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# CLASSIFICATION OF PNEUMONIA USING CHEST X-RAY IMAGES BY APPLYING AI & ML TECHNIQUES

[1]Chandranayaka I R,[2]Sarikhaa K, [3]Shashi Gowda, [4]Rukmini B Rao

[1]*Assistant Professor, Department of Electronics and Communication Engineering, Global Academy of Technology, Bangalore*
[2,3,4] *Student Department of Electronics and Communication Engineering Global Academy of Technology, Bangalore*

***Abstract*** —The novel coronavirus 2019 (COVID-2019) has become a pandemic disease, which first appeared in Wuhan city of China in December 2019. COVID-2019 has already caused thousands of causalities and infected several millions of people worldwide. It is critical to detect the positive cases as early as possible so as to prevent the further spread of this epidemic and to quickly treat affected patients. An infection caused by COVID-19, can be detected by a chest X-ray exam and should be treated appropriately. COVID-19 has emerged the need for computer-aided diagnosis with automatic, accurate, and fast algorithms. Since the symptoms of pneumonia and COVID-19 were almost similar, it become very important to distinguish the both, in order to provide proper diagnosis. The aim of the proposed project is to apply Machine Learning algorithm for COVID-19/ pneumonia detection over chest X-ray images. The database contains a mixture of COVID-19, viral pneumonia, and normal chest X-ray images. The proposed model uses different architectures of convolutional neural networks (CNNs) trained on ResNet, and adapt them to behave as feature extractors for the X-ray images. Proposed model can be very helpful to the front-line workers. It can also be employed to assist radiologists in validating their initial screening, and can also be employed via cloud to immediately screen patients**.**

***Keywords*- Detection, COVID-19, chest X-ray, convolutional neural network**

## I. INTRODUCTION

Machine learning methods for automatic diagnosis have lately acquired appeal in the medical arena, becoming an additional tool for physicians. Deep learning, a popular artificial intelligence (AI) research topic, allows for the building of end-to-end models that achieve promised results with input data without the need for manual feature extraction. Arrhythmia detection, skin cancer classification, breast cancer detection, brain disease classification, fundus image segmentation, and lung segmentation have all been successfully implemented using deep learning approaches.

The increasing spread of COVID-19 has required the necessity

for specialists in this field. This has sparked a surge of interest in building AI-based automated detection systems. Due to the limited number of radiologists, providing experienced

physicians to each institution is a difficult undertaking. As a result, simple, accurate, and rapid AI models may be useful in overcoming this difficulty and assisting patients in a timely manner.

A real-time reverse transcription-polymerase chain reaction is the most prevalent test technique currently utilised for COVID-19 diagnosis (RT-PCR). Early identification and treatment of this condition rely heavily on chest radiological imaging such as computed tomography (CT) and X-ray. Even if negative findings are obtained, symptoms can be discovered by evaluating radiological imaging of patients due to the poor RT-PCR sensitivity of 60–70%. According to the researchers, CT is a sensitive approach for detecting COVID-19 pneumonia and can be used as a screening tool in conjunction with RT-PRC. CT abnormalities are observed over a long period of time after the onset of symptoms, with most patients having a normal CT within the first 0–2 days. The most common lung CT of individuals who survived COVID-19 pneumonia was found in a study.

There have also been a number of recent research on COVID-19 identification that used CT scans and other deep learning models. However, the suggested model relies on chest X-ray pictures to detect COVID-19 infections because X-rays have been used for

decades and give an astoundingly fast way of examining the lungs, making them a useful tool in the identification of COVID-19 infections. They have the ability to create images that demonstrate lung injury. X-rays are quick and inexpensive, and they can help triage patients in areas where the healthcare system has failed or in areas where more complex technology are unavailable.

The diagnosis of COVID-19 infections entails a chest scan to confirm the patient's lung state, with the patient being diagnosed with COVID-19 infection if the scans reveal pneumonia. By isolating the patient sick with pneumonia, authorities can isolate and treat them as a covid patient. As a result, incorrect diagnoses are made, which can be damaging to the patient's health. A chest computed tomography scan is one of the approaches for detecting pneumonia (CT scan). COVID-19 infections are being detected, quantified, and monitored using automated image analysis based on artificial intelligence, as well as separating healthy lungs from diseased lungs.

The proposed approach aids in disease diagnosis by examining three classes: COVID19, viral pneumonia, and normal circumstances. In this research, we propose an autonomous system that uses transfer learning and convolution neural networks to categorise chest X-ray pictures as COVID-19 patients, pneumonia patients, or healthy patients (CNNs).

## II. RELATED WORK

In this section, various proposed system methodologies have been contemplated.

Debanjan Konar *et al.*[20] proposed a model, in which an attempt was made to fully automatic segmentation of lung CT images using an integrated semi-supervised shallow neural network encompassing the parallel self-supervised neural network model (PQIS-Net), followed by fully connected (FL) layers for patch-based classification with majority voting. The proposed integrated framework is semi-supervised in that the parallel self-supervised neural network model (PQIS-Net) is a fully self-supervised network for segmentation, followed by fully connected layers for COVID-19 disease random patch-based classification. The PQIS-Net model uses quantum formalism to incorporate the frequency components of the weights and inputs, allowing for faster network state convergence due to less computation. This inherent quality of the PQIS-Net model results in precise and time-efficient real-time segmentation, as illustrated by the findings.

Qingsen Yan *et al.*[17 ] proposed a CNN model using SegNet, a three-dimensional deep learning model for lung and COVID-19 segmentation from chest CT images. The proposed network incorporates feature variation and progressive ASPP blocks, which are advantageous in highlighting the boundary and position of COVID-19 infections and are inspired by contrast enhancement approaches and ASPP. These findings show that COVID-19 can be segmented from CT scans using convolutional network-based deep learning technologies. These contributions demonstrate the possibility of enhancing COVID-19 diagnosis and treatment.

Dufan Wu *et al.*[21] proposed a deep learning strategy based on hybrid week labels for infection and consolidation segmentation from CT images in this paper. Single-class contours were used to train the network, which was then fine-tuned using weak patient-level labels. The suggested framework's usefulness is demonstrated by evaluations based on datasets from numerous hospitals around the world. More evaluations and score calculations for various illness kinds will be the focus of future effort.

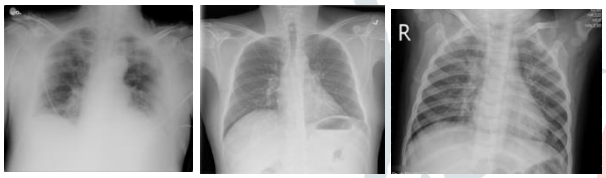
Amjad Rehman*et et al*.[22] provided a recent summary, as well as current developments and COVID-19 detection trends using deep learning approaches with CT and X-ray pictures. This paper also identifies certain data science use cases that could aid in the pandemic by utilising machine learning techniques for data analysis and prediction. The most common concerns are discussed and highlighted, as well as current chest X-ray results that have been uncovered as part of this comprehensive examination. Finally, in order to prevent the spread of COVID-19, it would be helpful for the data scientist to focus more on early illness prediction.

Muhammad E. H. Chowdhury *et al.*[24] proposed a deep CNN-based transfer learning strategy for detecting COVID-19 pneumonia automatically. Eight popular and previously reported efficient CNN-based deep learning algorithms for categorizing normal and pneumonia patients using chest X-ray images were trained, verified, and evaluated. When picture augmentation was utilized to train the CNN models, it was discovered that DenseNet201 outperformed other deep CNN networks. While image augmentation was not employed, CheXNet, a DenseNet variation, outperformed other networks. This is clear because the CheXNet was trained on a big X-ray database before being used in this work, and it performed better on a tiny non-augmented image dataset. Dense201, a more advanced variant of DenseNet, outperforms DenseNet when trained on a large augmented dataset.

Sammy V. Militante *et al.*[23] presented a trained VGG-16 model for COVID-19 identification and pneumonia detection on chest x-ray images using the CNN approach in this research study, and the findings were significant. The constructed CNN model proved successful at extracting features from an x-ray image and predicting the presence or absence of COVID-19, bacterial, and viral pneumonia. In the same way, data augmentation techniques were used to enhance testing data in the study. COVID-19 and pneumonia can be effectively detected using chest radiographs with the help of CNN and deep learning technologies, in addition to the advancement of computer-related applications in the medical division. COVID-19, bacterial, and viral-pneumonia may all be predicted with greater accuracy using the methodologies used during this investigation, and in this case, our study achieved 95 percent accuracy.

## III. METHODOLOGY

A larger dataset usually outperforms a smaller one when using deep convolutional neural networks. When the dataset for deep CNN training is small, transfer learning can be used. The aim of transfer learning is to adjust the SoftMax and classification layer of pre-trained networks using a learned model from a big dataset such as ImageNet. The pre-trained weights are then used to train the network more quickly for an application with a smaller dataset. This eliminates the need for a big dataset and shortens the training period that a deep learning system requires when created from scratch. .Despite the fact that COVID-19 patients are infected in huge numbers over the world, the quantity of publicly available chest X-ray images is minimal and scattered. The authors established a Kaggle database to make the database openly available to researchers all around the world, and the trained models were made public so that others might profit from this study. The posterior-to-anterior (AP)/anterior-to-posterior (PA) picture of a chest X-ray was employed in this study since radiologist use this view of radiography frequently in clinical diagnosis.



covid x-ray normal x-ray pneumonia x-ray

**Figure 1:sample chest x-ray images**

### A. Data Acquisition

The data set is gathered from a source, and a thorough analysis is performed. Only if the image meets our requirements and is not duplicated is it chosen for training/testing purposes .The Data Acquisition process begins with the collection of a dataset from a trusted source. The dataset's features are then examined, and only if they match the requirement is the dataset considered.

### B. Preprocessing

To make processing easier, the image is converted from RGB to greyscale, then an averaging filter is used to filter out the noise, global basic thresholding is used to remove the background and only consider the image, and a high-pass filter is used to sharpen the image by amplifying the finer details.

#### 1) Conversion from RGB to Greyscale

Converting the image from RGB to Greyscale is the first step in pre-processing. It can be obtained by multiplying the RGB image using the formula below.

2989*R+0.5870*G+0.1140*B

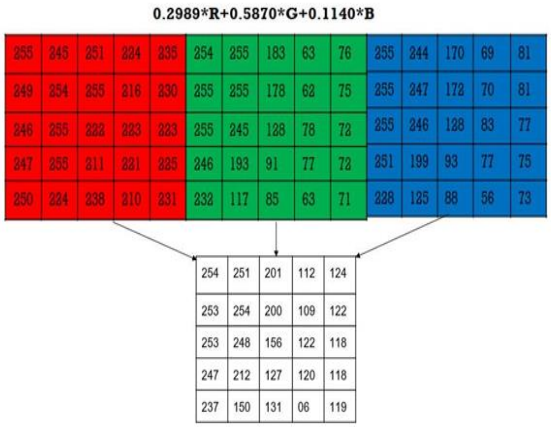



**Figure:2 RGB Format**

#### 2)Noise Removal

The technique of removing or reducing noise from an image is known as a noise removal algorithm. By smoothing the entire image and leaving sections near contrast boundaries, noise reduction algorithms diminish or eliminate the visibility of noise. The second phase in image pre-processing is noise removal. The grayscale image obtained in the previous phase is used as the input here. We're using the Median Filter, which is a Noise Removal Technique, in this case.

#### 3) Median Filtering

The median filter is a non-linear digital filtering technique for removing noise from images and signals.The matrix, which is the representation of the grey scale image, is appended with 0s at the edges and corners. Then, for each 3*3 matrix, arrange the elements in ascending order, locate the median/middle element of those 9 elements, and assign that value to that pixel spot. Noise filtering with the Median Filter is shown in figure 3.

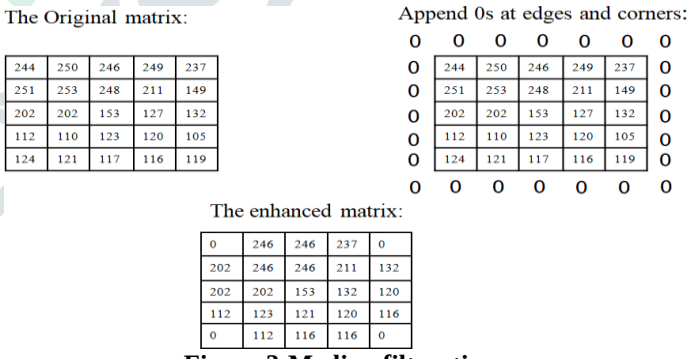



**Figure 3:Median filteration**

#### 4) Basic Global Thresholding

Image thresholding is a sort of picture segmentation in which the pixels of an image are changed to make the image easier to analyse. Keep A(i,j) if it is greater than or equal to the threshold T. Otherwise, substitute 0 for the value.In this case, the value of T can be changed in the frontend to suit the needs of various pictures. We'll utilise the trial-and-error method to find a threshold value that's right for us. Figure 4 shows thresholding using basic global thresholding.

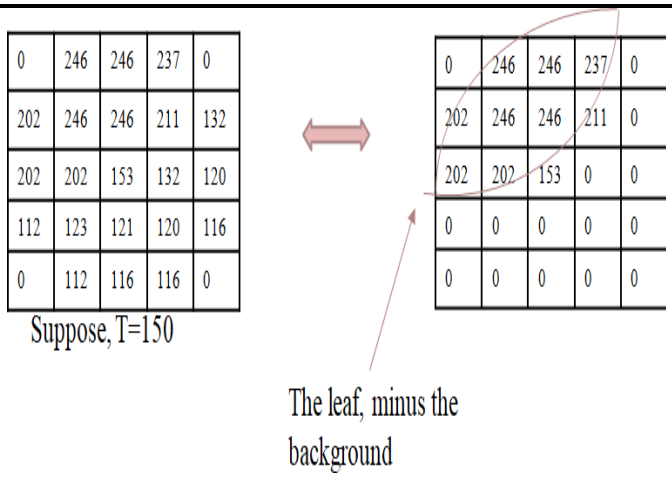



**Figure 4: Basic Global Thresholding**

**2) Image Sharpening**

Image sharpening refers to any enhancement technique that highlights edges and fine details in an image, Increasing yields a more sharpened image.

**3) High Pass Filtering**

To make an image appear sharper, a high-pass filter might be utilized. Fine features in the image are highlighted by these filters. The thresholding output is used as input in this case. We're using a filter here, and we're appending the closest values to pixels near the boundary pixels first.

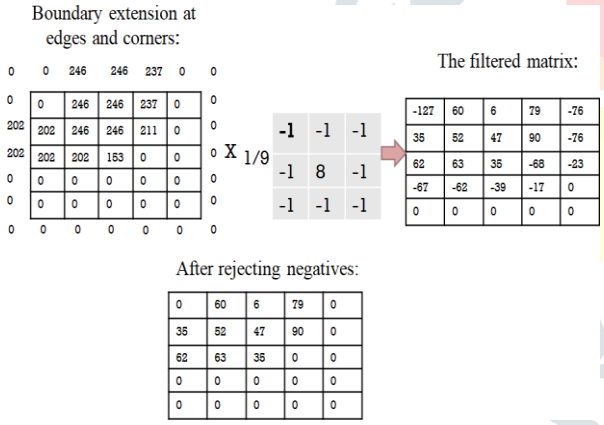



**Figure 5:High Pass Filtering**

**C.Image classification:**

As CNN is a classifier, we use the output of the high-pass filter as input and omit feature extraction. It uses convolution, correction, and bundling as three jobs in the iteration submodule to output the final comparison matrix, which is then classified by a classification algorithm such as Softmax.

Based on its shared weight architecture and the translational invariance of its human brain, convolutional neural network (CNN or ConvNet) is a class of deep neural networks most commonly used to analyse visual images, also known as displacement-invariant or space-invariant artificial neural network - SIANN. Each set of neurons in a CNN is split into 3D structures and examines a tiny region or feature of the picture. To put it another way, each group of neurons is trained to recognise a certain element of the image. The final output of a CNN is a vector of probability values representing the probability that a given feature belongs to a given class. CNNs use the predictions from each layer to produce the final output, which is a vector of probability values representing the probability that a given feature belongs to a given class.

Layers of CNN:

**1) Convolutional layer:**

we use the convolutional layer to extract a tiny portion of the image. Features or filters are the names given to these pictures or patches. In both photos, these basic feature matches are transmitted at nearly the same place. Convolutional layers are more effective at detecting similarities than complete picture matching situations. It uses a filter to scan the whole image, a few pixels at a time, to produce a feature map that predicts the class likelihood for each feature.

**2) Pooling layer (down sampling) or Max-pooling Layer:**

After that, in the convolutional layer, Reduce the quantity of data you have. For each feature, a convolutional layer is created that holds the most significant information (the process of convolutional and pooling layers is usually repeated multiple times). The feature with the highest weight is extracted in the max-pooling layer, which is accomplished by transforming the 3x3 matrix above into a more compressed matrix. The above 3x3 matrix is reduced to a 2x2 matrix with just the highest weights. A 3x3 matrix contains features..

**3) Fully connected layer:**

The preceding layer's outputs are smoothed, resulting in a single vector that may be used as the input to the following layer. To anticipate proper labels, apply weights to the data provided by feature analysis..

**4) Output layer:**

The output layer calculates final probabilities in order to identify the image's class. A softmax layer or sigmoid neurons, depending on the solution goal - binary or multi-class classification - is the last layer that generates network output. In the entire classification process, we apply ReLU and Softmax, both of which have activation functions.

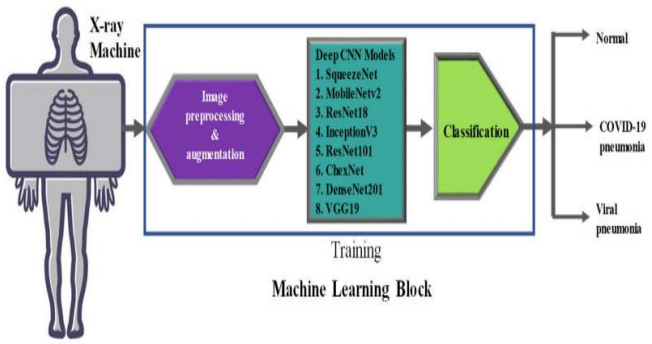



**Figure 5: Architecture**

## IV. IMPLEMENTATION DETAILS

### A. Technologies used:

1) Python IDE: Python is a general-purpose interpreted programming language with a high level of abstraction. Guido van Rossum created Python, which was initially released in 1991. Python's design philosophy prioritises code readability, particularly through the usage of large amounts of whitespace. On both small and big sizes, it provides frameworks that allow for straightforward programming. After 30 years as a leader in the language community, Van Rosen stepped down in July 2018.

**2) OpenCV-Python:**

OpenCV is a real-time image processing function library for programmers. It's modular, which means it may contain numerous shared or static libraries in a single package. Linear and nonlinear image filtering, geometric image transformations, colour space transformations, histograms, and other image processing modules are among the modules we utilise. HOG is one of the libraries included in the system.

**3)Keras:**

Keras is a Python-based high-level neural network API that operates on TensorFlow, CNTK, or Theano. It was created with the goal of allowing for quick experimentation.

**4) Flask Library:**

Flask is a lightweight Python web framework. Because it does not require any extra tools or libraries, it is characterised as a microframework. It doesn't have a database abstraction layer, form validation, or any other third-party library components that offer common functionality. Extensions, on the other hand, may be used to add functionality to your application as if they were written in Flask. Extensions are available for object-relational mappers, form validation, upload handling, several open authentication protocols, and a number of popular framework-related utilities. The core Flask software is updated less frequently than extensions. Flask is frequently used with MongoDB to offer the database and history greater control.

**5)HTML, CSS:**

The Hypertext Markup Language (HTML) is a standard markup language for creating web pages and online applications, and it is one of the two cornerstone technologies of the World Wide Web, together with Cascading Style Sheets (CSS).

### B. Results:

Here, we have created a webpage in which the user can sign-up to login in future, and can upload the patient's chest X-Ray image.

**Login:**

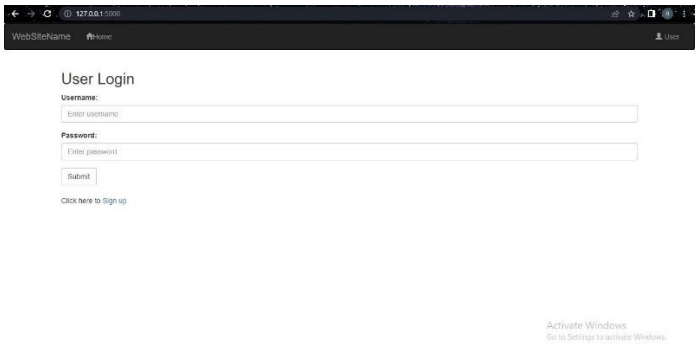



**Figure 6: Login**

Figure 6 depicts the page where the user can login with the required credentials such as email-id and password that they had used during the sign-up.

Once the user can successfully login, the user can upload the patients's chest X-Ray image to predict if the patient has i) Covid-19, ii) Viral pneumonia or is iii) Normal

**Dashboard:**

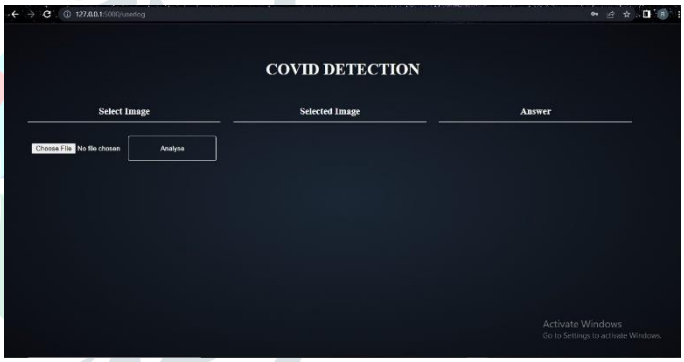



**Figure 7: Dashboard**

Figure 7 depicts the page where user can upload the chest X-Ray image and when analyze button is clicked, the system displays the result.

After uploading the patient's chest X-Ray image, when the user clicks the analyse button, the status is displayed as either Covid-19, Normal pneumonia or Normal.

**Prediction**:

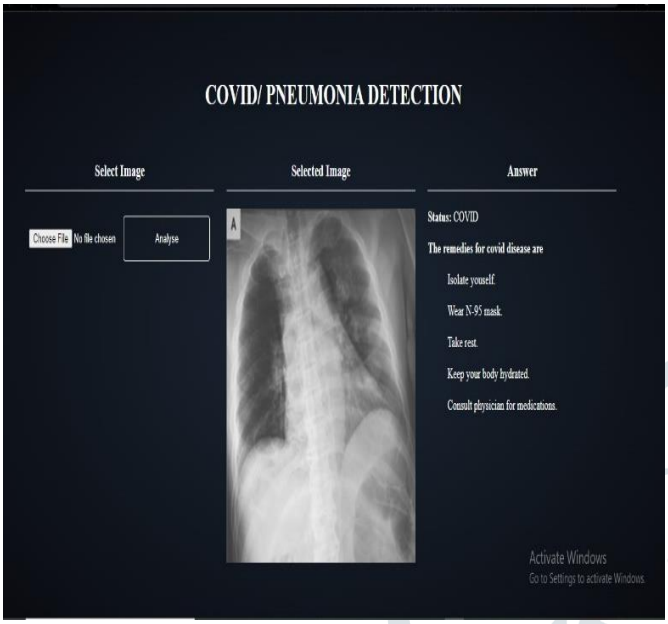



**Figure 8: prediction of covid x-ray image**

Figure 8 depicts the result, it displays the image uploaded by the user and to the right of the image, it displays the disease name and the stage of disease. The result also suggests the remedies to be followed by the patient.

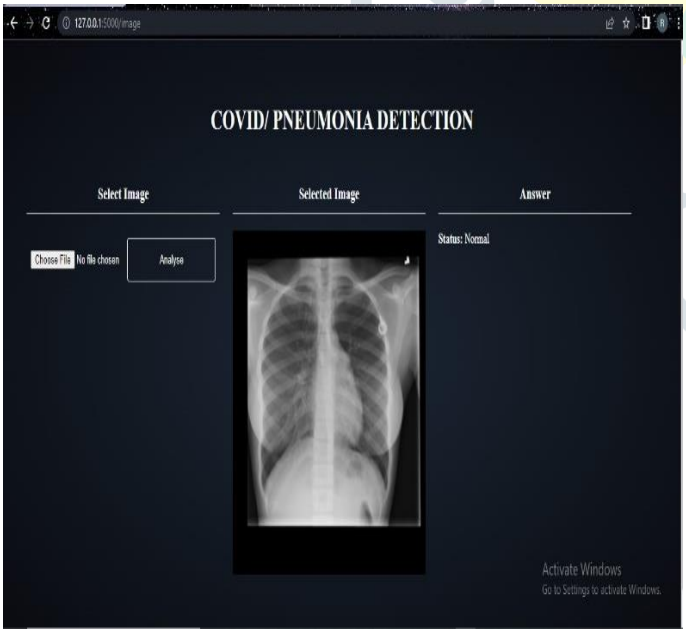



**Figure 9:Prediction of normal x-ray image**

Figure 9 depicts the result,User will be displayed the status has Normal. If the uploaded image is predicted to be as a normal condition.

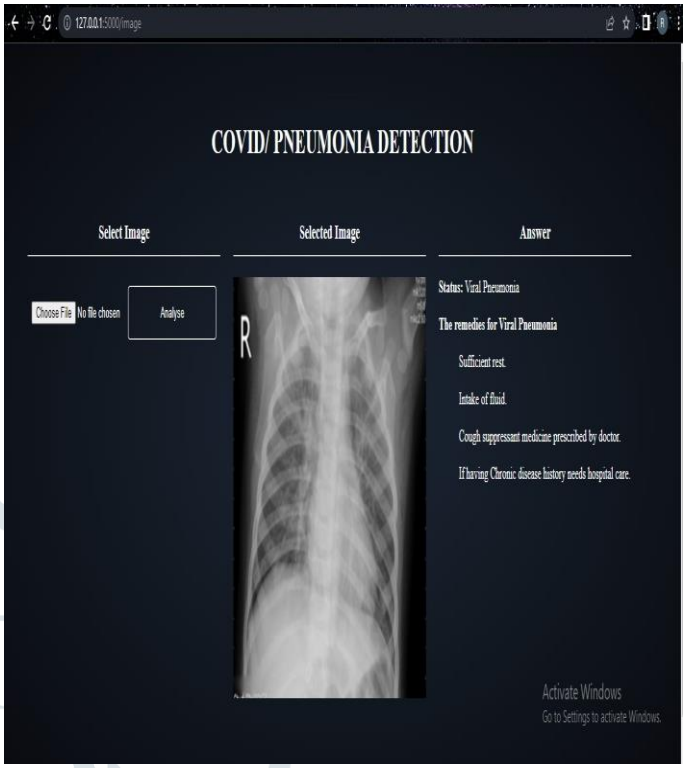



**Figure 10: prediction of pneumonia x-ray image**

Figure 10 depicts the result , User will be displayed the status has Pneumonia. If the uploaded image is predicted to be as a Pneumonia condition

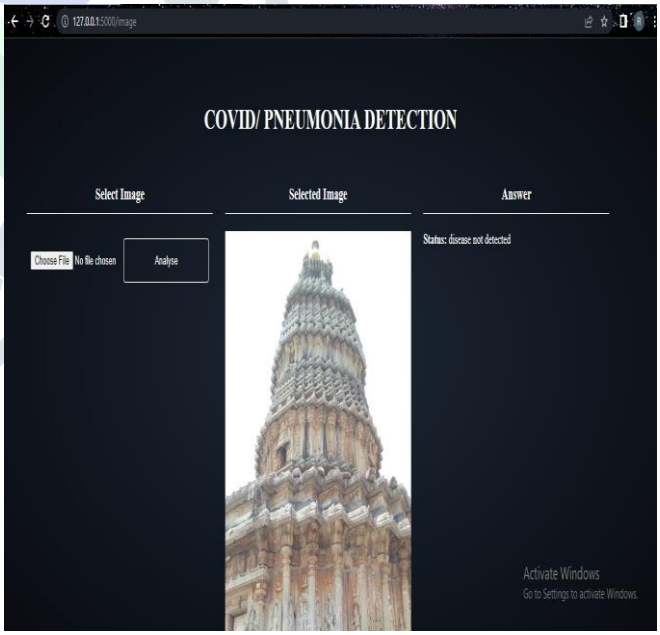



**Figure 11: invalid image**

Figure 11 tells user that's an invalid image.

## V. CONCLUSION

In this study, we have proposed a deep learning based model to detect and classify COVID-19/pneumonia cases from X-ray images. The proposed model is based on the Convolution Neural Network strategy. The main advantages of the model are: the chest X-ray images are classified using a feature extraction technique, it is an effective approach that can assist experts for diagnosis, the model are evaluated by an expert radiologist. The performance of the developed model is assessed by expert radiologists and is ready to be tested with a larger database. This system can be used to overcome a shortage of radiologists in remote places in countries affected by COVID-19. Also, such models can be used to diagnose other chest-related diseases. A limitation of the study is the use of a limited number of COVID-19 X-Ray images. Our system can further be improved by making our model more robust and accurate by using more such images from various local health-care centers.

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