International Journal of Engineering, Management and Humanities (IJEMH)
Volume 2, Issue 2, pp: 60-64 www.ijemh.com

Pneumonia Detection from Chest X-Ray Images using simple Self Created CNN Model

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Date of Submission: 12-03-2021 Date of Acceptance: 27-03-2021

ABSTRACT
Pneumonia is a life-threatening disease affecting lungs in humans commonly caused by bacteria called Streptococcus pneumoniae. One of the major causes of deaths in India is due to pneumonia as reported by the World Health Organization (WHO). Chest X-Rays which are used to diagnose pneumonia require expert radiotherapists for evaluation. So, developing an automatic diagnose system for detecting pneumonia would be beneficial for society by treating the patient without any delay particularly in remote areas. The proposed model for pneumonia detection from X ray images using deep learning consist of two main part: in first part development of a SVM classifier (features extracted from pretrained VGG16 convolutional neural network) for pneumonia detection and in second development of simple convolutional neural network (called self made CNN) for pneumonia detection. Chest X-Ray images (Pneumonia) have been downloaded from Kaggle. After data augmentation, the dataset for SVM classifier (Features extracted from VGG16) divided into two parts: 80% of the images were in the training set and 20% in the testing set and the for simple CNN , divided into three parts. 80% of the images were in the training set, 10% in the testing set and 10% in the validation set. After simulation both, SVM classifier (features extracted using pretrained CNN VGG16) and Simple convolutional neural network (called self made CNN) display accuracy more than 96% on testing dataset.

KEYWORDS: Pneumonia disease, VGG 16, Kaggle, SVM, Deep Learning.

I. INTRODUCTION

Pneumonia is a form of acute respiratory infection that affects the lungs, usually caused by viruses or bacteria. The lungs are made up of small sacs called alveoli, which fill with air when a healthy person breathes. When an individual has pneumonia, the alveoli are filled with pus and fluid, which makes breathing painful and limits oxygen intake. By the World Health Organization (WHO), pneumonia is the one of the leading causes of death in children worldwide. Currently the most accepted imaging modality for detecting pneumonia is chest radiographs. Computer-Aided Diagnosis (CAD) software can be defined as a second opinion in a diagnostic [1]. The common symptoms of pneumonia are : Chest pain when you breathe or cough, Confusion or changes in mental awareness (in adults age 65 and older),Cough, which may produce phlegm, Fatigue, Fever, sweating and shaking chills, Lower than normal body temperature (in adults older than age 65 and people with weak immune systems),Nausea, vomiting or diarrhea, Shortness of breath.Chest x-ray is a simple, easy and effective way that allows doctors to analyze inner organs or spot abnormalities and diseases of the blood vessels, lungs, heart, airways and bones. Pneumonia can be detected from an x-ray of the chest[2]. Machine learning has already been proved to facilitate the medical area primarily in detection of breast cancer, mammograms, lung nodules etc. [3]. The objective of this proposed work is to use a deep learning based model for pneumonia detection from X ray images. The deep neural networks have several applications in image classification and object detection.

II. LITERATURE REVIEW

Chest x-rays are interpreted by an expert radiologist. A number of research works are striving to make x-ray analysis automated. Sousa, R. T. et.al in [5] proposed, a Computer-Aided Diagnosis system for detecting pneumonia in infants using radiographic images. This implements and compares three machine learning classifiers, namely: Naıve Bayes, K-Nearest Neighbor (KNN), and Support Vector Machines (SVM). Results of experiments dem in [6] proposed four models based on CNN and transfer learning. D. Varshni, K. Thakral et.al in [7], uses pre-trained CNN models utilized as feature-

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extractors followed by different classifiers for the classification of abnormal and normal chest X-Rays. Statistical results obtained show that pretrained CNN models employed along with supervised classifier algorithms can be useful in analyzing chest X-ray images, specifically to detect Pneumonia. Lakhani and Sundaram in [8] proposed a method of detecting pulmonary tuberculosis following the architecture of two different DCNNs AlexNet and GoogleNet. P. Rajpurkar,J. Irvin et.al in [9] proposed 121-layer convolutional neural network trained on ChestX-ray. O. Stephen, M. Sainet.al in [10] proposed a convolutional neural network model from scratch to extract features from a given chest X-ray image and classify it to determine if a person is infected with pneumonia. They use several data augmentation to improve the validation and classification accuracy of the CNN model.

Human assisted diagnosis has its own limitations like the availability of an expert, cost, etc and hence an automated method for the detection of pneumonia from x-rays is a necessity. In this research, neural network models were developed to detect pneumonia from the chest x-ray images. Four models namely a basic convolutional neural network [11] [16], VGG16, VGG19, Inception [18] V3 were constructed using CNN [11] and transfer learning [12] methodologies. Deep learning-based [16] computer assisted diagnosis systems and medical imaging are becoming highly popular research topics. Currently, classification results are produced by hierarchically abstracting the original image using a classical convolutional neural network. These abstract features are less sensitive to the object's location and orientation, and the lack of spatial information restricts image classification accuracy development. As a result, researchers must continue to investigate how to build a suitable neural network architecture and training strategy in realistic clinical applications to avoid this issue. The novel [17] framework relies on the use of advanced classification to conduct direct lesion characterization and has a high level of accuracy in the classification task of children's pneumonia.

Four practicing academic radiologists annotate a test set, on which we compare the performance of CheXNet to that of radiologists. We find that CheXNet exceeds average radiologist performance on the F1 metric. We extend CheXNet to detect all 14 diseases in ChestX-ray14 and achieve state of the art re- sults on all 14 diseases[24]. Chest X-rays are often used to diagnose pneumonia, which kills around 50,000 people each year. Physicians can more effectively and quickly diagnose pneumonia using computer-assisted diagnosis. We hope to train a model using the dataset listed below to assist physicians in making pneumonia diagnoses in chest X-rays as part of this project.

The NIH dataset's images are 1024x1024. To begin, we used an anti-aliasing filter to resize each image. Our Logistic Regression baseline uses 32x32 resolution. The resolution of our Deep Learning model is 224x224. We also standardize the data to ensure that each function (pixel) has a zero mean and roughly unit variance[25]. The model may be able to help with the reliability and interpretability issues that come up often when working with medical images. Unlike other deep learning classification tasks with a large image repository, obtaining a large amount of pneumonia dataset for this classification task is difficult; as a result, we used multiple data augmentation algorithms to boost the CNN model's validation and classification accuracy, and we achieved remarkable validation accuracy [26].

III. METHODOLOGY OF PROPOSED MODEL

The proposed model for pneumonia detection from X ray images using deep learning consist of two main part: in first part development of a SVM classifier (features extracted from pretrained VGG16 convolutional neural network) for pneumonia detection and in second development of simple convolutional neural network (called self made CNN) for pneumonia detection. The flow chart of the proposed system shown in Figure 1

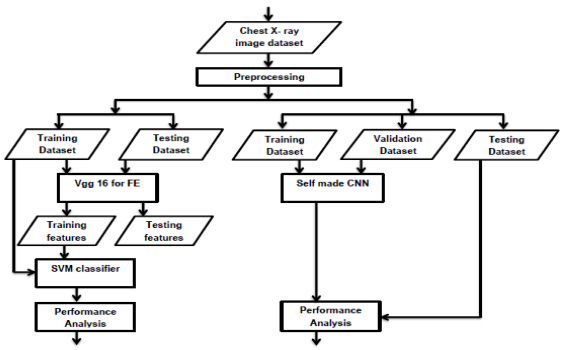

Figure 1: The flow chart of the proposed model

Dataset The dataset used is Chest X-Ray images (Pneumonia) has downloaded from Kaggle [7]. The downloaded dataset consists total 5856 images of two categories: Normal and Pneumonia (having 1583 and 4273 images of respective classes).The downloaded images were of varied sizes.

Preprocessing : The downloaded images were resized into 256×256 pixels to reduce the heavy

computation and for faster processing. In the proposed model, data augmentation operations performed at this step. Here data augmentation was required due to downloaded images not balanced. In this work, horizontal flip and rotation augmentation operation used to increase the number of images. After data augmentation, the dataset distribution for SVM classifier (Features extracted from VGG16) is shown in Table I

TABLE I DATASET PARTITION FOR SVM CLASSIFIER (Features extracted from VGG16)

	Normal	Pneumonia
Training dataset(80%)	3412	3412
Testing dataset (20%)	853	853
TOTAL	4265	4265

After data augmentation, the dataset distribution for simple CNN shown in Table II.

TABLE II DATASET PARTITION FOR SELF MADE CNN

	Normal	Pneumonia
Training dataset(80%)	3412	3412
Testing dataset(10%)	427	427
Validation dataset(10%)	426	426
TOTAL	4265	4265

SVM Classifier (features extracted from pretrained VGG16) for pneumonia detection Here pretrained VGG16 convolutional neural network used to extract features and on basis of that SVM classifier developed. VGG16 consist of 13 convolutional layers and 3 full connected layers. The first layer (image input layer) requires input images of size 224x224x3.

Description of features extracted from pretrained VGG16 CNN:

Trainfeatures = 6824x4096

Testfeatures = 1706x4096

Where Trainfeatures and Testfeatures denote training features and testing features. The Trainfeatures were used to train SVM classifiers and Testfeatures were used for performance analysis.

Self made convolutional neural network for pneumonia detection In this part, prepare a Simple Convolutional neural network classifier for pneumonia detection. Self made CNN consist of 3 convolutional layers and 1 full connected layer. The first layer (image input layer) requires images of size 256x256x1.

IV. RESULTS

The dataset for SVM classifier (Features extracted from VGG16) divided into two parts: 80% of the images were in the training set and 20% in the testing set.The dataset for simple CNN was divided into three parts. 80% of the images were in the training set, 10% in the testing set and 10% in the validation set.

Precision, recall and F1 score of Normal on testing dataset shown in table III for SVM classifier and in table IV for simple convolutional neural network for pneumonia detection

Table III Precision , Recall and F1 score of using SVM classifier

S. No	Class	Precision	Recall	F1 Score
1	Normal	96.7%	97.1%	96.89%
2	Pneumonia	97.1%	96.7%	96.89%

Accuracy of SVM classifier =96.89%

Table IV Precision , Recall and F1 score of using Simple CNN for pneumonia detection

S. No	Class	Precision	Recall	F1 Score
1	Normal	96.5%	97.4%	96.94%
2	Pneumonia	97.4%	96.5%	96.94%

Accuracy of Simple CNN for pneumonia detection =96.96%

V. CONCLUSIONS

On the basis of simulation, there are following conclusions that can be stated. SVM classifier (features extracted using pretrained CNN VGG16) for pneumonia detection from X-ray images display accuracy of 96.89% on testing dataset. SVM classifier (features extracted using pretrained CNN VGG16) for pneumonia detection from X-ray images display precision of more than 96% for each class on testing dataset. SVM classifier (features extracted using pretrained CNN VGG16) for pneumonia detection from X ray images display recall of more than 96% for each class on testing dataset. Simple convolutional neural network (called self made CNN) for pneumonia detection from X ray images display accuracy of 96.96% on testing dataset.Simple convolutional neural network (called self made CNN) for pneumonia detection from X ray images display precision of more than 96% for the each class on testing dataset. Simple convolutional neural network (called self made CNN) for pneumonia detection from X ray images display recall of more than 96% for the each class on testing dataset.

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