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CNN Based Pneumonia Detection System Using Chest X-Ray Images

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ABSTRACT: Pneumonia is a life-threatening infectious disease affecting one or both lungs in humans commonly caused by bacteria called Streptococcus pneumonia. One in three deaths in India is caused due to Pneumonia as reported by the World Health Organization (WHO). Chest X-Rays which are used to diagnose Pneumonia need expert radiotherapists for evaluation. Thus, developing an automatic system for detecting Pneumonia would be beneficial for treating the disease without any delay particularly in remote areas. Due to the success of deep learning algorithms in analyzing medical images, Convolution Neural Networks (CNNs) have gained much attention for disease classification. In addition, features learned by pre-trained CNN models on large-scale datasets are much useful in image classification tasks. In this work, we appraise the functionality of pre-trained CNN models utilized as feature-extractors followed by different classifiers for the classification of abnormal and normal chest X-Rays. We analytically determine the optimal CNN model for the purpose. Statistical results obtained demonstrates that pre-trained CNN models employed along with supervised classifier algorithms can be very beneficial in analyzing chest X-ray images, specifically to detect Pneumonia

KEYWORDS: Pneumonia, Convolution Neural Networks (CNNs), Chest X-Ray.

I. INTRODUCTION

Pneumonia is a common lung infection characterised by collection of pus and other fluids in the lung air sacs (alveoli). Lung air sacs are structures that help in the exchange of oxygen and carbon dioxide. Collection of pus in them makes breathing difficult. Pneumonia can be caused by many kinds of microorganisms (germs) including bacteria, viruses, fungi or parasites. When an infected individual coughs or sneezes, these organisms get into the air and breathing in of this air leads to contraction of the illness. It is thus a contagious disease. It is of various types occurring in individuals of all ages, affecting millions of people worldwide. The condition varies from mild to severe depending on the type of organism involved, age and the underlying health of the individual. Pneumonia can be categorized as: community-acquired, hospital-acquired and Pneumonia occurring in Immunocompromised individuals (individuals with weakened immune system).

Paper is organized as follows. Section II describes literature survey on existing CNN based pneumonia detection system and various techniques. Section III describes proposed methodology and data descriptions. The proposed block diagram represents the holistic view of CNN model used. Detection pneumonia using chest x-ray images and classifying the images in is also carried out in the same section. Section IV presents experimental results of images tested. Finally, Section V presents conclusion.

II. LITERATURE SURVEY

Many authors worked on deep learning-based CNN classifier for classifying Pneumonia. The following section describes the different papers on the same.

H. Sharma, J. S. Jain, P. Bansal and S. Gupta, "Feature Extraction and Classification of Chest X-Ray Images Using CNN to Detect Pneumonia. Sharma et al.[1] proposed two CNN architectures that are designed from scratch to detect Pneumonia from images of chest X-ray.

M. Tsai and Y. Tao, "Machine Learning-Based Common Radiologist-Level Pneumonia Detection on Chest X-rays. M. Tsai et al., [2] Presents different types in Pneumonia from chest x-ray images classification for pneumonia detection using CNN.

D. Varshni, K. Thakral, L. Agarwal, R. Nijhawan and A. Mittal, "Pneumonia Detection Using CNN based Feature Extraction," D. Varshni. [3], Proposed a combination of CNN based feature-extraction and supervised classifier algorithm resulted in optimal solution for classifying abnormal (Pneumonia labeled) and normal Chest X-Ray images primarily due to the substantive features provided by DenseNets followed by optimal hyper-parameter values of SVM classifier.

M. Aledhari, S. Joji, M. Hefeida and F. Saeed, "Optimized CNN-based Diagnosis System to Detect the Pneumonia from Chest Radiographs," M. Aledhari et al. [4], proposed new model that can help to improve the accuracy of Pneumonia. In this model user will input the x-ray image and model will output the correct classification label for Pneumonia with an average accuracy of (68%) and an average specificity of (69%) in contrast to the current state-of-the-art accuracy that is (51%).

S. Mahajan, U. Shah, R. Tambe, M. Agrawal and B. Garware, "Towards Evaluating Performance of Domain Specific Transfer Learning for Pneumonia Detection from X-Ray ImagesS. Mahajan et al. [5], Demonstrated CNN model chest x-ray images classification in ImageNet with 88.78% accuracy.

III. METHODOLOGY

Pneumonia is an infection that inflames the air sacs in one or both lungs. The air sacs may fill with fluid or pus (purulent material), causing cough with phlegm or pus, fever, chills, and difficulty breathing. A variety of organisms, including bacteria, viruses and fungi, can cause Pneumonia. This disease is severe in toddlers and elderly patients who have a weak immune system. Pneumonia kills 920.000 toddlers worldwide in 2015 [6]. Pneumonia can be detected using radiography such as conventional radiography, CT, or MRI. The doctor will examine the radiograph of patient's chest to detect Pneumonia. In addition, the golden standard for examining Pneumonia is accompanied by the examination of patient's medical record and phlegm. Soft tissue will produce dark colour on radiograph since X-rays can penetrate it. Weakening X-ray intensities on hard tissues such as bones will produce bright colour. Figure 1 shows that the chest cavity is clearly visible (dark color) since most of the lung cavities contain air. Patients with Pneumonia, there are fluids which fill the air sacs, causing chest cavity on radiograph image looks brighter. The brighter colour on the lung cavity may be caused by several abnormalities [6] such as cancer cells, swelling of blood vessels, heart abnormalities, and pneumonectomy.



Fig. 1. a(left) chest X-ray of normal and b(right) patient with Pneumonia

In this proposed work, we put forth an automatic system that classifies Chest X-ray images into Pneumonia affected or Normal using Deep learning algorithms. Fig. 2 shows an overview of a proposed design.

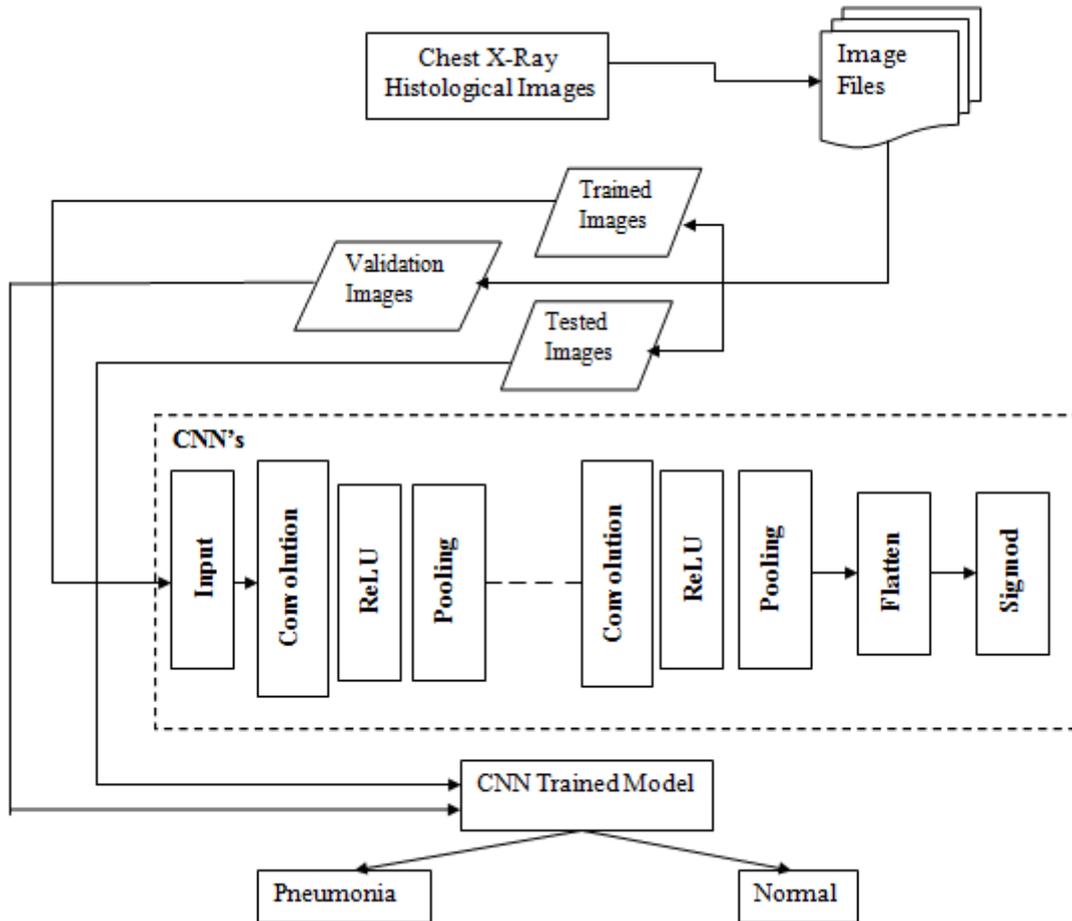


Fig. 2 Overview of the proposed system.

The proposed system has different sub modules involved in it, Chest X-ray images were downloaded from Kaggle data repository. We are taking Kaggle chest x-ray images as input to our proposed system. We have three categories of images training, testing and validation images. Training images are inputted into the proposed CNN model and testing and validation images are inputted into the CNN trained model. Our proposed CNN has multiple layers, first being convolution layer, ReLU and Pooling layer. Flatten layer collapses data into a 1-dimensional array for inputting it into the next layer [1,2]. Our proposed model has sigmoid function in the last layer, which classifies images into Pneumonia or Normal images. Testing and Validation data are verified in CNN trained model based on which classification takes place.

IV. EXPERIMENTAL RESULTS

Figures shows the results of CNN based pneumonia detection; Chest x-ray images are classified as two different classes which are predicted and actual class. Fig.3 shows non infected/actual x-ray images where as Fig 4 show infected/predicted images.

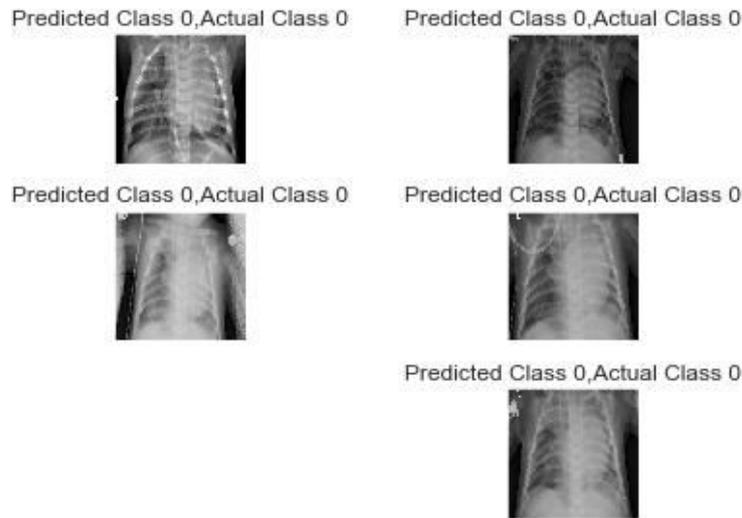


Fig. 3 Non-infected Images

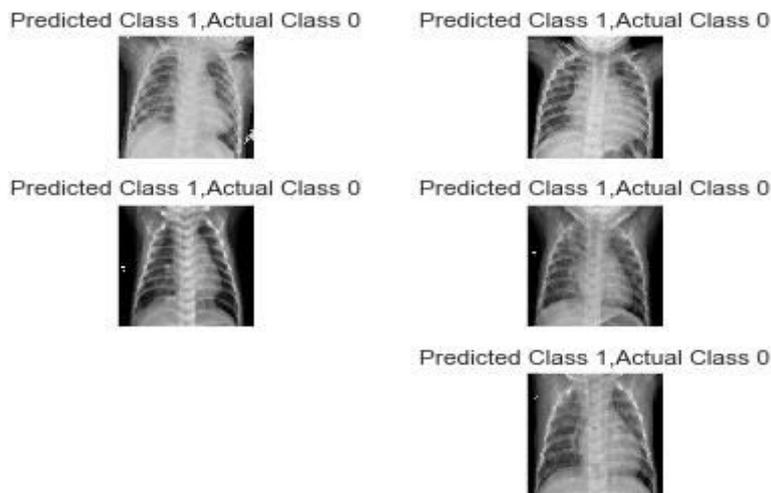


Fig. 4 Infected Images

V. CONCLUSION

In this work, we propose CNN architectures that are designed from scratch to detect Pneumonia from images of chest X-ray. We are using Convolutional Neural networks to solve classification problem. Kaggl dataset is used as input to a proposed system. The proposed work can also be used for Covid-19 pneumonia detection techniques, which predicts symptoms based on patients x-ray. Proposed work promises to get accurate and optimistic results in classifying Pneumonia or normal images.

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