Pneumonia Detection System using AI

[1]Neha Kudu, [2]Manasi Sherkhane, [3]Omkar Wadekar, [4]Ritesh Rahatal

[1,2,3,4]Department of Information Technology, Vidyalankar Institute of Technology, Mumbai, India

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Abstract— Pneumonia is known as one of the most life-threatening diseases in the world which affects the lung(s) of humans and is known as one of the leading causes of death in India. Roughly 33% of the deaths in India are caused as a result of pneumonia and as reported by the World Health Organization (WHO). Currently pneumonia is diagnosed using a Chest X-Ray image which is then evaluated by an expert radiotherapist. This process is quiet exerting and travail and it often leads to a difference in opinion among the experts. Thus developing a solitary system would be beneficial for identification, preventing further transmission and treatment in remote areas. This system proposes a cnn model which has been trained from scratch and that will classify and also detect the presence of pneumonia from a dataset of chest X-ray images. For this system the cnn model would extract features from a given dataset of chest X-ray image and then classify it to work it out if an individual is infected with pneumonia or not.

Keywords—*Pneumonia, Chest X-ray images, Deep learning, convolutional Neural Network.*

I. INTRODUCTION

Pneumonia is a disease that disturbs the alveoli of the lungs and has a mortal account which accounts to about 16% of the world deaths [1], being the world's leading cause for deaths among many children. Pneumonia is responsible for almost 127,000 deaths in India the numbers are rising due to the spread of novel coronavirus. The risk of pneumonia is quite high, especially in developing countries where billions of people live in energy poverty and rely on polluting energy sources. Each year, nearly 4 million people die prematurely as a result of diseases related by indoor air pollution, such as pneumonia, according to the World Health Organization. On a yearly basis, about 150 million individuals, mostly children under the age of five, become sick with pneumonia. Chest X-ray (CXR) is the most suitable imaging modality to diagnose pneumonia among others. Pneumonia manifests as an area or areas of increased opacity on CXR. In the automated analysis and clinical diagnosis of medical pictures, deep learning has played a critical role. In particular, convolutional neural networks (CNN)-based approaches have been effectively used to categorise illnesses and detect aberrant areas or segment lesions in CXR pictures. A chest x-ray is one of the most common medical methods used to identify the illness.. As a focused beam of electrons known as x-ray photons passes through the human tissues, a picture is created on a metal surface known as photographic film. When a radiologist examines chest X-rays for Pneumonia, he or she will look for white spots in the lungs called infiltrates, which suggest an infection. The restricted colour palette of x-ray pictures consists of just black and white colours, which has limitations for detecting whether an infected region in the lungs exists.

II. LITERATURE SURVEY

The latest improvements in the field of Machine Learning and AI mainly due to large scale usage of Convolutional Neural Networks (CNNs) and the availability of free dataset. That was once considered to be very rare and has assisted various algorithms to perform much better that was not considered to be a commonplace a few years ago. The automated diagnosis of varied diseases has received a high interest. The low performance of several CNN models on diverse abnormalities proves that a single model cannot be used for all the purposes. So for a better exploration of machine learning in the chest screening, Wang et al. (2017) [2] released a larger dataset of frontal chest X-Rays.

Huang et al. [3] adopted deep learning techniques. Performance of different variants of Convolutional Neural Networks for abnormality detection in chest X-Rays was then proposed by Islam et al. using the publicly available OpenI dataset for the better exploration of machine learning in chest screening.

Cicero et al. discussed the training and validation of CNNs with modest-sized medical data to detect pathology in 2017 [4]. Ma et al. presented a survey on deep learning for pulmonary medical imaging in 2019 [5]. Jaiswal et al. from University of Bedfordshire described an approach based on deep learning for identifying pneumonia in chest X-way in 2019 [6].

In recent times, Pranav Rajpurkar, Jeremy Irvin, et al. (2017) [7] explored the dataset for detecting pneumonia at a level far better than radiologists, they referred their model as ChexNet that uses DenseNet-121 layer architecture for detecting all the 14 diseases from a lot of 112,200 images that are available in the dataset. After the CheXNet [7] model, Benjamin Antin et al. (2017) [8] worked on the same dataset and proposed a logistic regression model for detecting pneumonia.

Okeke Stephen, Mangal Sain , Uchenna, and Do-Un Jeong In [9] proposed a cnn model **t**hat's trained from scratch to classify and to detect the presence of pneumonia from a collection of chest X-ray image dataset. Unlike other methods that rely only on transfer learning approaches **to** realize an interesting classification performance, they constructed a convolutional neural network model from scratch that extract features from a given chest X-ray image and classify it to work out if an individual is infected with pneumonia. This model could help mitigate the reliability and interpretability challenges often faced when handling medical imagery.

III. PROPOSED SYSTEM

This method presents a convolutional neural network model that can identify and detect the presence of pneumonia from a set of chest X-ray image samples after being trained from scratch. In our model, we'll use the data from x-ray pictures. We'll build a convolutional neural network model from the ground up to extract characteristics from a chest X-ray picture and then categorize it to see if a person has pneumonia or not. Parts of the lungs afflicted by pneumonia would be recognized using computer vision.

This research proposes an optimal approach for detecting pneumonia using chest X-rays.

IV. METHODOLOGY

In our model, we'll use the data from x-ray pictures. Parts of the lungs afflicted by pneumonia would be recognised using computer vision. This research proposes an optimal approach for detecting pneumonia using chest X-rays. Our approach is based on a chest X-ray picture collection. The proposed pneumonia detection system uses the Custom Sequential Model. The aforementioned model's design has been broken down into three traditional stages: preprocessing, augmentation, and classification.

A. DATASET

Chest Radiograph x-ray (CXR) pictures were collected from the Kaggle website for this research. The dataset is categorized into four major folders: training, testing, and validation, with two subfolders for pneumonia (P) and normal (N) chest X-ray pictures in each of them. There are a total of 5,856 X-ray images of chests, with 4,273 Pneumonia photos and 1,583 Normal images.

B. CONVOLUTIONAL NEURAL NETWORK

Convolutional neural networks (CNNs, or ConvNets) are a type of deep neural network used to analyse visual images. CNN is a form of deep neural network (DNN) that specialises in image processing and achieves better illness diagnosis accuracy than previous techniques. It's frequently utilised in computer vision applications including clustering, object recognition, and picture classification as a result. It's a Deep Learning system that can take an image as an input, assign significance to distinct parts of the picture, and distinguish between them. CNN models include AlexNet, VGG-Net, GoogleNet, and ResNet. The number of convolution layers implemented in each of these models is varied. The more convolution layers in a CNN model, the better the classification accuracy. CNN employs a minimal amount of pre-processing in comparison to other image classification methods. This implies the network will learn the filters that were previously hand-engineered in traditional methods. The ability to develop features without relying on past knowledge or skilled effort is a significant benefit.

C. PREPROCESSING AND AUGMENTATION

In most picture classification applications, the major aim of utilizing a Convolutional Neural Network is to minimize the computational complexity of the model, which is likely to rise if the input is taken as images. To decrease expensive calculation and speed up processing, the original 3-channel pictures will be reduced from 1024 × 1024 to 224 × 224 pixels.

V. ALGORITHM

Loading the dataset.

The dataset is divided into 3 folders: train, test, and val, with subfolders for each visual category (pneumonia and normal).

Data visualization and pre-processing.

The data seems to be imbalanced therefore to increase the number of training examples we shall use data augmentation.

Matplot is used for previewing the images and dividing it into 20X20 squares. We will perform a grayscale normalization for reducing the effect of illumination's differences. Here we would be normalizing the data by dividing it by 255 as it's the maximum pixel of an image.

Data augmentation.

We need to artificially increase our dataset to prevent the overfitting problem. To recreate the variances, the answer is to change the training data using minor modifications. Horizontal flips, grayscales, random cuts, rotations, and other data augmentation techniques are some of the most common. We can simply increase the

number of training instances by using a few of these modification strategies to our training data.

Training the model

The experiments were performed on the NVIDIA GeForce GTX 1660 Super configuration. With Cuda acceleration, processing 32 images per batch, the initial learning rate is set to 0. 000001, and the 12 epochs and the classification uses the binary cross-entropy (CE) loss function.

Analysis after model training

Precision is the ratio between the True Positives and all the Positives. For our problem statement, that would be the measure of patients that we correctly identify having a Pneumonia out of all the patients actually having it. Mathematically:

$$\text{Precision} - \frac{True\ Positive\ (TP)}{True\ Positive\ (TP)+False\ Positive(FP)}$$

Recall is the measure of our model correctly identifying True Positives. Thus, for all the patients who actually have heart disease, recall tells us how many we correctly identified as having a heart disease. Mathematically:

$$\text{Recall} - \frac{True\ Positive\ (TP)}{True\ Positive\ (TP)+False\ Negative(FN)}$$

Accuracy is the ratio of the total number of correct predictions and the total number of predictions

$$\text{Accuracy-}\frac{True\ Positive\ (TP)+True\ Negative(TN)}{True\ Positive + False\ Positive + True\ Negative(TN)+False\ Negative}$$

Role of the F1-Score

F1-score is the Harmonic mean of the Precision and Recall:

$$\text{F1-Score} - 2 * \frac{\boldsymbol{Precision * Recall}}{\boldsymbol{Precision + Recall}}$$

VI. CONCLUSION

To a certain extent, machines can emulate humans. As a result, even the most sophisticated computers and technology cannot always completely replace the function of experts in a certain sector. Although the presence of itinerant medical professionals is required, the presence of experienced radiologists is unavoidable thanks to the advancement of AI technology. Early diagnosis of pneumonia can save a lot of lives and lessen the strain on our healthcare system.

A model has been presented that identifies all positive and negative pneumonia data from a set of X-ray pictures. This technology will assist medical staff in making real-time decisions.

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