Pneumonia Detection Using Deep Convolutional Neural

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Abstract— Pneumonia is the most significant reason behind death worldwide although it's a vaccine-preventable disease. Analyzing chest X-rays may be a difficult task and requires precision. An improved and advanced AI system for pneumonia detection can go a protracted way in decreasing the mortality and increasing anticipation. The proposed paper presents a deep neural network supported convolutional neural networks and residual network together with techniques of identifying optimum differential rates using cosine annealing and stochastic gradient with restarts to achieve an efficient and highly accurate network which will help detect and predict the presence of pneumonia using chest X-rays.

Keywords—Pneumonia Detection, Convolutional Neural Networks, machine learning, deep learning, Architecture, Data Augmentation, Data Preprocessing.

I. INTRODUCTION

Pneumonia in India accounts for 20 percent of the death worldwide caused by pneumonia. It's an acute respiratory infection which affects the lungs which might be detected by analyzing chest X-rays. This could be credited to the way that pathological changes, additionally to its bloodless characteristics and financial considerations. Analyzing and classifying chest X-rays may be very tedious for radiologists since X-rays are often tormented by noise thanks to sensors, electronic devices, and implantation. Utilization of ML(machine learning) and AI(man-made intelligence) in medicinal services field in ascending thanks to its ability to deal with enormous datasets which is past the extent of human potential, and at the moment dependably convert examination of that information into clinical bits of data that help doctors in preparing and giving assistance in consideration, inevitably giving results , less expenses of consideration and improved patient fulfillment.

Numerous algorithms are proposed by researchers to effectively analyze X-rays for disease detection. However, these algorithms could not achieve significant level of accuracy and decision making and hence couldn't be deployed in medical applications. Variety of researches are conducted in the field of diagnosing diseases using chest X-rays using artificial intelligence. A paper proposed used convolutional neural networks to diagnose disease using X-rays. For comparative analysis, BPNNs (back propagation neural networks) with supervised learning, competitive neural networks (CPNNs) with unsupervised learning were also developed. However, the network didn't provide satisfactory results. In, the performance measure of assorted CNN architectures to spot pneumonia from radio graphs are discussed. All the CNN architectures discussed within the paper didn't have satisfactory accuracy value. The success within the field of deep learning motivated researchers to further improve these networks for medical image assay for disease detection. CNN is widely utilized in image classification because of its capability to handle spatial characteristics from images.

This paper concentrates on developing a deep neural network which will help in detecting the presence of pneumonia using chest X-rays . In order to accomplish this, CNN along with residual networks have been employed to increase efficiency and accuracy.

II. LITERARY SURVEY

Several new frameworks and designs using various learning models are developed together with infinite datasets have helped counts to beat restorative work power in different remedial imaging assignments. For instance;

Kalyani Kadam, Dr.Swati Ahirrao, Harbir Kaur ,Dr. Shraddha Phansalkar , Dr. Ambika Pawar

This paper focuses on developing a deep neural network which will predict pneumonia using chest X-rays. To further add to the performance, optimum differential learning rates have been selected using the techniques of cosine annealing.

Garima Verma, Shiva Prakash

This study contributes CNN algorithms used along with different data augmentation techniques for improving the classification accuracies which results in increased performance.

Ravi Soni, Rohan Singh, Shadib Shah, Shivang Malik

This paper extracts proficiency using deep convolutional neural networks architecture which can predict various chest diseases like pneumonia with significant accuracy.It has localize the pathology by generating Class Activation Maps(CAM).

Okeke Stephen, Mangal Sain, Uchenna Joseph Maduh, Do-Un Jeong

This study proposes a convolutional neural network model trained to classify and detect the presence of pneumonia. It constructed a model by using chest X-ray image and classifying whether the person is infected or not.

Abhinav Sagar

This work proposes to build an algorithm which will directly identify whether the person is suffering from pneumonia or not. The algorithm used is exactly accurate as lives of people are on stake.

Tej Bahadur Chandra, Kesari Verma

This work focuses on pixels of lungs segmented ROI (Region of Interest) that are more contributing toward pneumonia detection than the surrounding regions, thus the features of lungs segmented ROI confined area is extracted. The proposed has been examined using Multilayer Perceptron, Random Forest, Sequential Minimal Optimization and Logistics Regression.

III. METHODOLOGY

The proposed model aims to attain maximum accuracy for pneumonia detection using techniques of data augmentation, residual networks, and stochastic gradient with restarts, cosine annealing and differential learning rates. Fig1. shows the process flow of model development. Further sub-sections give detailed information about the method of the proposed work.

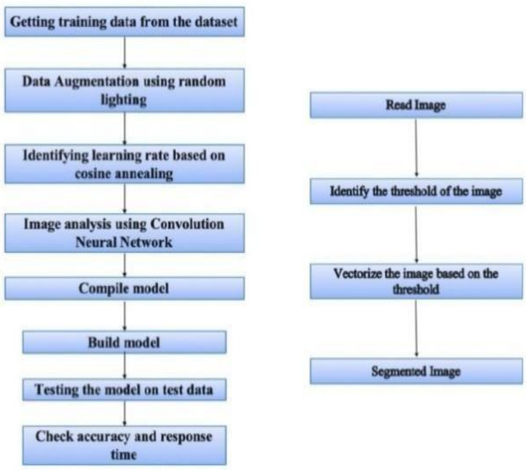

Fig. 1 Process flow of model development

A. Dataset

The Kaggle dataset employed consists of total, 5863 X-Ray images (JPEG) . The dataset structured into 3 parts like train, test, and validation,contains sub folders for each image category or class like Pneumonia or Normal. Chest X-ray images (anterior-posterior) were looked over review accomplices of pediatric patients of 1 to 5 years from Guangzhou Women and Children's Medical Center, Guangzhou. All chest X-ray imaging was gathered and executed as a major aspect of patients' normal clinical consideration.

B. DATA AUGMENTATION

In AI when model is being prepared, it tunes its parameters with the top goal that it can outline specific info (an image) to some yield (a class label).As number of parameters increase, a proportional amount of examples must be shown to the model for achieving good performance. A poorly trained neural network might not be ready to predict satisfactory results if the images (x-rays) within the target application change color, brightness act. As the dataset is quite less, and our target application may exist in a very sort of conditions, data augmentation is employed to make new data with different orientations. Data augmentation was tired order to get more data and avoid the matter of overfitting. So as to realize this, random lighting transformation capabilities were used. Employing a balance of 0 and contrast of 10 data were augmented. The result of augmentation of some images is shown in Fig.2.

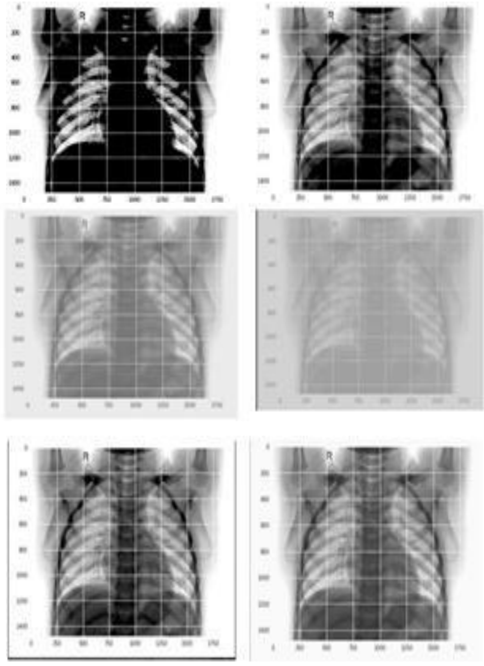

Fig. 2. Data augmentation using random lighting with balance **0 and contrast 10**

C. *Analysis using neural networks*

CNNs (Convolutional Neural Networks) are instrumental for performance in image analysis thanks to convolutional units and, it’s ability to incorporate various hidden layers handling convolution and subsampling so as to tug out low to high levels of structures of the input data and hence were used for building the model architecture. A dropout of 0.6 to cut back overfitting. The model was first trained with smaller 64 images using CNN so steadily increase in image size is finished for better CNN so gradually a rise within the image size were in serious trouble better efficiency. Only the last fully connected layer added on top of ResNet34 is trained first.

D.*LEARNING RATE WITH COSINE ANNEALING AND STOCHASTIC GRADIENT WITH RESTARTS*

In typical Gradient Descent improvement, like Batch Gradient Descent, the batch is taken to be the whole dataset. Despite the actual fact that, utilizing the whole dataset is extremely helpful for going to the minima during a less uproarious or less arbitrary way, however the problem emerges when the datasets get extremely tremendous. just in case of Gradient Descent the whole set is required for completing one iteration and it has to be done for each iteration until minima is reached. Due to this, it becomes computationally very expensive. So as to resolve this problem Stochastic Gradient Descent has been used. In this, it uses one sample instead of the entire dataset for every iteration. The sample is randomly shuffled and chosen for doing the iteration.

For choosing idle learning rate, the graph of loss versus learning was plotted. The estimation of the learning rate was picked dependent on where it’s most noteworthy and therefore misfortune is so far sliding. As shown in Fig. 2 the optimum learning rate is 0.01. As the network gets closer to a global minimum value of loss with each batch of stochastic gradient descent, the learning rate must likewise decrease therefore the calculation doesn't overshoot. Cosine tempering, a way of decreasing functions admirably with the learning rate, taking place extraordinary outcomes in an exceedingly computationally proficient way.

During training the model might get stuck at local minima rather than approaching to the global minima. To avoid this, stochastic gradient descent with restarts (SGDR) was incorporated into the model. This adds to the performance of the model in a way that by rising the learning rate all of sudden, gradient descent may ―hop‖ out of the local minima and find its way near the global minimum. To handle the matter of the model getting stuck at local minima, the learning rate is retune at the beginning of every epoch to the first value entered as a parameter, then reduce again over the epoch as described cosine annealing. Further to achieve better accuracy, differential learning rates were introduced. As per the paper, an perfect learning rate will be evaluated via preparing the model initially with a low learning rate and increase its value at each step. When learning rate is simply too small, loss doesn't change much, but as learning rate goes higher, loss should decreases faster and faster until some extent where it doesn't decrease anymore and eventually starts increasing. As per this, the model was trained on three different learning rates - [1e-4, 1e-3, 1e-2] for 500 epochs, with a cycle length of 1andcyclemultipleof2. The model was trained for image size 64*64 initially followed by gradual increase in image size (128*128, 256*256,512*152) to extend accuracy and tackle overfitting, An overall decrease in training loss was observed which is almost like validation loss suggesting that the model could be a acceptable fir to the problem.

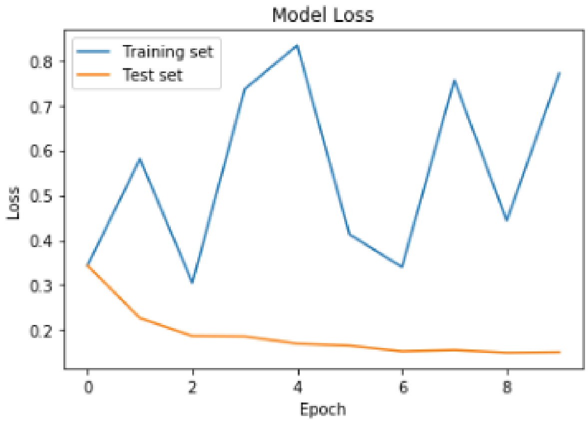

Fig. 4. Graph of learning rate versus loss to find optimum learning rate

IV. RESULTS

After training the model for 500 epochs, test time augmentation was done and also the model was tested for performance on the test data. The model accomplished an accuracy of 87.5%, is considerably superior than the baseline accuracy of 63%. The precision and recall values were approximately around 0.9088 and 0.9927 respectively. These values prove that the model is well-fit. After training and building the model, the weights are saved into a pytorch file for prediction of recent single image .The pre-trained model is then loaded and evaluated supported architecture of the trained model .The new data image for classification is transformed as per the trained model and converted to tensor for prediction. Prediction function of the model is employed which classifies the image as ―pneumonia‖ or ―normal‖ supported probabilistic predicted value. Multi-level thresholding is applied to the Chest X-rays for segmentation This is often achieved using Otsu thresholding technique which keeps clusters as tight as possible and at the same time maximizes the separation between two clusters(to minimize the overlap). Using thresholding the X- ray image is converted into an image with 4 discrete levels. This is achieved by quantising the image with the threshold values obtained via Otsu thresholding.

Fig.5. Original and segmented image of normal lungs

Fig.6. Original and segmented image of pneumonia affected lungs

As per Fig.5 and Fig .6, the collection of mass (colored light- grey) in the chest cavity of a pneumonia affected person can be seen clearly. On the other hand, a clear dark-grey chest cavity is observed for a person not affected with pneumonia.

V. CONCLUSION AND FUTURE SCOPE

The proposed work will help doctors better predict pneumonia in minimal time with high efficiency. The aggregation of this can contribute to the health care system for better patient satisfaction and care. This work is in its early stages and may be improved by adding more images to the dataset, incorporating better architectures, training the model supported on more transformations and orientations. Early diagnosis and treatment of diseases is critical to preventing complications including death. With billions of procedures per year, chest X-ray scans are one of the most common and important diagnosis tools used in practice. They are used for diagnosing and screening a variety of diseases like pneumonia. Statistics by the World Health Organization indicate that about two thirds of the global population lacks access to proper X-ray diagnostics.

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