Topic
Pneumonia Detection
by
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1.Abstract:-

Pneumonia remains a threat to human health; the coronavirus disease 2019 (COVID-19) that began at the end of 2019 had a major impact on the world. It is still raging in many countries and has caused great losses to people's lives and property. In this report we present a method based on DeepConv-DilatedNet of identifying and localizing pneumonia in chest X-ray (CXR) images. Two-stage detector Faster R-CNN is adopted as the structure of a network. Feature Pyramid Network (FPN) is integrated into the residual neural network of a dilated bottleneck so that the deep features are expanded to preserve the deep feature and position information of the object. In the case of DeepConv-DilatedNet, the deconvolution network is used to restore high-level feature maps into its original size, and the target information is further retained. On the other hand, DeepConv-DilatedNet uses a popular fully convolution architecture with computation shared on the entire image. Then, Soft-NMS is used to screen boxes and ensure sample quality. Also, K-Means++ is used to generate anchor boxes to improve the localization accuracy. The algorithm obtained 39.23% Mean Average Precision (mAP) on the X-ray image dataset from the Radiological Society of North America (RSNA) and got 38.02% Mean Average Precision (mAP) on the ChestX-ray14 dataset, surpassing other detection algorithms. So, in this paper, an improved algorithm that can provide doctors with location information of pneumonia lesions is proposed.

2.Problem Statement:-

Before Problem Statement first to know the question-:
What is Pneumonia?
Pneumonia is an infection that inflames air sacs in one or both lungs infection can be life-threatening to anyone.The germs that cause pneumonia are contagious.
Both viral and bacterial pneumonia can spread to others through

a.Inhalation of airborne droplets from a sneeze or cough.

b.By coming into contact with surfaces or objects that are contaminated withpneumonia-

causing bacteria or viruses.

Hence the problem is big and wants to be cure so that the according to this disease-:
Statement-:
Pneumonia is a life-threatening infectious disease affecting one or both lungs in humans commonly caused by bacteria called Streptococcus pneumoniae. One in three deaths in India is caused due to pneumonia as reported by World Health Organization (WHO). Chest X-Rays which are used to diagnose pneumonia need expert radiotherapists for evaluation. Thus, developing an automatic system for detecting pneumonia would be beneficial for treating the disease without any delay particularly in remote areas. Due to

the success of deep learning algorithms in analyzing medical images, Convolutional Neural Networks (CNNs) have gained much attention for disease classification. In addition, features learned by pre-trained CNN models on large-scale datasets are much useful in image classification tasks. In this work, we appraise the functionality of pre-trained CNN models utilized as feature-extractors followed by different classifiers for the classification of abnormal and normal chest X-Rays. We analytically determine the optimal CNN model for the purpose. Statistical results obtained demonstrates that pretrained CNN models employed along with supervised classifier algorithms can be very beneficial in analyzing chest X-ray images, specifically to detect Pneumonia .

3. Market / Customer/ Business Need Assessment-:

Global Pneumonia Testing Market was valued at $932 million in 2016, and is estimated to reach $1,738 million by 2023, registering a CAGR of 9.2% from 2017 to 2023. Pneumonia is a complicated infection that affects the lower respiratory tract and is characterized by symptoms such as short breathing, fever, chest pain, nausea, and vomiting. In pneumonia, the air sacs of lungs called as alveoli are filled with fluid or pus that cause inflammation. It is mainly caused by microorganisms such as bacteria, virus, fungi, and parasites and mostly affects people with weakened immune systems and is common in children and older people. As per WHO, pneumonia is one of the major factors causing death in children and is estimated to affect approximately 1.2 million children under the age of five years annually. As per WHO, 95% of all pneumococcal episodes occur in children in the developing countries.

The market is expected to witness a steady growth owing to the development of advanced nucleic acid etection tests and advancement in POC testing products. Moreover, rise in awareness about the benefits of early diagnosis among the patient population has increased the number of diagnostic tests in the developing regions such as India and Africa. Moreover, the increase in adoption of molecular diagnostic testing and untapped markets in the developing economies are expected to provide new avenues for the growth of pneumonia testing market in the near future.

GLOBAL PNEUMONIA TESTING MARKET
BY METHOD

2016   2023

Immunodiagnostics   Molecular Diagnostics   Point of Care Testing
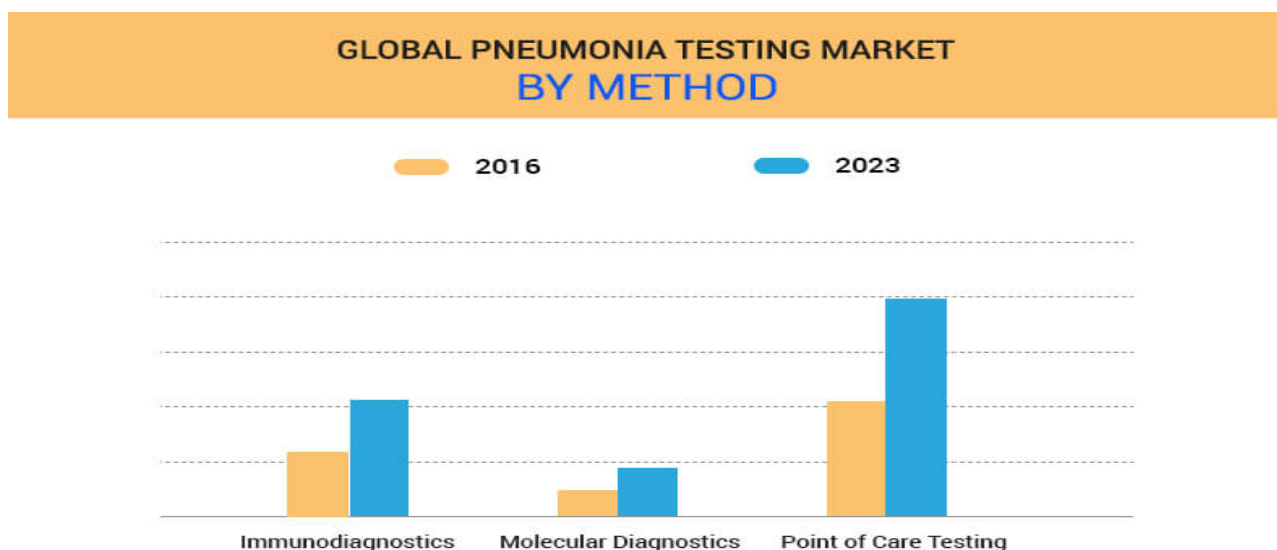
Point of Care Testing segment is projected as one of the most lucrative segments.

4. Target Specifications and Characterization:

A. To change traditional Health sector process to faster and accurate process.
B. Reducing frustration and death of patients due to delay in the prognosis process
C. Predetermined dataset of pneumonia patients and normal patients is taken and based on that prediction is performed
Above, mentioned targets can be achieved by analyzing:
1. What the patient look for
2. How are present pathology processes are being performed
3. Problems faced by people suffering from pneumonia disease
4. How to identify and provide treatment in initial stage accurately.
5. How efficiently are the pathologists performing prognosis process
6. When and where a patient likes to trust and spend on?
7. Analyzing the needs of the patients suffering from disease
8. To help patient fight pneumonia early stage
9. To send results to the patient within minutes and prescribing the next step to be taken by the patient if he's been found of suffering from disease.
10. To remind the patient about the latest changes in the pneumonia prognosis process.

5.Concept Generation:

Environment Setup-:

1.on run on a normal CPU, having a 'CUDA' enabled GPU helps models get trained   quicker.
2.'Google's Colaboratory' is the developer's best friend when it comes to deep learning.

3.Colaboratory is a Google research project created to help machine learning education   and research.

4.Hosted on Google Cloud instances which we can use for free.

Tensorflow Dataset API-:

A.The tensorflow dataset API helps us in writing custom and efficient input pipelines.
B.Dataset API is used for:

1.Creating a Stacked object for Input data and labels.

2.Applying transformations to the data.

3.Iterating over the object to fetch the data.

ResNets:-

1.It was the time when 'AlexNet' was released and people were just trying to build bigger   and bigger networks.
2.Bigger networks were actually getting better accuracies but there was a limit and after   that the errors went higher i.e. no improvement in performance.

Issues using Plain Convolutional Networks:-

A.Validation errors for two plain convolutional networks

- 18 layers.

- 34 layers.

B.The error for a 34 layers network is higher compared to 18 layers.
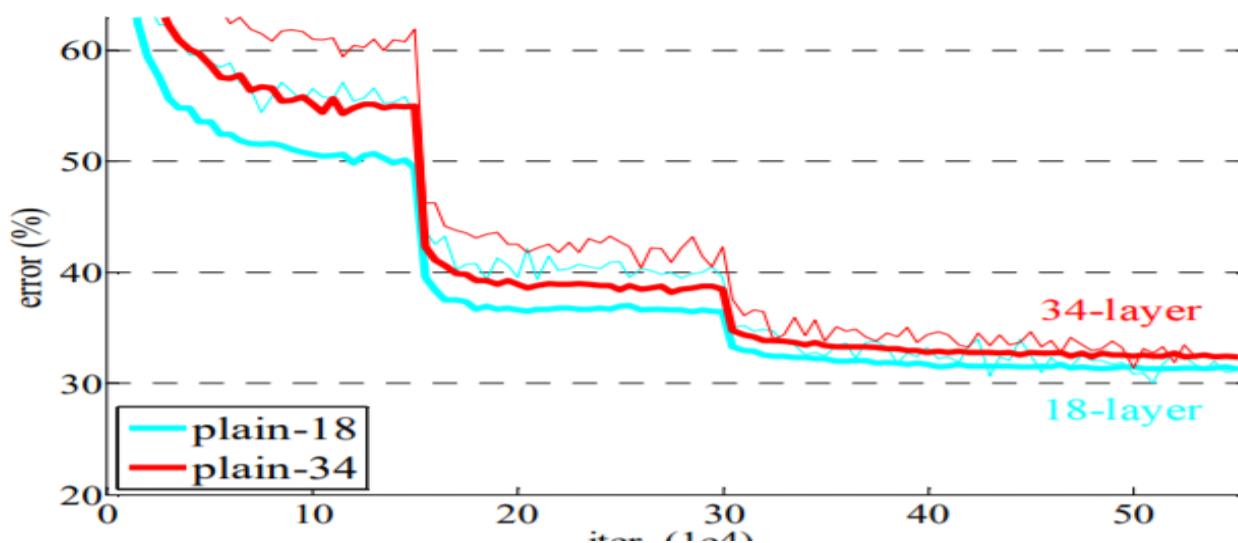
1.Adding more layers can lead to more complex learning functions which might lead to an overfitting situation.
2.Deeper networks might face an issue backpropagating the gradients, this issue is most commonly called the 'Vanishing Gradients' problem.

Solution:-

1.Overfitting can be handled by using regularization and dropout where we   deactivate few random neurons to help other neurons learn.
2.'Vanishing Gradients' problem can be handled using 'ReLu' activation which maximizes the gradient flow, we can use 'Batch Normalization' to address this issue as well.
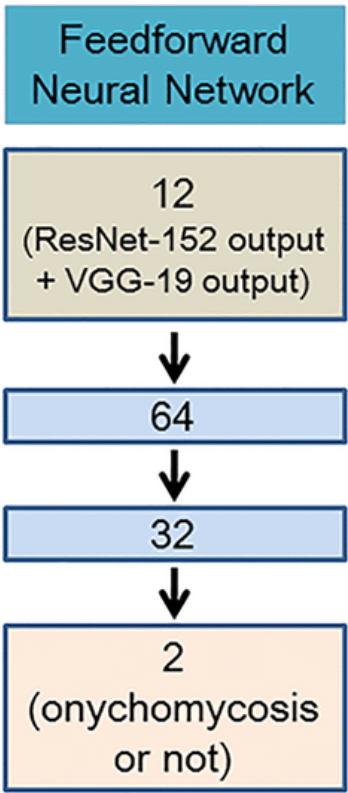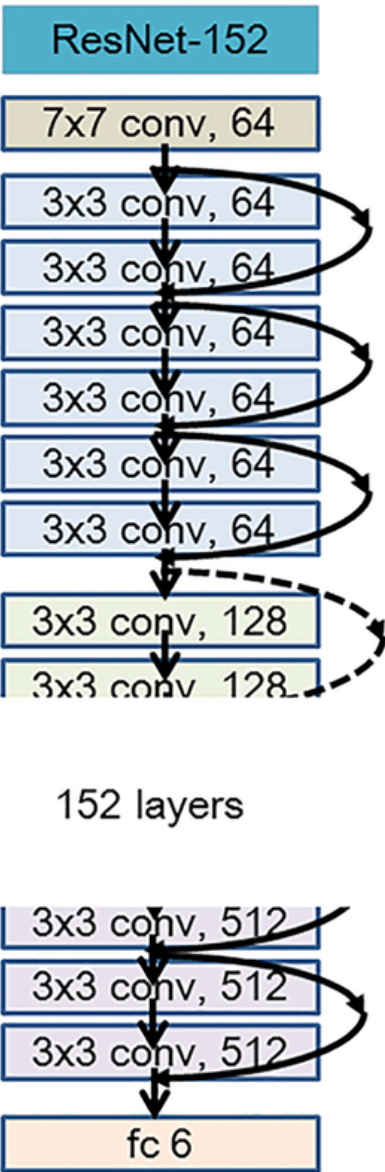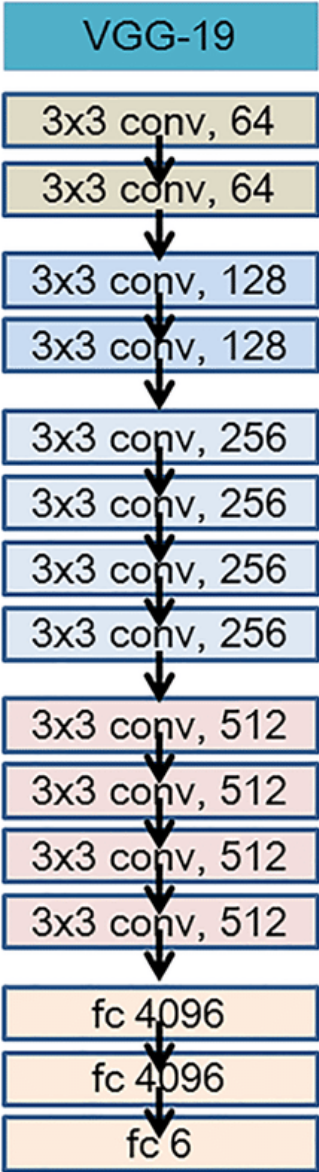
Residual Block:-

1.A residual block takes in the output of a layer and forwards the output to further layers.

2.It also remembers the past information which is nothing but the identity function.

3.This type of connection is also called "Skip connection".
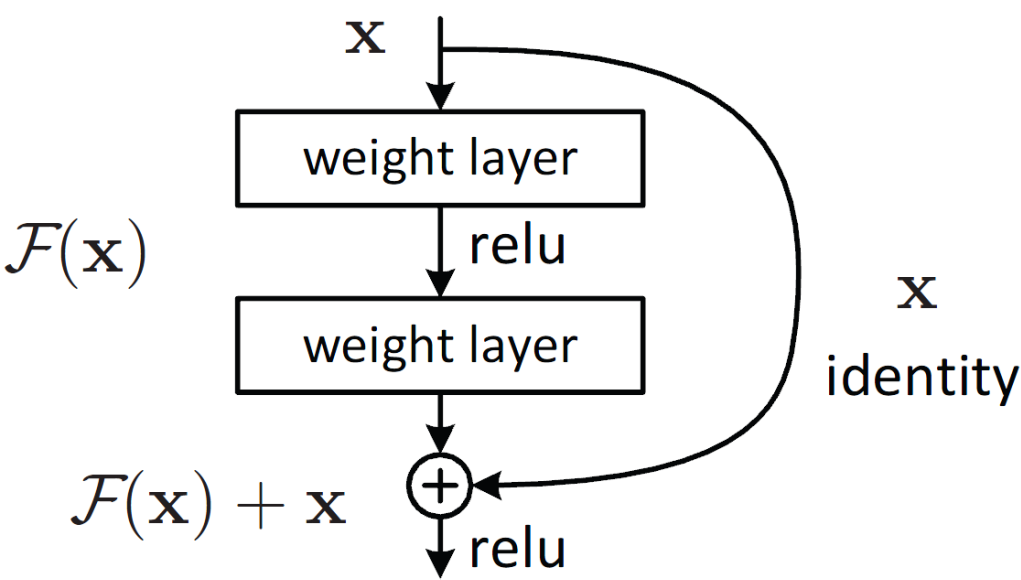
Deeper ResNet :-

ions part.

6.About Pneumonia Detection:-

In this Project, we will detect Pneumonia using Deep Learning. We will create a model that will classify whether the patient is normal or suffering from pneumonia by looking at Chest X-ray images. The algorithm or the model which we will create should be extremely accurate because the lives of people are at stake.
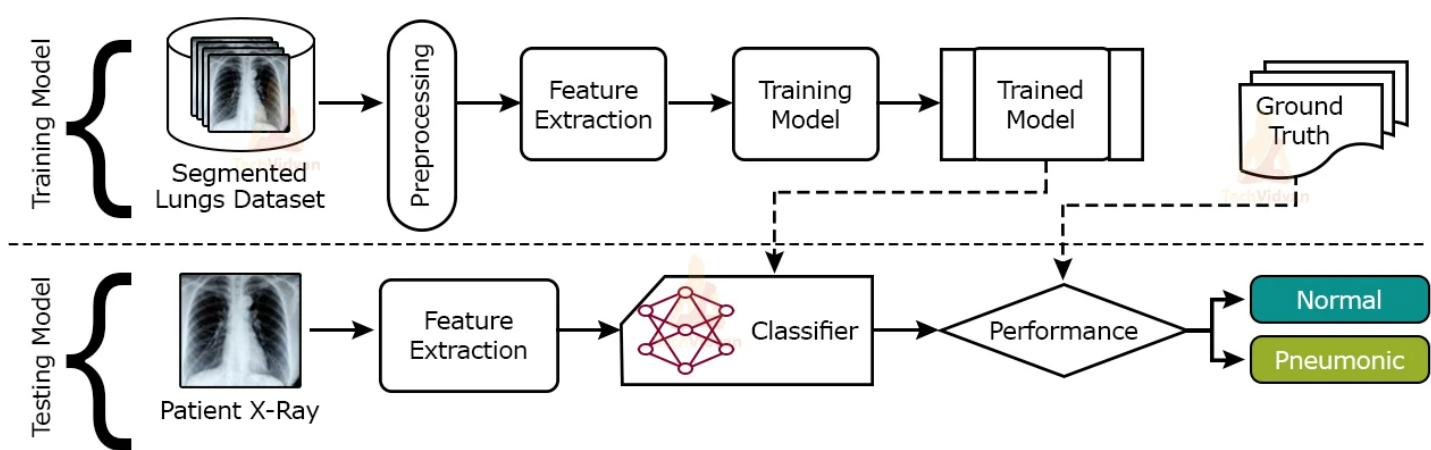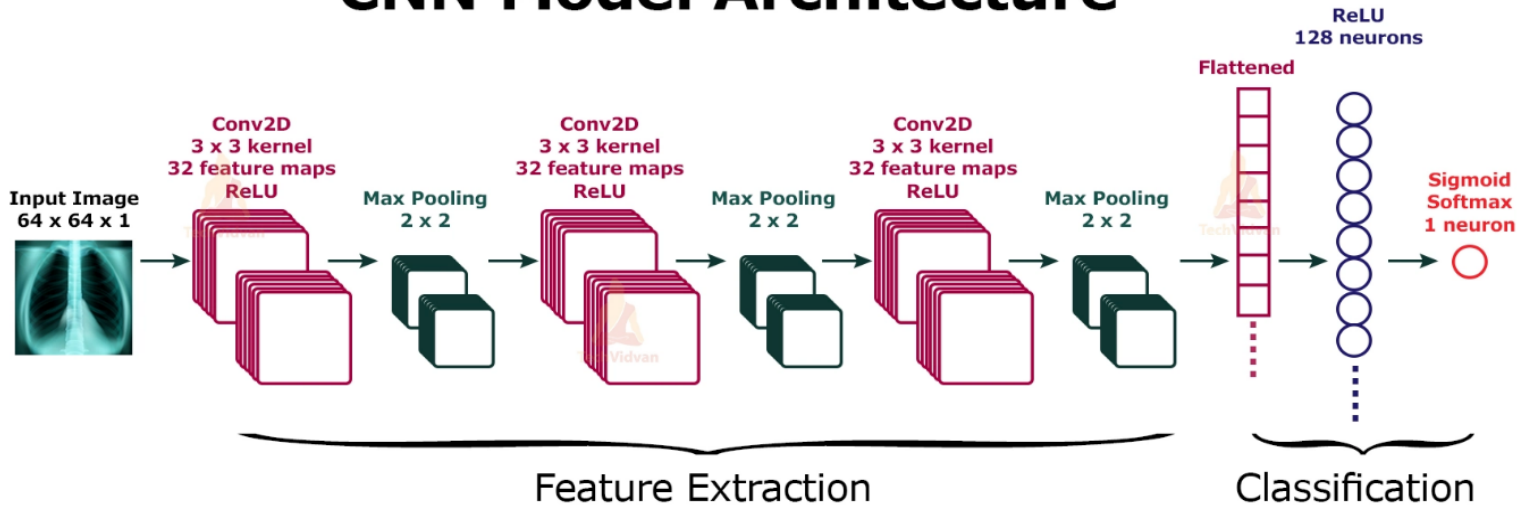

Pneumonia Detection Chest X-ray Dataset:-

We will be using is Chest X-ray images (Pneumonia) for this deep learning project, please download the dataset from the following link:

https://www.dropbox.com/s/tlxserrdhe240lu/archive.zip

The dataset we are using is already splitted into train, test, and val. Train folder contains   training data / images which we will use to train our model, similarly the test and val folder   also contains Normal and Pneumonia images which will be used to test our model. There   are a total 5856 images consisting of normal and pneumonia images both.

CNN Model Architecture

Input Image 64 x 64 x 1 → Conv2D 3 x 3 kernel 32 feature maps ReLU → Max Pooling 2 x 2 → Conv2D 3 x 3 kernel 32 feature maps ReLU → Max Pooling 2 x 2 → Conv2D 3 x 3 kernel 32 feature maps ReLU → Max Pooling 2 x 2 → Flattened → ReLU 128 neurons → Sigmoid Softmax 1 neuron

Feature Extraction — Classification

7.Project Code:-

Please download the pneumonia detection project code from the following link:

https://github.com/vijay2020pc/Feynn-Projects/tree/main/Task1

Required Libraries:

These are the following libraries you need to install for pneumonia detection project:
- Numpy
- Matplotlib
- OpenCV
- Tensorflow
- keras

You can install it using pip. So open your command prompt and type pip install numpy, pip   install matplotlib, pip install tensorflow etc. You can install all the required libraries like   this.

8.Model Checkpoints-:

Tensorflow Callback Object:-

1.A Tensorflow callback object is used to perform an action in various stages of   training process.

2.It could be at Start or End of an Epoch or Step.

Key Takeaways:-

1.We need to apply some Resampling Techniques to make it balanced.

2.We need to apply some Data Transformation techniques.

3.We Must Perform Univariate and Bivariate Analysis to understand the Better.

4.Finally, Try more and more Predictive Models, Compare them using various Evaluations   5.Metrics is a good way of finding the Best Model

9.More Things to Try:-

1.Medical problem statements are complex and there's a high chance to miss some important point before solving the issue.

2.X-ray scanners made by different companies do post processing in different ways.

3.Changes are huge in pixel level.

4.To improve the existing dataset by collecting X rays from multiple hospitals and different machines.

Augmentation

1.Augmentation is the tricky part in medical imaging.

2.We cannot use most of the augmentations

3.It might change the image itself.

4.To use augmentations which do not affect pixel values like horizontal rotations , random image cropping.

5.We could also try out Blurring images in a minimal way.

10.Summary & Conclusion:-

We have created a Convolutional Neural Network Model which is able to correctly   predict that the patient is suffering from Pneumonia or not by using that person's   chest X-ray. So, in this project we have learned how to create CNN models and also learn how to generate data using ImageDataGenerator that is given by keras.

The framework, evaluated on two publicly available pneumonia chest X-ray datasets, obtained an accuracy rate of 98.81%, a sensitivity rate of 98.80%, a precision rate of 98.82%, and an f1-score of 98.79% on the Kermany dataset and an accuracy rate of 86.86%, a sensitivity rate of 87.02%, a precision rate of

86.89%, and an f1-score of 86.95% on the RSNA challenge dataset, using a five-fold cross-validation scheme. It outperformed state-of-the-art methods on these two datasets. Statistical analyses of the proposed model using McNemar's and ANOVA tests indicate the viability of the approach. Furthermore, the proposed ensemble model is domain-independent and thus can be applied to a large variety of computer vision tasks .

11.References:-

1.Neuman M., Lee E., Bixby S., Diperna S., Hellinger J., Markowitz R., et al. Variability in the interpretation of chest radiographs for the diagnosis of pneumonia in children. *Journal Of Hospital Medicine*. 7, 294–298 (2012) pmid:22009855

•View Article
•PubMed/NCBI
•Google Scholar

2.Williams G., Macaskill P., Kerr M., Fitzgerald D., Isaacs D., Codarini M., et al. Variability and accuracy in interpretation of consolidation on chest radiography for diagnosing pneumonia in children under 5 years of age. *Pediatric Pulmonology*. 48, 1195–1200 (2013) pmid:23997040

•View Article
•PubMed/NCBI
•Google Scholar

3.Kermany D., Zhang K. & Goldbaum M. Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification. (Mendeley,2018)

•View Article
•Google Scholar

4.Kermany D., Zhang K. & Goldbaum M. Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification. (Mendeley,2018)

•View Article
•Google Scholar

5.Lal S., Rehman S., Shah J., Meraj T., Rauf H., Damaševičius R., et al. Adversarial Attack and Defence through Adversarial Training and Feature Fusion for Diabetic Retinopathy Recognition. *Sensors*. 21, 3922 (2021) pmid:34200216

•View Article

- PubMed/NCBI
- Google Scholar

6. Rauf H., Lali M., Khan M., Kadry S., Alolaiyan H., Razaq A., et al. Time series forecasting of COVID-19 transmission in Asia Pacific countries using deep neural networks. *Personal And Ubiquitous Computing*. pp. 1–18 (2021) pmid:33456433

Sites:-

1. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0256630/

2. https://www.analyticsvidhya.com/blog/2020/09/pneumonia-detection-using-cnn-with-implementation-in-python/

3. https://techvidvan.com/tutorials/deep-learning-pneumonia-detection/

4. https://towardsdatascience.com/deep-learning-for-detecting-pneumonia-from-x-ray-images-fc9a3d9fdba8