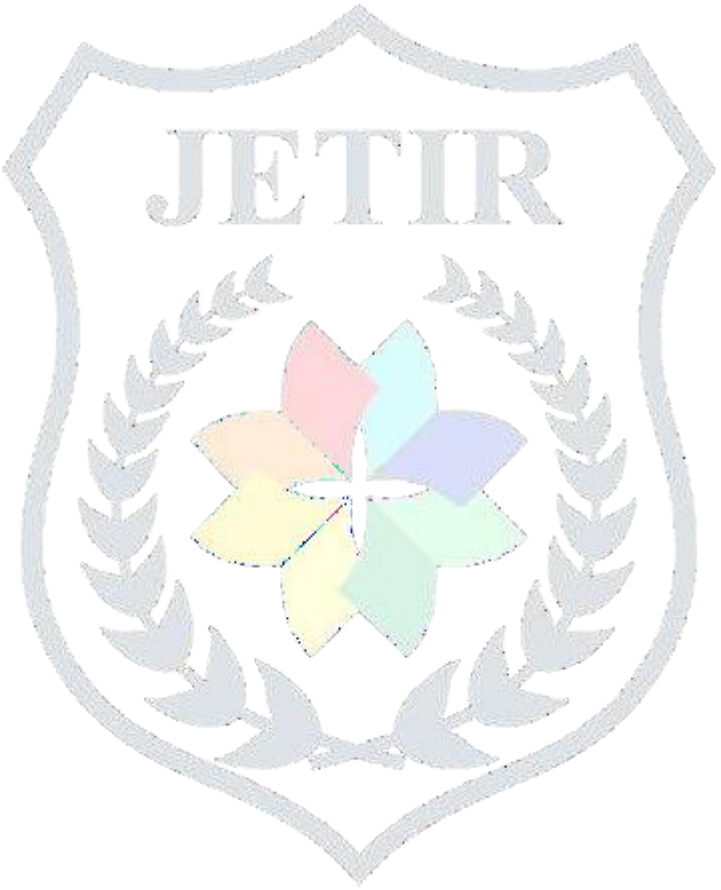
DIAGNOSIS OF PNEUMONIA FROM X-RAYS USING DEEP LEARNING

V. Sathya Preiya, Pavithra D, Pooja K,Priyadharscini S
NAssociateProfessor[+], Students[+]
[+]DepartmentofComputerScienceEngineering,
[+]PanimalarEngineeringCollege,Chennai,T
amilnadu,India



Abstract --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. It is an infection of the lungs with a range of possible causes. It can be a serious and life-threatening disease. It normally starts with a bacterial, viral, or fungal infection. The lungs become inflamed, and the tiny air sacs, or alveoli, inside the lungs fill up with fluid. Over 150 million people get infected with pneumonia on an annual basis especially children under 5 years old. COVID-19 pneumonia is a serious illness that can be deadly. Early detection of Pneumonia and COVID-19 is crucial in reducing mortality. The rich collection of annotated datasets piloted the robustness of deep learning techniques to effectuate the implementation of diverse medical imaging tasks. This proposed system involves detection of Pneumonia and COVID-19 based on deep learning which is proposed for thoracic X-Ray images.

Keywords - Pneumonia, X-rays, Convolutional neural network, deep learning.

I. INTRODUCTION

Pneumonia is a life-threatening infectious disease affecting one or both lungs in humans commonly caused by bacteria called Streptococcus pneumoniae. Some of its symptoms appear suddenly and may include chest pain and difficulty breathing, a high fever, shaking chills, excessive sweating, fatigue, and a cough with phlegm that persists or gets worse. Another infectious illness COVID-19, also known as Severe Acute Respiratory Syndrome Corona virus-2 is a contagious disease that is released from tiny droplets containing saliva or mucus from respiratory system of a diseased person who talks, sneeze, or cough. It spreads rapidly through close contact with somebody who is infected or tapping or holding a virus contaminated objects and also the surfaces.

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.

It is crucial to have quick and accurate detection of pneumonia so patients can receive treatment in a timely manner especially in impoverished regions. With the growing technological advancements, it is possible to use tools based on deep learning frameworks to detect pneumonia and COVID-19 based on chest x-ray images.

The successes of deep learning algorithms in analyzing medical images have lead Convolutional Neural Networks (CNNs) to gain much attention for disease classification. The progression of Deep Learning contributes to aid in the decision-making process of experts to diagnose patients with pneumonia and COVID-19.

The study employs a flexible and efficient approach of deep learning by applying the model of CNN in predicting and detecting a patient's unaffected and affected lungs with the disease, employing a chest X-ray image. The trained-model produced an accuracy rate of 95% during the training. The proposed system can detect and predict pneumonia and COVID-19 diseases based on chest X-ray images.

II. RELATEDWORKS

Timely detection of pneumonia in children can help to fast-track the process of recovery. The convolutional neural network models to accurately detect pneumonic lungs from chest X-rays, which can be utilized in the real world by medical practitioners to treat pneumonia. CNN models have been created from scratch and trained on Chest X-Ray Images dataset on Kaggle. Keras neural network library with Tensor Flow backend has been used to implement the models. Adam optimizer function was finalized to be used for all classifiers. The models presented at best could achieve 92.31% accuracy.

Evolutionary algorithm for searching neural architectures under multiple objectives, such as classification performance and floating point operations (FLOPs). By populating a set of architectures to approximate the entire Pareto frontier through genetic operations that recombine and modify architectural components progressively the proposed method overcomes the problem where obtained architectures are either solely optimized for classification performance, or only for one deployment scenario. Analysis towards validating the generalization and robustness aspects of the obtained

architectures is also provided along with an application to common thorax disease classification on human chest X-rays.

One of the primary clinical observations for screening the novel corona virus is capturing a chest x-ray image. In most patients, a chest x-ray contains abnormalities, such as consolidation, resulting from COVID-19 viral pneumonia. In this paper, numerous chest x-ray images from various sources are collected, and the largest publicly accessible dataset is prepared. Using the transfer learning paradigm, the well-known CheXNet model is utilized to develop COVID-CXNet. At first, a base Convolutional model is designed and trained on different portions of the dataset. Then, pretrained models based on the ImageNet dataset are discussed. Finally, a pretrained model on a similar image type is explained.

The research work mainly proposes a Convolutional neural system (CNN) model prepared without any preparation to group and identifies the occurrence of pneumonia disease from a given assortment of chest X-ray image tests. The Data Augmentation techniques have helped to perform various types of operations in the images. Keras which is an open-source neural network

library in deep learning having tensor flow backend is used. Some of the research challenges include lack of homogeneity in the architectures, frameworks and device is and lack of image datasets and information leads to inaccurate results.

During diagnosis, expert radiologists corresponds white spots on the image to infiltrates identifying an infection, and white areas to the pneumonia fluid in the lungs. However, the limited color scheme of x-ray images consisting of shades of black and white, cause drawbacks when it comes to determining whether there is an infected area in the lungs or not. YOLO and SSD algorithms might be effective for the localization of the pneumonia region, while different pre-processing methods may be needed for training the respective algorithms which is the disadvantage.

II. PROPOSEDSYSTEM

Chest X-rays are one of the best methods for the detection of pneumonia. X-ray imaging is preferred over CT imaging because X-ray imaging typically takes considerably less time than CT imaging. X-rays are the most common and widely available diagnostic imaging technique, playing a crucial role in clinical care and epidemiological studies. The proposed methodology uses a deep transfer learning algorithm using CNN that extracts the features from the X-ray image that describes the presence of disease automatically and reports whether it is a case of pneumonia or COVID-19 or normal.

III. Modules:

1. Exploring the Dataset

The dataset that will be used for this project will be the Chest X-Ray Images from Kaggle. The dataset consists of training data, validation data, and testing data. The training data consists of 144 chest x-ray images with 50 images shown to have pneumonia, 50 images shown to be COVID and 44 images shown to be normal. The testing data consists of 20% of images in training images.

2. Pre-processing

The X-Ray image of a person is fed as the input to the pre-processor. If the images are of low resolution or poor contrast, the pre-processor will

enhance the contrast to get the accurate classification type. It enhances the better visualization of the image.

Steps involved are as follows:

- Read the image
- Resize the image
- Remove noise
- Segmentation.

Read the image -Reading an image

Resize the image -Some images vary in size, so to establish a base size for all image compression or resizing is done

Remove the noise -In order to smooth our image,the unwanted noise has to be removed.

Segmentation - Separating the leisen from the image is segmentation.

DWT:

It is the lossless image compression technique use in preprocessing .High quality images that require large storage are to be compressed. So DWT is required to compress the image without any appreciable loss of information. Digitize the source image into signal. Decompose signal to wavelet (sub bands) LL, LH, HL, HH. DWT retains images from LL to produce next level of decomposition, because the low frequency images have finer frequency and time resolution than high frequency images.DWT produces 4 images and size is reduced to 1/4 of original image.

3. Classification

CNNs are a class of Deep Neural Networks that can recognize and classify particular features from images and are widely used for analysing visual images. Their applications can be seen widely in the medical images analysis. The term "Convolution" in CNN denotes that two images can be represented as matrices which are multiplied to give an output that is used to extract features from the image.

Layers of CNN

1.Input Layer

Modified GLCM image is fed as a input in theform of 3-D array of pixel values.

2.Convolutional Layer

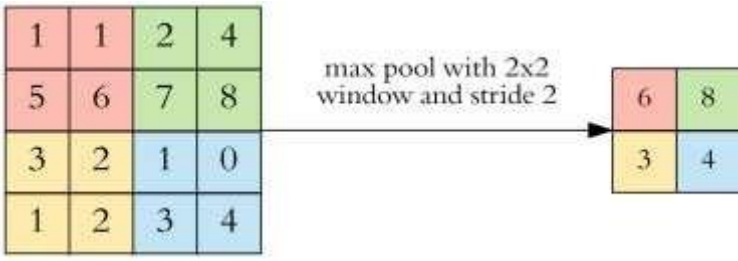
In this layer, the mathematical operation of convolution is performed between the input image and a filter of a particular size MxM. By sliding the filter over the input image, the dot product is taken between the filter and the parts of the input image with respect to the size of the filter (MxM). The dot products so obtained are called **feature maps**. The sum of those dot products is used to produce the output image which is fed as input to next layer.

3.ReLU Layer (rectified linear activation function or ReLU)

ReLU (Rectifier Linear Unit) is one of theactivation function. Its formula is max(x,0) means if the resultant value coming from node is positive then output would be the same positive value and if it is negative value then output would be zero. This layer increases the nonlinear properties of the model and the overall network without affecting the receptive fields of the convolutional layer

4. Pooling Layer

A pooling layer is another building block of a CNN. Its function is to progressively reduce the spatial size of the representation to reduce the amount of parameters and computation in the network.Pooling layer operates on each feature map independently. The most common approach used in pooling is max pooling.



5.Fully-Connected Layer

The Fully Connected (FC) layer consists of the weights and biases along with the class score for each of the classification category. In this, the input image from the previous layers are flattened and fed to the FC layer. In this stage, the classification process begins to take place.

6.Drop out Layer

Usually, when all the features are connected to the FC layer, it can cause overfitting in the training dataset. Overfitting occurs when a particular model works so well on the training data causing a negative impact in the model's performance when used on a new data. To overcome this problem, a dropout layer is utilised wherein a few neurons are dropped from the neural network during training process resulting in reduced size of the model.

Softmax Function

The softmax function is used as the activation function in the output layer of neural network models that predict a multinomial probability distribution. That is, softmax is used as the activation function for multi-class classification problems where class membership is required on more than two class labels. The final output is calculated using softmax which gives the probability of each class for given features.

Adam Optimizer

The Adam optimization algorithm is an extension to stochastic gradient descent that has recently seen broader adoption for deep learning applications. Adam is an optimization algorithm that can be used instead of the classical stochastic gradient descent procedure to update network weights iterative based in training data. The attractive benefits of using Adam are,

- ✓ Straightforward to implement.
- ✓ Computationally efficient.
- ✓ Little memory requirements.
- ✓ Invariant to diagonal rescale of the gradients.
- ✓ Well suited for problems that are large in terms of data and/or parameters.
- ✓ Appropriate for non-stationary objectives.
- ✓ Appropriate for problems with very noisy/or sparse gradients.

4. Training

The sample of data used to fit the model. The actual dataset that used to train the model. The model sees and learns from this data. A number of recommended approaches in the toolkit that could be experimented with,

- ✓ Weight Initialization.
- ✓ Learning Rate.
- ✓ Activation Functions.
- ✓ Network Topology.
- ✓ Batches and Epochs.
- ✓ Regularization.
- ✓ Optimization and Loss.
- ✓ Early Stopping.

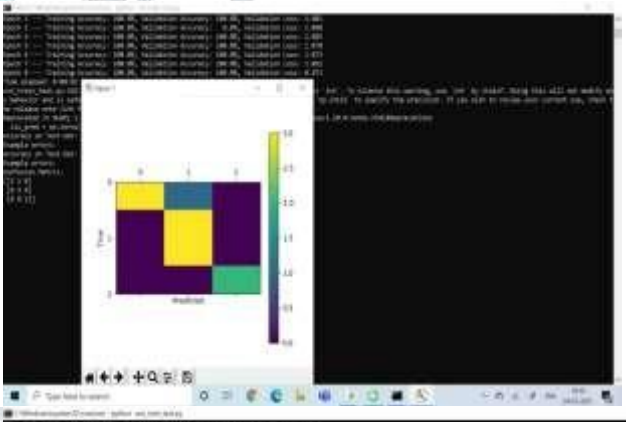
5. Testing

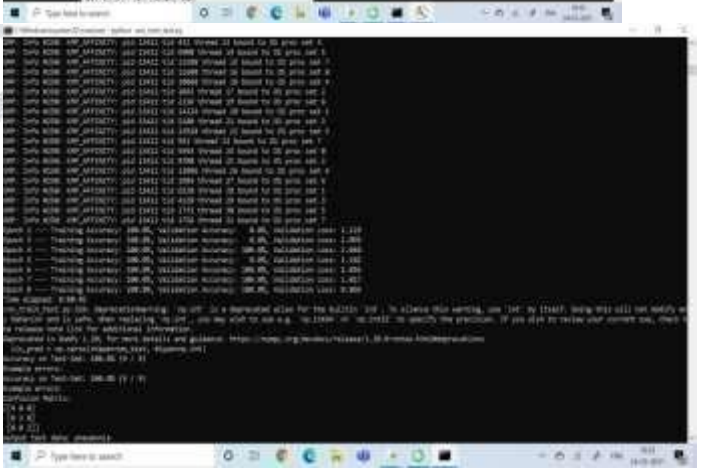
The dataset contains a test folder and in a test.csv file, the details related to the image path and their respective class labels are specified. The image path and labels are extracted using pandas. Then to predict the model, the images are resized to 30×30 pixels and numpy array containing all image data are made. From the sklearn metrics, the confusion matrix is imported and observed how the model predicted the actual labels.

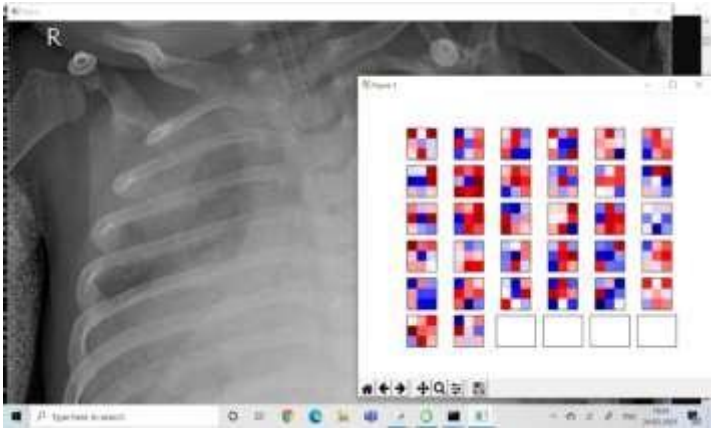
Confusion Matrix

A confusion matrix is a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known. A Confusion matrix is an N x N matrix used for evaluating the performance of a classification model, where N is the number of target classes.The matrix compares the actual target values with those predicted by the machine learning model.

IV. Experimentalresults







V. CONCLUSION

The risk of pneumonia and it's severity in the form of COVID-19 are immense for many, especially in developing nations where billions face energy poverty and rely on polluting forms of energy. The proposed system can detect and predict pneumonia and COVID-19 diseases at an early stage based on chest X-ray images. The study employs a flexible and efficient approach of deep learning by applying the model of CNN in predicting and detecting a patient's unaffected and affected lungs with the disease, employing a chest X-ray image. The models presented could achieve 90% accuracy and 100% of validation accuracy. High validation accuracy will ensure that the number of false-negative instances is lower, hence lowers the risk to the patient's life. Thus, it is concluded that CNN classfier therefore, be effectively used for early detection of pneumonia and COVID-19 in children as well as adults. A large number of X-ray images can be processed very quickly to provide highly precise diagnostic results, thus helping health care systems provide efficient patient care services and reduce mortality rates.

REFERENCES

1. Tatiana Gabruseva, Dmytro Poplavskiy,Alexandr A. Kalinin, "Deep Learning for Automatic Pneumonia Detection" in 2020.
2. Pranav Rajpurkar, Jeremy Irvin, Kaylie Zhu, Brandon Yang, Hershel Mehta ,Tony Duan, Daisy Ding, Aarti Bagul, Robyn L. Ball Curtis, Langlotz Katie Shpanskaya, "Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning" in 2017.
3. Vikash Chouhan , Sanjay Kumar Singh, Aditya Khamparia , Deepak Gupta , Prayag Tiwari , Carina Moreira , Robertas Damasevicius , and Victor Hugo C. de Albuquerque, "A Novel Transfer Learning Based Approach for Pneumonia Detection in Chest X-ray Images" in 2020.
4. Manuel Vázquez Enríquez, Juan Carlos Burguillo Rial,"A Deep Learning approach for pneumonia detection on chest X-Ray", in 2019
5. Deniz Yagmur Urey, Can Jozef Saul, Doruk Taktakoglu", Early Diagnosis of Pneumonia with Deep Learning" in 2019.
6. Mohammad Rahimzadeh, Abolfazl Attar,"A Modified deep convolutional neural network for detecting COVID-19 and pneumonia fromchestX-ray images based on the concatenation and ResNet50V2" in 2020.
7. Okeke Stephen, Mangal Sain, Uchenna Joseph Maduh and Do-Un Jeong," An Efficient Deep Learning Approach to Pneumonia Classification in Healthcare" in 2019.
8. V. Sirish Kaushik, Anand Nayyar, Gaurav Kataria ,Rachna Jain, "Pneumonia Detection Using Convolutional Neural Networks " in 2020.

9. Jaiswal, A.K., Tiwari, P., Kumar, S., Gupta, D., Khanna, A., Rodrigues, J.J.: Identifyingpneumonia in chest x-rays: a deep learning approach.

10. Rajpurkar, P., Irvin, J., Zhu, K., Yang, B., Mehta, H., Duan, T., Ding, D., Bagul, A., Langlotz, Radiologist-Level Pneumonia Detection on Chest X-rays with Deep Learning (2017).

11. Krizhevsky, A., Sutskever, I., Hinton, G.E:. Imagenet classification with deep convolutional neural networks. In: Advances in Neural Information Processing Systems, pp. 1097–1105(2012)