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Detection of covid-19 and pneumonia using deep learning

Dhivya A[1], Dharani G[2], Bharathi S[3]*
[1]UG Scholar, Department of Computer science and Engineering, Kongu Engineering College, Erode, India
[2]UG Scholar, Department of Computer science and Engineering, Kongu Engineering College, Erode, India
[3]UG Scholar, Department of Computer science and Engineering, Kongu Engineering College, Erode, India

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Abstract
The survival percentage of lung infected patients can be improved by early diagnosis of pneumonia disease and COVID-19. As the symptoms of COVID19 and pneumonia are very similar, but a chest X-ray can tell the difference for the identification and diagnosing of these diseases. It can be difficult for a professional radiologist to identify pneumonia and Covid-19 from CXR images as the occurrence of manual errors are highly possible. Deep learning (DL) techniques plays an important part in the field of medical imaging and image classification. The problem statement is difficulty in separating COVID-19 infected people from normal healthy people using chest X Rays as the have the similar symptoms. Here the work depicts by comparing with various CNN models and detects the differences in chest X-rays for the identification of diseases, with high accuracies. A new approach of multi classification method is accomplished. Preprocessing techniques such as histogram equalization and bilateral filtering are used to enhance the quality of chest X ray images. The proposed system is experienced with the CNN architectures such as VGG16 and InceptionV3 which are used for multi classification. It is noted that InceptionV3 is less expensive. The comparison is done both the models, and the accuracies are compared to identify the best model .VGG16 attained accuracy of 88%, InceptionV3 attained the highest accuracy with 93%. All architecture performances are compared using various classification metrics for estimating the performance of DL techniques.

1. Introduction

Deep learning, which is fundamentally a neural network with three or more layers, is a subset of machine learning. It makes the large amount of data to a meaningful information. For detection and classification of defects in Chest X rays deep learning techniques were carried out, as it is the most commonly used method in image recognition. CNN is one of the deep learning techniques examined in this work for identifying whether the patients are affected with pneumonia ,COVID 19 or they are free from diseases through the Xray images and explained in terms of accuracy. In the existing system, binary classification method is used for classifying the defects with the accuracy of 85%. Multiclass classification is a classification task with more than two classes as pneumonia, COVID 19 and normal are the three various classes defined in the proposed system. This approach brings the detection more faster and easier with the help of Chest X ray images. For the better quality of images pre-processing methods of histogram equalization and bilateral filtering are carried out. Histogram equalization is an image pre-processing method which stretching out the intensity range of images. Smoothening and preservation of edges is achieved with bilateral filtering. CNN models of VGG16 and

Contact – Dhivya[1] Kongu Engineering College , dhivya.arumugam28I.@gmail.com

InceptionV3 architectures are established for identifying the best performances among them.

Detection of COVID 19

The SARS-CoV-2 virus causes coronavirus disease, which is an infectious disease. It belongs to the coronavirus family, which also includes viruses that cause more serious disorders like Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS). Droplets released when an infected individual coughs, sneezes, or speaks are the major means of transmission for this. A person can contract the coronavirus from another individual. A test is used to diagnose it. The severity of the infection will determine how COVID-19 is treated. Resting at home and taking medication to lower the fever usually suffices for lesser illnesses. As with the delta and omicron versions, mutations may make it possible for the coronavirus to spread more quickly from person to person. More infections can lead to more people being seriously ill, as well as more chances for the virus to evolve new mutations.

Diagnosis of pneumonia

A pleural fluid culture, in which the physician takes a tiny amount of fluid from the tissues surrounding your lungs in order to check for germs that could potentially cause pneumonia. Measures the amount of oxygen in a little amount of blood drawn from one of your arteries during an arterial blood gas test. Bronchoscopy to check for obstructions or other issues in your airways, a CT scan to obtain a more thorough picture of your lungs. If you fall into one of the high-risk for children under the age of two, or those with an underlying medical condition or impaired immune system, it is very crucial that you seek medical assistance for pneumonia. Pneumonia has the potential to swiftly become a life-threatening condition for some of these susceptible people. White spots on an X-ray may be signs of bacterial pneumonia. Other pathological characteristics, such as fluid encircling the lungs (pleural effusion) or abscesses, can also be seen in the imaging.

Diagnosis of covid-19

Reverse Transcription Polymerase Chain Reaction for infected secretions can be used to confirm a tentative diagnosis of COVID-19. Chest CT scans may be useful in conjunction with laboratory tests to diagnose COVID-19 in patients with a high clinical suspicion of infection. Serological tests, which look for antibodies the body produces in response to an infection, can identify a previous illness. Depending on where you reside, different criteria may be used to determine whether or not to test you for the virus which causes COVID-19. Your clinic may need to screen you in order to decide whether testing is necessary and accessible for you given your location. After that, the samples are taken to a lab for analysis. Sputum from your cough may be submitted for analysis. The COVID-19 virus can now be tested for at-home by the FDA. These can only be obtained with a prescription from a doctor.

Deep learning

Deep learning is a form of mimic of the human brain, much like Artificial Neural Networks are. A branch of Machine Learning called "deep learning" is solely dependent on neural networks. The concept of deep learning is not new. It has been around for some time. Accessing more data and computational power than the procedure had in the past, it is more common now. Over the past 20 years, processing power has grown exponentially, which is the development of deep learning and machine learning. Deep learning is formally defined as neurons.

Convolutional neural network

Convolutional neural networks (CNN), a particular kind of deep learning architecture, are designed for certain tasks like classifying images. An input layer is one of the components of a CNN. However, the input for fundamental image processing typically consists of image's pixel values which is a two dimensional array of neurons. It also has an output layer, which is made up of a single dimensional array of output neurons. CNN processes the incoming images by combining convolution layers with sparse connections. They also include down sampling levels known as pooling layers used to reduce the number of neurons required in subsequent layers of network.

VGG16

The VGG model, also known as VGGNet, is a 16layer convolutional neural network model that is commonly abbreviated as VGG16. The model which these researchers released is defined as

"Deep Convolutional Networks for Large Scale Image Recognition". ImageNet is a dataset that contains over 14 million images arranged into about 1000 sections. It also performed well in comparison to other models submitted to ILSVRC-2014. It outclasses AlexNet by using many 3x3 kernel-sized filters instead of the massive kernel-sized filters. Over the course of several weeks, Nvidia Titan Black GPUs were used to train the VGG16 model. The previously mentioned 16-layer VGGNet-16 can classify photos into 1000 different object classifications, such as animals, pencil, mouse, and many more. Chest X rays with a resolving of 224 x 224 are also supported by the model.

InceptionV3

Convolutional Neural Networks are a deep learning method for categorizing images called Inception V3. The basic model V1 of Inception, which was first made available in 2014 as Google Net, has been upgraded into the more complex Inception V3. When a model has numerous thick layers of convolutions, the data became overfit. The conception V1 model uses the idea of numerous on the same level, filters of different sizes to get around this. As a result, inception models use parallel layers rather than deep layers, which results in a larger model than a deeper one.

The inception V3 model is simply the inceptionV1 model with improvements. The InceptionV3 model optimizes the network using a variety of techniques for enhanced model adaptability. It yields better results. Compared to the Inception V1 and V2 models, it has a larger network, but its speed is unaffected. In terms of computing, it is less expensive. It makes use of auxiliary Classifiers as it regularizes.

2. Existing system

Most research domains have used machine learning and deep learning techniques. Deep Learning is a component of machine learning that helps create intelligent solutions to complex problems. Artificial neural networks are used in deep learning to examine data and create predictions. Almost all corporate sectors have used it. However, they need a lot of data, a lot of processing power, and not a lot of resources. In addition, for smart various applications to enable and assist their services, developed systems must be secure and have high energy efficiency.

In terms of accuracy and efficiency, medical healthcare systems are one of these applications that needs improvement. In existing, the dataset is trained as two binary classification without pre-processing. A CNN architecture is made up of a stack of unique layers that, by using a differentiable function, convert the input volume into an output volume (such as keeping the class scores). There are several uses for CNN, including medical imaging, object identification, and picture classification. VGGNet, ZFNet, and Alexnet, are three CNN models for classification of image that excel in practical applications. In existing, the covid x CT 1,94,922 chest X-ray slices from 3,745 patients are trained as hybrid binary classification without pre-processing with greater accuracy. There are two phases: The accuracy in the first phase, used the DenseNet-201 structure to separate the covid and normal CT slides, which was high and the accuracy of the second phase which used the InceptionV3 architecture to classify Normal and Pneumonia CT slices was greater. The data are divided into Covid and Pneumonia categories using the Phase-1 model. The phase-2 model may categorize Pneumonia pictures after phase 1 into groups of either normal or pneumonia. Consequently, phase 1 and 2 both undergoes classification.

Rajpurkar, Pranav, and Jeremy Irvin, trained CheXNet on the recently released Chest X-ray14 dataset to expert-level automation, wishing that this technology is improving healthcare delivery and increase access to medical image analysis, particularly X-rays. The retrained model is then analysed by comparing the results to state-of-the-art approaches. Creating an algorithm that identifies the disease pneumonia from anterior chest X-ray images to a level that exceeds the abilities of practicing radiologists.

3.Proposed System

The proposed system explains that the dataset is collected with respect to the chest X rays which were distinguished as covid 19, pneumonia, normal images. After collection, the images were undergone to two different kinds of preprocessing methods. The first preprocessing method used here is histogram equalization ,which is helpful in improving the contrast in images. This method clearly depicts and visualize the defected area in

chest X ray images. The second method is bilateral filtering, this method is a edge-preserving, and noise-reducing smoothing filter used in chest X ray images. The models used were VGG16 and InceptionV3 in this proposed system. This system experiences four phases for identifying the best performance among them. At first, the images were preprocessed using histogram equalization with VGG16 with accuracy of 87%. Second phase, the images are processed with both preprocessing methods of histogram equalization and bilateral filtering with the model VGG16 of 88% .The third phase portrays that the images treated with the histogram equalization along with the model InceptionV3 of 93% .The last phase set out that the chest X ray images experiences the histogram equalization and bilateral filtering with the model of

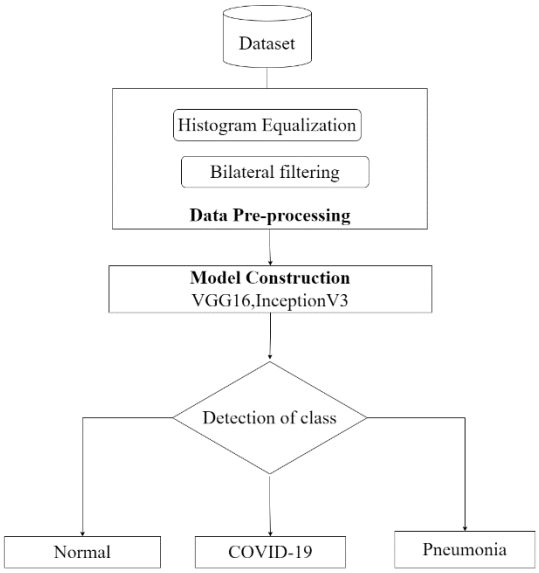


FIGURE 1. Proposed model architecture

InceptionV3 with the accuracy 92%. The phases are evaluated with respect to the performance and accuracy obtained. This method gives us the clear view of finding the defect in the chest X ray images with great accuracy. This makes the detection of classes such as covid19, pneumonia and normal are identified easily. Figure. 1 represents proposed model architecture.

4. Dataset

The first and most important duty in each application is dataset collection. Here are a few procedures to follow when gathering datasets.

Chest x ray images

The dataset are collected from Kaggle (https://www.kaggle.com/datasets/anasmohammedtahir/covidqu) which consists of 33,920 chest X-ray (CXR) images. The datasets are in the form of images which refers the diseases such as covid19, Pneumonia and Normal. All images are in Portable Network Graphics format. Figure. 2 represents the normal chest x rays without pre-processing of covid-19, normal, pneumonia.

Covid-19 Normal Pneumonia

FIGURE 2. Normal chest x-rays

Data pre-processing

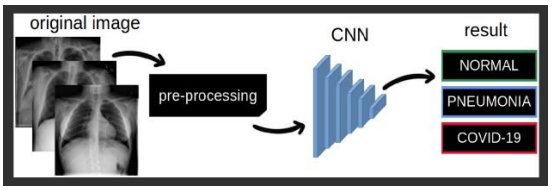


FIGURE 3. Model image

Figure 3 display how the pre-processing method is carried out step by step has shown above.

Histogram equalization

A contrast-normalized image is produced using the histogram equalization technique that exclusively use authentic Chest X-ray pictures. The suggested approach is to manipulating the histogram before applying histogram equalization. The results suggested that the suggested strategy would be more effective than other common strategies for contrast enhancement. Future iterations of a approach may be more effective if the background is automatically removed before use.

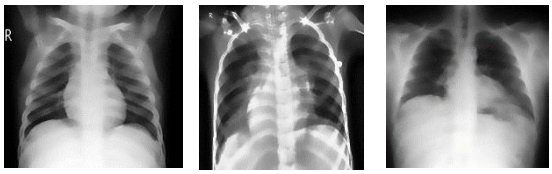
Figure.4 the images that are preprocessed using histogram equalization are represented below.

Covid-19 Normal Pneumonia

FIGURE 4. Histogram Equalization chest X-rays

Bilateral filtering

The bilateral filter is a method for image smoothing that keeps edges clean. It solely depends on two factors that define the size and contrast of the features that should be preserved. According to the BF's formulation for noise reduction, each pixel is replaced by a weighted average of its neighbours, as is done, for reference, when an image is convoluted with a Gaussian filter. The concept of combining domain and range filtering is embodied by bilateral filtering. The authors come to the conclusion that the bilateral filter in image space significantly reduces noise while maintaining sharp edges. Figure.5 the images that are pre-processed using bilateral filtering are shown below.



Covid-19 Normal Pneumonia

FIGURE 5. Bilateral Filtering chest X-rays

5.Performance metrics

Various parameters are employed during the evaluation, including

- Accuracy
- Precision
- Recall
- F1 Score

Some basic terms associated with performance evaluation are,

- True positive: A state where both the expected and actual values are positive.
- True negative: A state where the expected and actual values are opposite to each other.
- False Positive: A state in which the value expected is positive but the value actually obtained is negative.
- False Negative: A state where the actual value is positive and expected value is negative.

A. Accuracy

Accuracy is one of the most important for analysing the performance of the model. The ratio between the sum of true negative and true positive to the total number of samples is the accuracy

$$\text{Accuracy} = \frac{\text{No of correct predictions}}{\text{Total number of predictions}} \quad (1)$$

B. Precision

The precision is calculated between the variety of positive samples properly classified either properly or incorrectly they were classified as positive for all the samples. The precision measures the accuracy of a model in classifying a sample positive. The below equation depicts the formula for calculation of precision.

$$\text{Precision} = TP/(TP+FP) \quad (2)$$

C. Recall

The quantitative relationship between number of correctly identified Positive samples as well as the overall number of Positive samples is used to estimate recall. The recall is a metric that measures a model's capacity to recognize positive samples. The elevated the recall, the more positive samples are found.

$$\text{Recall} = TP/(TP+FN) \quad (3)$$

D. F1 Score

The F1 Score is the harmonic mean of both precisions. It achieves its maximum value of1(perfect precision and recall) and its minimum value of 0 respectively.

6. Results and Discussion

A. Accuracy

Figure 6 Accuracy comparison displays the accuracy comparison of the DL approaches of the algorithms. The graphical representation clearly shows that the accuracy of 87% in VGG16 along with pre-processing method of histogram equalization. 88% in VGG16 with both histogram equalization and bilateral filtering. As in InceptionV3 with histogram equalization attained 93% of accuracy and in histogram and bilateral attained 92%. To increase the predictability of the dataset, InceptionV3 applies a number of perceptron layers to diverse subsets of the data and chooses the average. As a result, it is shown that InceptionV3, based on testing accuracy, has the highest accuracy.

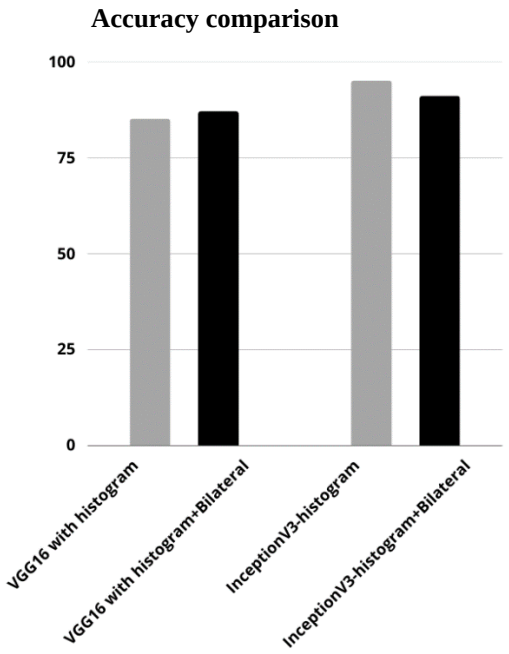


FIGURE 6. Accuracy comparison

B. Precision

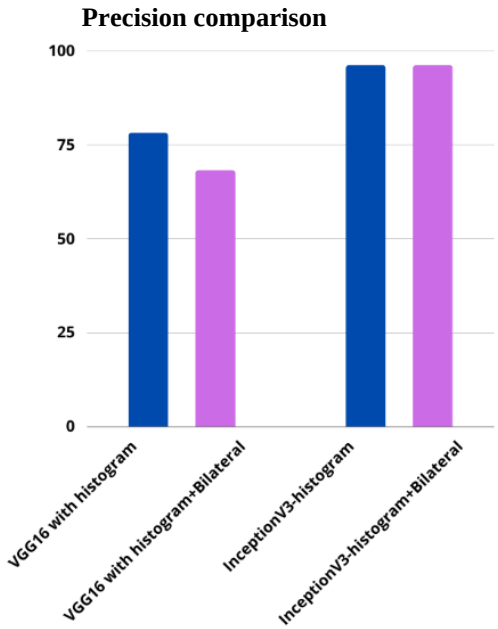


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FIGURE 7. Precision comparison

Figure 7 displays the precision comparison of the DL approaches. The graphical representation clearly shows that the accuracy of 78% in VGG16 along with pre-processing method of histogram equalization. 68% in VGG16 with both histogram equalization and bilateral filtering. As in InceptionV3 with histogram equalization attained 96% of accuracy and in histogram and bilateral attained 96%. It is demonstrated that across all methods, the InceptionV3 Algorithm has the highest precision score. The InceptionV3 blends various perceptron layers to forecast the dataset is class. In light of testing precision, it is shown that InceptionV3 has the highest precision score.

C. Recall

Figure 8 displays the recall comparison of the DL approaches. The graphical representation clearly shows that the accuracy of 73% in VGG16 along with pre-processing method of histogram equalization. 65% in VGG16 with both histogram equalization and bilateral filtering. As in InceptionV3 with histogram equalization attained 96% of accuracy and in histogram and bilateral attained 95%. The InceptionV3 algorithm has the highest recall of all the techniques. It employs a number of perceptron on various subsets of the data and averages the outcomes to improve the dataset is accuracy. For the purpose of predicting the dataset is class, the InceptionV3 combines several perceptron. As a result, it is demonstrated that InceptionV3 has the highest memory score based on the recall score.

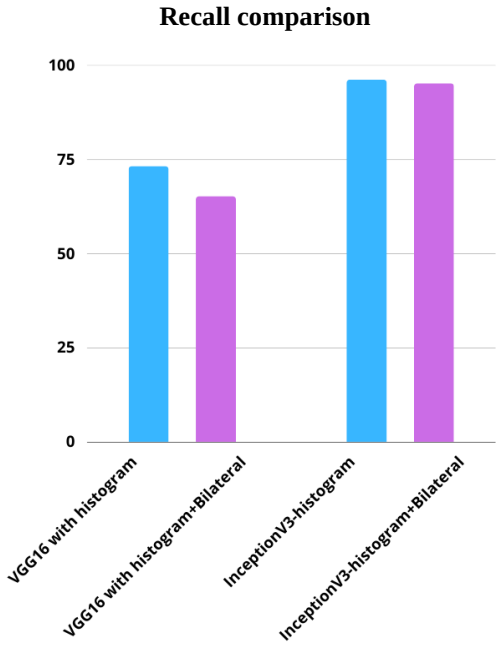

FIGURE 8. Recall comparison

D. F1 Score

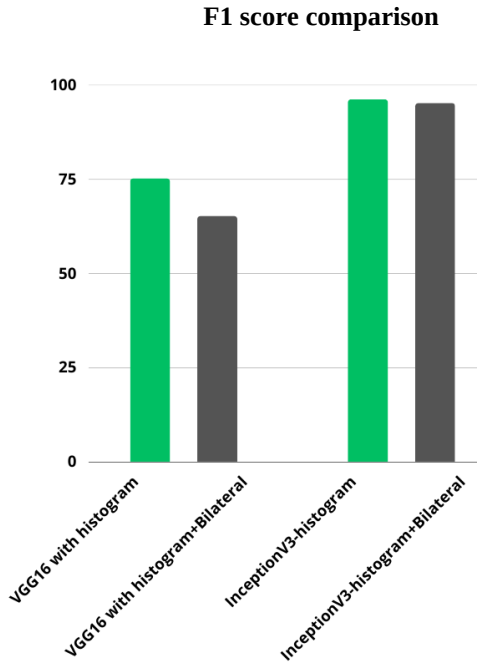

FIGURE 9. F1 score comparison

The F1 Score comparison of the DL techniques is shown in Figure 9. The graphical representation clearly shows that the accuracy of 75% in VGG16 along with pre-processing method of histogram equalization. 65% in VGG16 with both histogram equalization and bilateral filtering. As in InceptionV3 with histogram equalization attained 96% of accuracy and in histogram and bilateral attained 95%. Of all algorithms, InceptionV3 Algorithm has the highest f1 score. It employs a number of perceptron's on various subsets of the data and averages the outcomes to improve the dataset is accuracy. The InceptionV3 blends various perceptron's in order to forecast the dataset is class. As a result, it is demonstrated by the testing f1 score that InceptionV3 has the greatest f1 score.

7. Conclusion and future work

In conclusion, the healthcare system predicts that highly accurate diagnostic results will enable it to deliver effective treatments to the patient more quickly. In order to accomplish this, VGG16 and InceptionV3 deep learning frameworks was created in our study to examine x-rays of covid-19, pneumonia, normal. In present study deep learning models of Multi-class classification is used and compares the accuracy with different image pre-processing techniques and analyses the differences in accuracy. The comparison is done both the models, and the accuracies are compared to identify the best model .In VGG16 attained highest accuracy of 88%, as in InceptionV3 attained the highest accuracy with 93%. In future, steps may be taken to improve the accuracy and to evaluate the model by implementing hybrid multi classification approach.

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