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Pneumonia Detection from Chest X-ray Images using Deep Learning

Anil Kulkarni, Shah Farhan Quadri, Nitin Jadhav, Sameer Khan, Shah Md Tameem k

Dept of CSE, GNDEC, Bidar/585401, India

A B S T R A C T

Pneumonia is a life-threatening infectious disease affecting one or both lungs in humans commonly caused by bacteria called Streptococcus pneumoniae. One in three deaths in India is caused due to pneumonia as reported by 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, Convolutional 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 model RESNET 50 utilized as feature-extractors followed by the classification of abnormal and normal chest X-Rays. Statistical results obtained demonstrates that pretrained RESNET50 model employed along with supervised classifier algorithms can be very beneficial in analyzing chest X-ray images, specifically to detect Pneumonia.

Keywords:RESNET50, Chest X-rays

1. INTRODUCTION

Pneumonia is an acute respiratory infection that affects the lungs. It is a fatal illness in which the air sacs get filled with pus and other liquid. Due to pneumonia, every year, 3.7 lakh children die in India, which constitutes a total of fifty percent of the pneumonia deaths that occur in India. The disease frequently goes overlooked and untreated until it has reached a fatal point, especially in the case of old patients. It is the single largest cause of death in children (especially under the age of five) worldwide. According to the WHO, "Every year, it kills an estimated 1.4 million children under the age of five years, accounting for 18% of all deaths of children under five years old worldwide.

One of the following tests can be done for pneumonia diagnosis: chest X-rays, CT of the lungs, ultrasound of the chest, needle biopsy of the lung, and MRI of the chest. Currently, chest X-rays are one of the best methods for the detection of pneumonia. X-ray imaging is preferred over CT imaging because CT imaging typically takes considerably more time than X-ray imaging, and sufficient highquality CT scanners may not be available in many underdeveloped regions. In contrast, X-rays are the most common and widely available diagnostic imaging technique, playing a crucial role in clinical care and epidemiological studies.

Over the recent years, Computer Aided Designs (CAD) have become the major research domain in machine learning. The subsisting CAD systems have already been proved to facilitate the medical area primarily in detection of breast cancer, mammograms, lung nodules etc. In the procedure of employing Machine Learning (ML) techniques to medical images, significant features are of uppermost importance. For this reason, most of the previous algorithms used hand crafted features for developing CAD systems based on examining images. However, the hand-crafted features with limitations varying according to tasks were not capable of supplying much meaningful features. Employment of Deep Learning (DL) models particularly Convolutional Neural Networks (CNNs) revealed their self-potential of extracting useful features in image classification tasks. This process of feature-extraction demands transfer learning methods where pretrained CNN models learn the generic features on largescale datasets like ImageNet which are later transferred to the required task. In addition, the classification used with high-rich extracted features exhibit improved performance in classifying images.

* *Corresponding author.*
E-mail address: farhanquadri017@gmail.com

2. LITERATURE SURVEY

With the recent outbreak of COVID-19 also known as the coronavirus, it does seem like history is repeating itself and we are going back in time to the 1900s during the Spanish influenza.

The coronavirus is a deadly virus that has claimed hundreds of thousands of lives in countries around the world. Older adults and people who have severe underlying medical conditions or prior cases of pneumonia seem to be at higher risk for developing more serious complications from the virus.

With rising deaths and limited medical resources, doctors and medical professionals around the world are working around the clock to treat patients and prevent the spread of the virus. Severe forms of the virus can cause pneumonia leading to greater risk of death. It is crucial to have quick and accurate detection of pneumonia so patients can receive treatment in a timely manner especially in impoverished regions. The predominant way hospitals diagnose pneumonia today is through getting a radiologist to create radiology reports for all the key pneumonia findings. The latest AI system that can report key pneumonia findings is called chexpert. This is an AI system that uses Convolution Neural Networks (CNN) as a deep learning algorithm that can be used in a variety of image analysis and hence is befitting for the analysis of chest x-ray images. The reason for creating such a system that already has substitutes in the market that have had success is because this system may provide fresh insight. This insight might be useful when building more systems in the future. It is important to approach solutions to problems from all directions. Deep learning-based methods are already being used in various fields. Different authors have already proposed several biomedical image detection techniques.M.I.Razaak discussed the challenges and the future of medical image processing. Much work has already been done for the detection of numerous diseases by using deep learning-based techniques, as stated by Dinggang Shen. Andre presented a deep learning model for dermatologist-level classification of skin cancer, and F.Milletari also proposed a methodology for the depiction of prostate in MRI volumes using CNN. Grewal used the technique of deep learning for brain hemorrhage detection in CT scans, and Varun proposed a method for detecting diabetic retinopathy in retinal fundus photographs.

3. METHODOLOGY

3.1 Information Gathering

The first step in designing a successful web site is to gather information. Many things need to be taken into consideration when the look and feel of your site is created. Certain things we considered are:

- **Purpose**
  What is the purpose of the project?
  Our purpose here is to provide a website that can quickly give you the result for the patient.
- **Goals**
  What do you hope to accomplish by building this web site?
  Our main goal here is to share accurate pneumoniae detection.
- **Content**
  Is there a specific group of people that will help you reach your goals?
  The goal of this project is to help as much people as possible and to improve the accuracy of the web application.
- **Target Audience**
  What kind of information will the target audience be looking for on your site?
  Our target audience will be looking for a result of whether the patient is suffering from Pneumoniae or not.

3.2 Designing Phase

Following steps were implemented to gain completion of design phase:

Requirement analysis - The process of obtaining all pertinent information regarding the project complete control over how the website looks and the features it must include.

Rough design/Prototypes - Prototypes was designed in form of sketches, to understand the requirements and design difficulties.

Prototype analysis - Analysis of prototype (rough design) was done understand and improve the design for better UI (User - Interface).

Initial design - An initial design or final prototype was developed for further development of project and to fulfill the project requirement. Final Prototype further will have some minor changes as the development proceeds.

3.3 Coding and Testing

Coding:

In Coding phase of the web development process, the actual functional site was built. After the proper testing of the prototype, the developer must work on developing the actual live web project. The actual live web project is built according to the requirements. We developer must consider all the situations from the design phase to create all the features in the web project. This phase involves both front end development and back-end development of the website. Pneumonia detection from chest x-ray images using deep learning. Front end development comprises of the writing codes with the basic technologies like HTML, CSS, etc. according to the web standards. We generally started by developing the home page first and then other

pages. Back-end development is also completed in this phase by installing and configuring the content management systems, databases, and frameworks. After completing all the steps that were finalized in the strategy and design phase by which the original website was functional, it was tested in the next phase.

Testing:

Testing is an important phase in the web development process. Testing is performed by the developers and testers to ensure the requirements after completion of the web project. In this phase, quality assurance and browser compatibility issues of the website are checked. We tested all the developed features and assure the validity of the written code. Various types of testing such as integration testing, regression testing, functional testing, smoke testing, load testing, and performance testing are performed in this phase by both testing and development teams. Testing was performed manually on the basis of the type of testing and web projects. If desired and satisfactory results are not found, the proper actions for removing the bugs were taken.

4. DATASET

The original dataset consists of three main folders (i.e., training, testing, and validation folders) and two subfolders containing pneumonia (P) and normal (N) chest X-ray images, respectively. Total number of 5,863 X-ray images of anterior-posterior chests were carefully chosen from retrospective pediatric patients. Below fig- 2 and 3 shows the sample x-ray images of pneumonia and images without pneumonia.

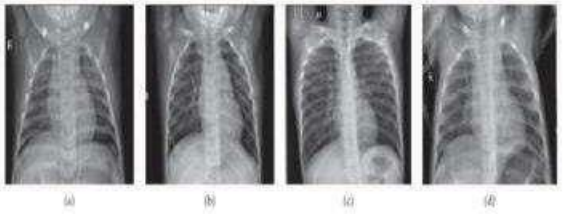


Fig 3.1: Sample images without pneumonia

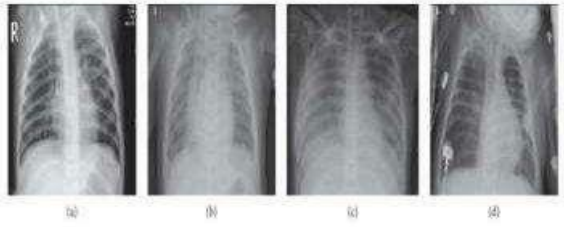


Fig 3.2: Sample images with pneumonia

5. IMAGE PROCESSING

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them.

Following steps are performed for implementing image processing module:

1. Take the dataset of 5,863 images.
2. Repeat the steps from for all the images in a particular folder.
3. Load the image in python. Perform image processing on it to get only the required part of the image.
4. This can include getting rid of the background, finding the outline, etc.
5. Perform Feature Extraction on the image. Migrate the extracted features to an external storage location. These extracted features will be used for the further steps in the algorithm.

6. SYSTEM DESIGN

DATAFLOW DIAGRAM

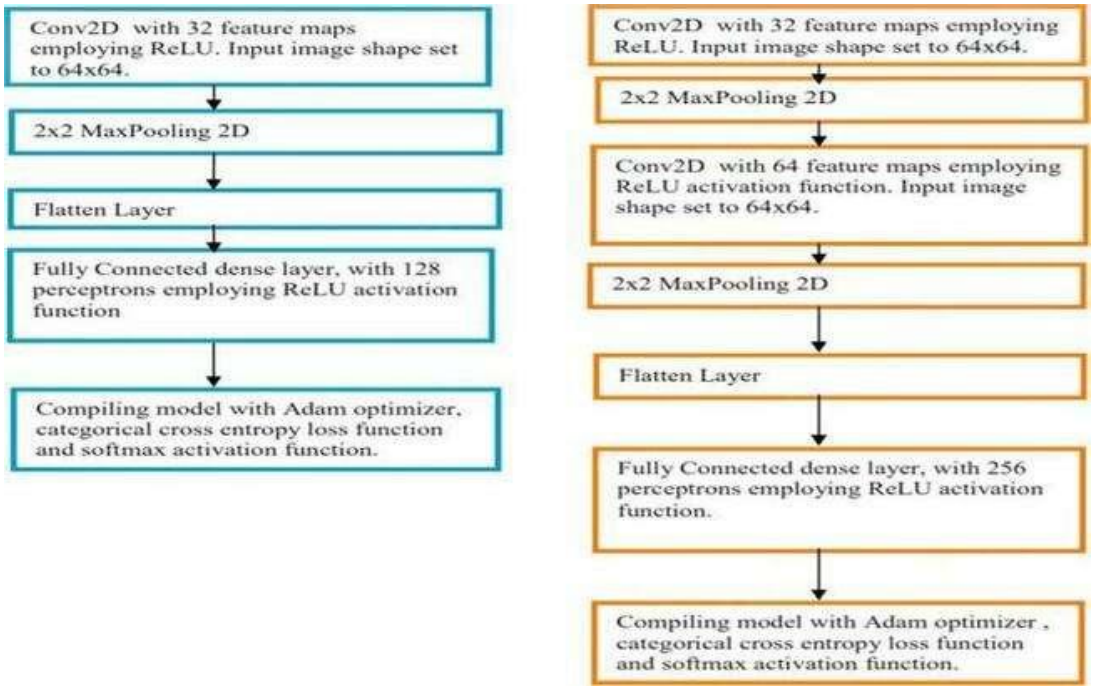


Fig 6.1. Algorithms of CNN classifier model 1 (left) and model 2 (right)

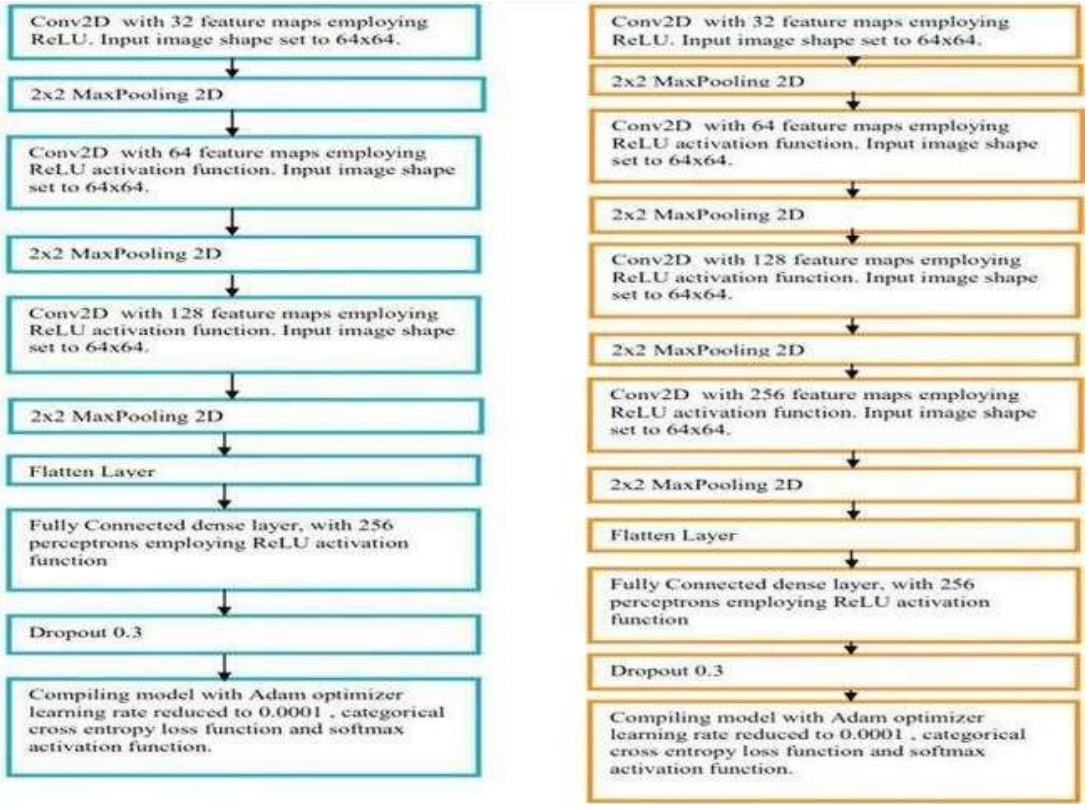
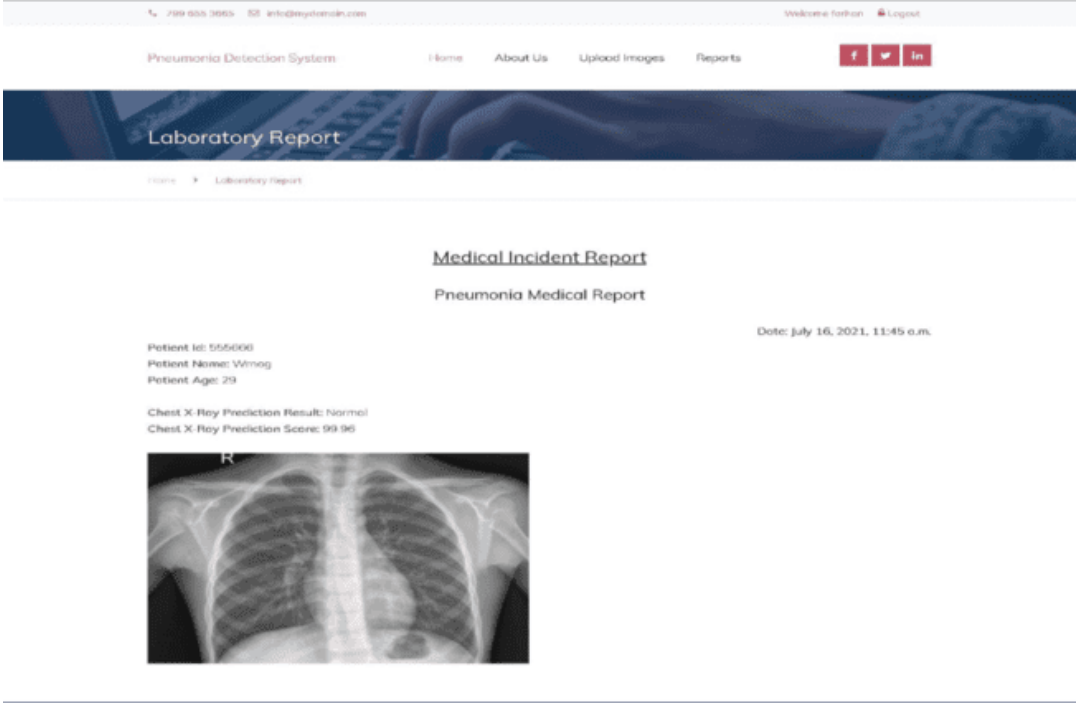


Fig 6.2. Algorithms of CNN classifier model 3 (left) and model 4 (right)

7. EXPECTED OUTCOME

1.Pneumoniae Patient

2.Normal Patient



8. CONCLUSION

Presence of expert radiologists is the topmost necessity to properly diagnose pneumoniae disease. This project aims to improve the medical adeptness in areas where the availability of radiotherapists is still limited. Our project helps to facilitate the early diagnosis of Pneumonia to prevent adverse consequences (including death) in such remote areas. By using ResNet50 a pre-trained Deep learning model(winner of ImageNet challenge in 2015) And with user-friendly interface to upload patient information with user friendly reports. The trained model helps the user to detect the pneumoniae with very high (98%) accuracy and in very short time.

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