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# Pneumonia Disease Detection Using Efficient Architectures

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**Abstract**
A respiratory infection called pneumonia can be brought on by bacteria or viruses. Numerous people are affected, particularly in emerging and underdeveloped nations where there is a high level of pollution, unhygienic living conditions, congestion, and insufficient medical facilities. make breathing challenging. It results from pneumonia. To ensure effective treatment and boost survival chances, pneumonia must be diagnosed as soon as possible. Chest X-ray imaging is the technique most frequently used to diagnose pneumonia. However, it might be difficult and sensitive to subjective variability to examine chest X-rays. Using chest X-ray pictures, we created a computer-aided diagnosis method this work to automatically detect pneumonia. To deal with the dearth of data available, we used the transfer learning technique. To deal with the lack of data that is available, we used deep transfer learning and created a Convolutional Neural Network (CNN) model using the four transfer learning techniques CovXNet, RNN, and VGG16. Whereas ResNet 50 is employed in the current approaches, which did not achieve the appropriate accuracy but are improving. So, it is suggested to combine the current strategy with additional transfer learning techniques. On a dataset of pneumonia X-rays that was available to the public, the proposed technique was assessed.

**Keywords -** Pneumonia, Chest X-ray images. Deep Learning, CNN, CovXNet, RNN, VGG16.

## Introduction

Pneumonia, which ranges in severity is a popularly known lung inflammation that mainly affects the tiny air pockets known as alveoli. Fever, a combination of dry or productive cough, casket pain, fever, and breathing difficulties are its typical symptoms.

The most frequent origins that beget pneumonia are contagions and bacteria, and a few others. It can be grueling to pinpoint the contagion at fault. The physical test and symptoms are constantly used to make an opinion. Blood tests, foam culture, and casket X-rays can all help to confirm the opinion. The position of the infection may be used to categorize the illness, similar to community-, sanitarium-, or healthcare-associated pneumonia.

Cystic Fibrosis, Chronic Obstructive Pulmonary Disease (COPD), Sickle Cell Disease, Asthma, Diabetes, Heart Failure, a History of Smoking, a Bad Cough Kickback (akin to a Stroke), and a Weak Vulnerable System are among the health risks for pneumonia. Some kinds of pneumonia, especially those caused by the COVID-19 or Streptococcus pneumonia bacterium, can be treated with vaccinations. Other safety measures include quitting smoking, cleaning others.

The initial cause defines the treatment plan. When pneumonia is allowed to be brought on by bacteria, antibiotics are used to treat it. The patient is usually hospitalized if the pneumonia is severe and oxygen treatment may be used if oxygen levels are plummeting.

Each year, pneumonia affects 450 million people worldwide, about 7% of the world's population, and it causes about 4 million fatalities. The development of medicines and vaccinations in the 20th century significantly improved survival rates. However, among the very young, the very old, and the chronically ill, pneumonia continues to be the greatest cause of mortality in developing nations. Because it frequently lessens the suffering of individuals who are already on the verge of passing away, pneumonia is referred to as "the old man's friend." Children under the age of five frequently exhibit signs and symptoms such as fever, coughing, and rapid or labored breathing. In addition to existing in many other common illnesses, fever is a generic symptom that might be absent in elderly, malnourished or extremely ill individuals.

Both bacterial and viral pneumonia may present with identical signs and symptoms. Several causes are linked to recognizable but generic clinical characteristics. Diarrhea, disorientation, and abdominal pain are some signs of Legionella pneumonia. Streptococcus pneumonia is indicated by rust-colored sputum. Some people call bloody sputum from pneumonia caused by Klebsiella "currant jelly." Mycoplasma pneumonia symptoms can include joint pain, middle ear infection, or swollen lymph nodes in the neck. Wheezing is a sign of viral pneumonia more often than bacterial pneumonia. The idea that the symptoms would reveal the underlying cause led to the classification of pneumonia as "typical" or "atypical" in the past. The emphasis on this distinction has been dropped because the evidence does not support it.

Pneumonia is typically caused by bacterial or viral infections, while fungi and parasites can also cause it occasionally. Although there are more than 100 distinct strains of infectious germs, the majority of infections are caused by just a few of these. About 45% of infections in children and 15% of disorders in adults are estimated to be caused by infections involving both viruses and bacteria. In about 50% of cases, a causal ingredient may not be found despite extensive testing. Between January 2010 and June 2012, 2259 patients with radiographic signs of pneumonia and samples that could be examined for the causative bacteria were found at Chicago and Nashville hospitals. This was a component of a population based surveillance program for hospitalization related community acquired pneumonia. Unexpectedly, respiratory viruses, which made up 62% of the total patients, were more frequently discovered in patient samples than bacteria. More specifically, 11% of people were infected with one or more bacteria, 3% were infected with both bacterial and viral pathogens, and 1% were infected with a fungal or mycobacterial illness.23% of people had one or more viruses. Streptococcus pneumonia (in 5% of affected people),human rhinovirus (in 9% of affected people), and influenza virus (in 6% of affected people) were the most prevalent pathogens.

Deep learning is a distinctive form of machine learning that achieves significant capacity and adaptability by teaching people to see the world as a multi-wrap ranking of ideas, where each idea is limited by a more natural idea and more abstract readings are judged in agreement with less abstract ones. Even while convolutional architectures have been abandoned for a very long time and are now obsolete, new architectures and GPUs have elevated bureaucracy to the status of machine intelligence. Several well-known deep knowledge architectures, including CNNs, RNNs, LSTM/GRU, SOM, AE, and RBM, are introduced.

**Literature Survey**

In order to visualize and quantify the structural and functional effects of thoracic disorders, one of the most often utilized imaging modalities is the chest X-ray, which offers high-resolution images of disease development and therapeutic response.

Researchers eventually adopt the most recent developments in DL (deep learning) to interpret chest X-ray pictures to increase efficiency and lessen the stress on radiologists. Wang et al. [1] proposed a weakly-supervised classification and localization framework for computer-

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aided diagnosis of 14 common thoracic diseases, Rajpurkar et al. [2] built a 121-layer dense convolutional neural network that can complete the task better than training radiographers, and Wang et al.

[3]Lal S., Rehman S., Shah J., Meraj T., Rauf H., and Damas˘evičius R: Artificial intelligence (AI) and deep learning (DL) approaches are growing swiftly, thus it's critical to assure the security and dependability of the algorithms being employed. It is well known that DL algorithms are prone to adversarial circumstances in terms of security. The intentionally generated instances will lead to various situations that the DL models incorrectly recognize yet appear harmless to humans. Their capabilities are put into use in actual, hostile physical settings to show how well they work. Due to this, research on adversarial attacks and defense, including machine learning and its dependability, has gained more attention. This system offers a protective model against an adversarial speckle-noise attack, an adversarial training method, and a feature fusion technique that upholds classification with accurate labeling. We explore and analyze the adversarial attacks and defenses on the retinal fundus images for the Diabetic Retinopathy detection problem, which is regarded as a cutting-edge attempt.

| S.No | Author | Model | Approach | Accuracy |
|---|---|---|---|---|
| 1. | Rahman T., Chowdhury M., Khandakar A., Islam K., Islam K., Mahbub Z [4] | Long ShortTerm Memory networks (LSTM), Recurrent Neural Networks (RNN), and Gated Recurrent Units (GRU) | Cutting-edge deep learning techniques | 0.900 |
| 2. | Rauf H., Lali M., Khan M., Kadry S., Alolaiyan H., Razaq A [5] | DenseNet1 21, InceptionR esNetV2, and ResNet152 V2 | Deep Convolutional Neural Networks (CNNs) | 0.800 |
| 3. | Albahli S., Rauf H., Algosaibi A. &Balas V [6] | AlexNet, ResNet18, DenseNet2 01, and Squeeze Net | Four separate pre-trained deep convolutional neural networks(CNNs) were used for transfer learning | 0.900, 0.950, and 0.933, |

Table 1: Previous Works

In our suggested method, we classify if a person has pneumonia or not using CNN (Convolution Neural Network), a deep learning technique, along with CNN's transfer learning techniques (VGG16, CovXNet, and RNN). As pleural effusion, a condition in which fluids fill the lung and create respiratory trouble is brought on by pneumonia. Early detection of pneumonia is essential for ensuring curative care and boosting survival rates. Because of this, appropriate classification is crucial for the proper therapy, which will be possible with the help of our suggested method.

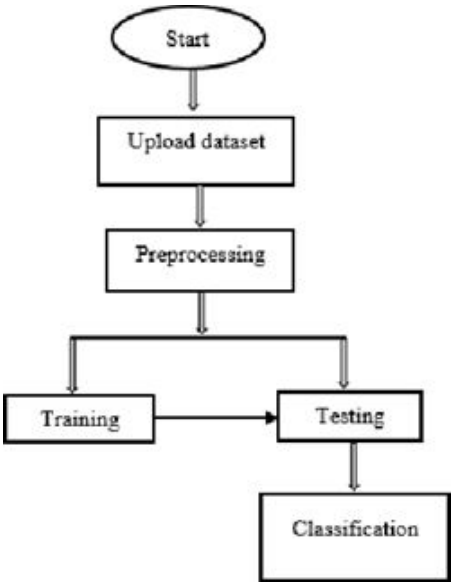


Fig 1. Proposed Method

**Architecture:**

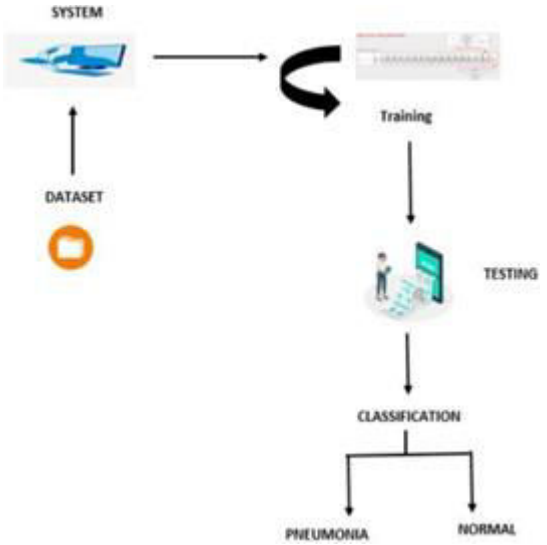


Fig 2. Architecture

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**Convolutional Neural Network:**
We will briefly discuss feature detectors, which are the filters for the neural network. Pretend that the input is a color image made up of a 3D pixel matrix. As a result, the input will have three dimensions (height, width, and depth), similar to RGB in an image. Additionally , we have a feature detector, also referred to as a kernel or filter, which will examine the image's receptive fields and determine whether the feature is there.

**ReLU:**
ReLU stands for rectified linear activation function, it will produce output zero if the input is negative and otherwise it takes the actual value because it is easier to train and frequently performs better it is the function which uses frequently and makes this a standard activation function for several types of neural networks.

The key benefit of using the ReLU activation function instead of other functions is that not all of the neurons are activated simultaneously it activates over time.

**Pooling Layer**
Down sampling an image is all that pooling is. The most popular size 2x2 pooling layer filter eliminates three-fourths of the activations.
The purpose of the pooling layer is to lower the feature map's resolution while preserving the features needed for classification using translational and rotational invariants.

**VGG**
Very Deep Convolutional Networks for Large Scale Image Recognition, a 2014 publication by Simonyan and Zisserman, provided the initial description of the VGG network architecture. This network uses a single 3*3 convolutional layer that is stacked on top of itself in increasing depth.
One can decrease volume size by using max pooling. Then comes a Softmax classifier, which is followed by two fully connected layers with a total of 4,096 nodes each. The weight layers in the network are indicated by the numbers "16" and "19".

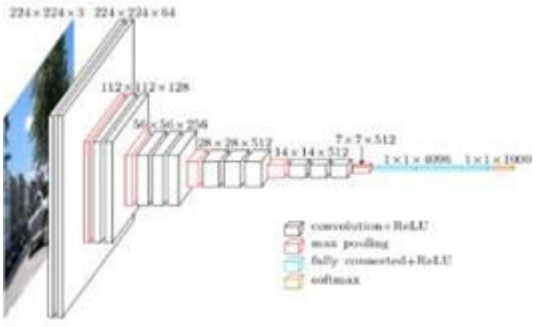


Fig. VGG Architecture

**CovXNet:**
Ilya Sutskever, Geoffrey Hinton, and Alex Krizhevsky developed the convolutional neural network (CNN) known as CovXNet. Geoffrey Hinton was Krizhevsky's Ph.D. advisor. CovXNet took part in the ImageNet Large Scale Visual Recognition Challenge on September 30, 2012.

The network performed better than the runner-up by over 10.8 percentage points with a top-5 error of 15.3%. The primary discovery of the initial study was that the depth of the model, which required expensive calculation but was made possible by the use of graphics processing units (GPUs) during training, was essential for its high performance.

Convolutional layers made up the first five layers of CovXNet, max-pooling layers made up the next few, and completely linked layers made up the last three.
In comparison to tanh and sigmoid, training efficiency was enhanced using the non-saturating ReLU activation function.

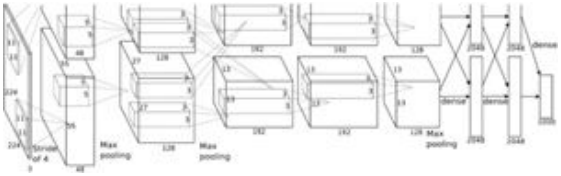


Fig 4. CovXNet Architecture

**MobileNet:**
The convolutions used by MobileNet are depth-wise independent. Especially in comparison to a network with conventional convolutions of the same depth in the networks, the number of parameters is greatly reduced. The end

product is a class of lightweight deep neural networks.

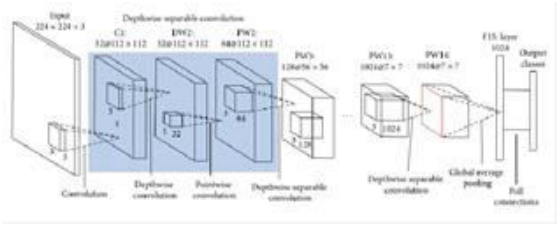
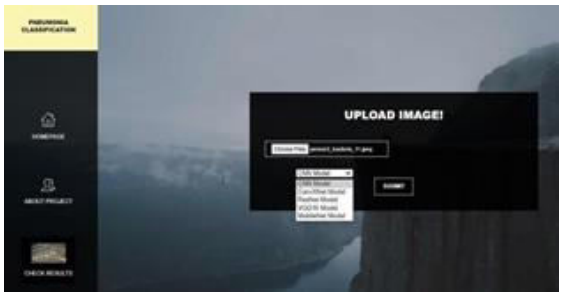


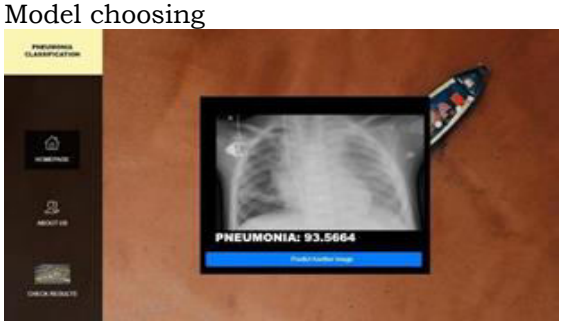
Fig 5. MobileNet Architecture

**Experimental Results**
**Output Screenshots**


Image Uploading




Model choosing




Classified Output

**Conclusion**

Using deep learning, we were able to identify if a person's chest X-ray scans were normal or altered by pneumonia in this experiment. Here, we considered a CNN-trained dataset of chest X-rays and different transfer learning techniques and classified them into two different categories (affected by pneumonia and normal). After training, we tested the system by submitting images for classification. This can be used in the future to easily classify different infectious disease types. These infections tend to be easier to recognize in the early stages and curable only in the early stages.

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