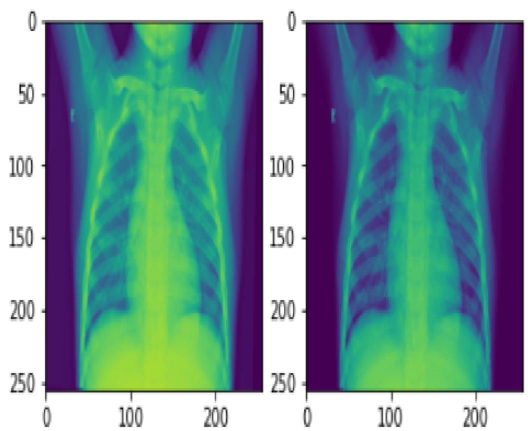
The size of the dataset is low so by increasing the size we can achieve better results. The given images are flipped ,rotated and experienced noise.So the final size becomes as follows:. Adaptive Contrast Enhancement : Then adaptive contrast enhancement methods are applied to the whole data set(after data augmentation).Data after augmentation is shown below.

Type of data	Normal	Pneumonia
Test	1404	2340
Train	8046	23250
Validation	48	48

- **contrast enhancement:** Mathematical details Example samples for the different gain values

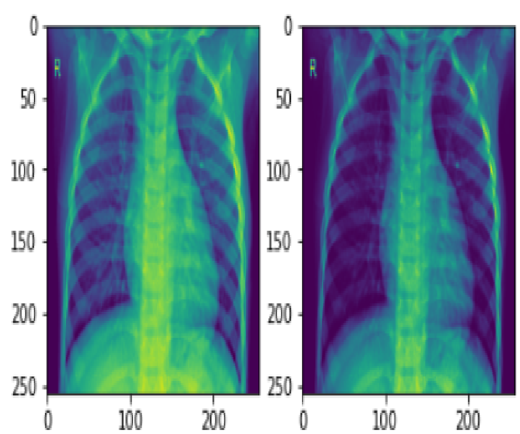
1) Gamma Contrast Enhancement:It is is a nonlinear operation used to encode and decode luminance or tristimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression.

   Gamma Contrast Enhanced Image=$Image^{\gamma}$

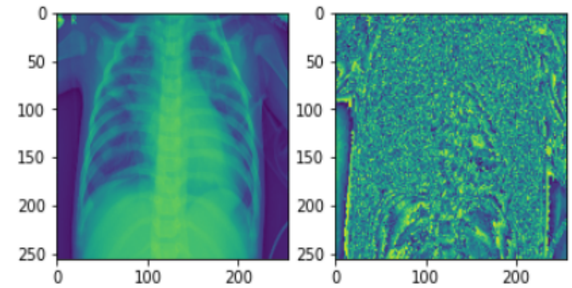
   left is original and right is enhanced(at $\gamma = 2$)

2) Gaussian Contrast Enhancement:Its a Non-linear transformation function to enhance brightness and contrast and defined by the following mathematical equation
   Gaussian Contrast Enhanced Image=1-exp $\frac{-I^2}{gain}$

   left is original and right is enhanced at gain=0.3

3) Brightness contrast enhancement: It is also a non linear transformation function to enhance brightness and defined(E) as follows.
   Log Enhanced Contrasted Image=αI+β



left is original and right is enhanced at α and β at 25

IV. Algorithm

Input: Chest X ray data
Output: Pneumonia detection
Data: Chest X ray Images-Kaggle

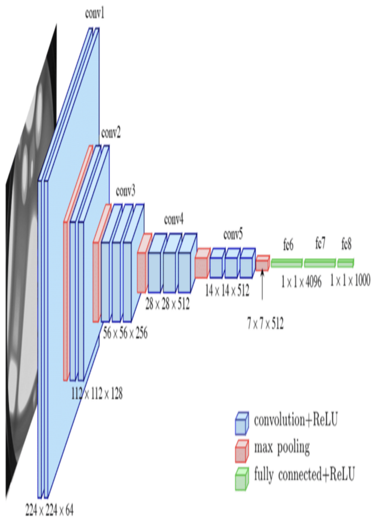
Imported all the required libraries
Downloading Chest-X Ray data set from kaggle https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia
Function `Contrast Enhancing(`*Images, Parameters*`)`**:**
    Gamma Contrast Enhanced Image=$Image^{\gamma}$
    Gaussian Contrast Enhanced Image=1-exp $\frac{-I^2}{gain}$
    Log Enhanced Contrasted Image=αI+β
    return Contrasted Image

Def `Data Augmentation(`*Images*`)`**:**
    Ir=Rotate 35 degrees
    Ih=Horizontal Flipping
    Iv=Vertical Flipping
    Ig=Gaussian Noise
    return All Images are stored In Folder

Now we have data ready ,Data is splitted into training,testing,validation.
Vgg-16 model is trained using training dataset.
The trained model is tested with the testing data
Results are displayed

V. Model

VGG16 Model
Model Parameters Training batch size-128
Validation batch size-128
testing batch size-8
Optimizer = Adams
Learning rate = 2exp -4



$Number of epochs = 10$

VI. Results

Due to the computational limitation I decided to train the model for only 10 epochs and the results are shown below.P1,P2,P3 are with data augmentation and contrast enhancement.

Contrast	Without-Data-augmentation and enhancement	P2	P3	P4
Gamma γ	84%	81% $\gamma = 6$	86% $\gamma = 2$	83% $\gamma = 0.6$
Gaussian	84%	79% gain=0.3	81% gain=0.9	82% gain=2
Bright	84%	79% $(\alpha = 25, \beta = 25)$	81% $(\alpha = 1, \beta = 25)$	82% $(\alpha = 25, \beta = 1)$

(a) Training Losses

(b) Training accuracy

(c) Testing accuracy

Figure 1. without data augmentation and contrast enhancement

The below figure is the loss plots of the experiment with γ as 0.6

(a) Training Losses

(b) Training accuracy

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Test Accuracy of     0: 61% (868/1404)
Test Accuracy of     1: 95% (2246/2340)

Test Accuracy (Overall): 83%
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(c) Testing accuracy

Figure 2. gamma as contrast enhancer with 0.6

VII. Conclusion

Due to the computational issues I trained it for only 10 epochs all cases.From the above results it is clear that when we use gamma as contrast enhancement the accuracy is good even with the low number of epochs.The accuracy without any data augmentation and enhancement is 84 ,we saw few cases where after augmentation is also less than 84 %. This mainly because ,we have to choose the parameter values manually for example values of γ, α etc.This selection is purely depends on input and trail and error approach.In recent trends the medical diagnosis is efficiently handled by modern computer vision models like GAN's.If we could able to make adaptive contrast enhancement with the help of GAN's then there may be a good improvement in accuracy.

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References

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