Pneumonia Detection Using Deep Learning: A Review

Ganesh D. Kokare [1], Rahul D. Chaudhari [1], Pratik B. Khomane [1], Tushar P. Borawake [1]

[1] *Student, Dept. of Information Technology, Vidya Pratishthan's kamalnayan Bajaj Institute of Engineering and Technology, Baramati, Pune, India.*

Corresponding Author: tusharborawake2001@gmail.com

Abstract: - Pneumonia is a severe infection which directly affects the one or both the lungs of human and it is actually affected by the fungi, bacteria or viruses. The air sacs of a person who is suffering from a pneumonia are filled with the pus or other fluids. It causes difficulty in breathing. Infection can be life-threatening for anyone, but they are especially deadly for people at the age of 65 and above and children. Pneumonia is very life- threatening especially for children below the age of 5 due to this 14% of all deaths in, and in 2019 he had 7,40,180 child deaths. Several machine learning or deep learning techniques and models have been proposed and developed for pneumonia detection using chest X-Ray images as input. In this article, we have described various pneumonia detection models that have been developed so far. The main purpose of this work is to compare previous work in this area.

Key Words: - ***Pneumonia Detection, Pneumonia, CNN, Machine Learning, Chest x-ray Images, Deep Learning.***

I. INTRODUCTION

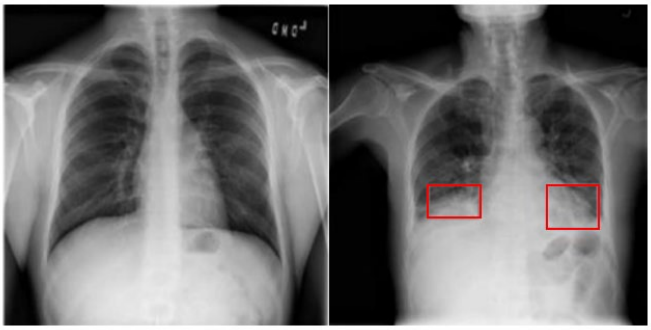
Basic Symptoms of pneumonia were first recorded around 460 BC which is written by the Greek physician Hippocrates. In 1875, German pathologist Edwin Klebs first observed pneumonia bacteria under a microscope. Now a days, Pneumonia has become very common disease worldwide. Diagnosing pneumonia at an early stage is a very important step in saving many lives. With the advancement in Artificial Intelligence, we can detect the Pneumonia in the early stages. There are several methods for pneumonia detection. Cheapest way for detection of pneumonia is using chest X-ray images. Artificial Intelligence helps us to maintain consistency and accuracy in our diagnosis.

Manuscript revised May 19, 2023; accepted May 20, 2023. Date of publication May 21, 2023.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

Evaluation of chest radiographs for pneumonia, like several problems such as pulmonary scarring, congestive heart failure, can be misleading for radiologists. Can mimic a pneumonia. Thus, the task is challenging and developing algorithms to detect chest diseases such as pneumonia would improve access to medical facilities, even in remote areas. Pneumonia can be detected in early stage with the help of deep learning and computer-aided detection (CAD).



Normal (Left) **Pneumonic (Right)**

Fig.1. Normal and Pneumonia Affected Chest X - ray Image

It is possible to detect pneumonia using chest x-ray images by techniques such as conventional x-rays, CT and MRI. Doctors examine chest x-rays to detect pneumonia.

As you can see in the image above, soft tissue is transparent to X-rays and thus produces darker colours in the X-ray image. On the other side bright colour is produced by Hard tissues such as Bones. In the fig a. (Left Image) You can see the chest cavity clearly visible (dark colour) due to the presence of air in the lung cavity. while in a pneumonia patient the lung cavity is filled with the fluid or pus, causing chest cavity in X-ray image looks brighter which can be noticed in the fig on the right side (Right Image) given above.

The Radiologists or the doctors can be assisted by CAD technology for the purpose of interpreting the X-ray image for the pneumonia. The CAD will provide the second opinion in the detection of pneumonia. The CAD also improves the accuracy.

There are multiple techniques used to develop the CAD such as deep convolutional architecture. VGC16 and ResNet50 are the two architectures which are widely used for image classification.

In short, we can conclude that with the help of Artificial Intelligence we can save many of the lives by detecting pneumonia in early stages to avoid further delay in treatment.

II. LITERATURE SURVEY

There are several ways to identify pneumonia from a chest x-ray. Some uses feature extraction techniques along with Machine Learning Algorithm to classify chest x ray whereas other uses different Deep learning techniques for feature extraction and Classification.

In this W. Abdullah Brooks et al focuses on paediatric pneumonia and, in particular, research to reduce infant mortality from this disease to unacceptable levels. The authors want to convey the message that, Pneumonia is a global disease which is curable in developed countries but can be life threatening in developing countries. As it is a public health problem still pneumonia do not UN agency to highlight its importance [7].

Author P. Rajpurkar et al (2017) introduced ChexNet, is an algorithm in which Convolutional Neural Network (CNN) consists of 121 layers to classify several diseases one of them is pneumonia which is seen on the chest X ray. By using chest x ray images, the ChexNet was trained. The performance of ChexNet is compared to radiologists and it was found that, ChexNet surpasses the average radiologist performance on F1 metric [8].

The Xianghong Gu et al (2018) have used CAD (Computer Aided Diagnosis) to detect viral as well as bacterial pneumonia as early as possible. CAD system has played a vital role in to detect lung diseases based on chest X-ray images. It mainly consists of two parts, first the regions of lungs are identified then pneumonia category classification is there. The authors have used Deep Convolutional Neural Network (DCNN) model to classify the regions where the targets are set in lungs. Features of the that particular regions are extracted so that we can compare manually. Then SVM classifier is used for binary classification. The dataset used is Guangzhou Women and Children's Medical Centre, China, with 4,513 Pediatric patients in total and also from JSRT (Japanese Society of Radiological Technology) database which contains 241 X-ray chest images. The accuracy of the model is 82% [29].

A CoupleNet, fully convolutional network, was used by J. Merkow et al (2018) for Pneumonia Detction through x-ray images. The dataset used is provided by Radiological Society of North America (RSNA) [33].

The author Jeffrey A. M. et al uses the Radiological Society of North America's Kaggle RSNA Pneumonia Detection Challenge Dataset. This dataset consists of radiographs of patients with and without pneumonia. Here, the authors implement residual networks and use faster regional CNN algorithms, typically used in object localization and semantic segmentation. The goal of object detection is to identify each object in an image using its bounding box. To extract features, the model uses bottom-up and up-bottom extraction path. ResNet50 participates in a bottom-up extraction path. A Feature Pyramid Network (FPN) is involved in the up-bottom extraction path. The residual network produces a bounding-boxed output of a pneumonia chest radiograph. Accuracy obtained by trained Residual Network is 85.60% and sensitivity and Specificity is 51.52% and 94.83%. Here author compares his Residual Network with the mask-RCNN and concludes that Residual Network is more informative and shows better performance as compared to mask-RCNN [1].

Then D. Varshni et al (2019) uses the Kaggle dataset named Chest X-ray 14 which is released by Wang et al. The proposed model is divided into three stages – the Pre-processing Stage, the feature extraction stage and the Classification stage. In the first step that is Pre-processing stage, the images of size 1024×1024 are taken as input then further resized to 224×224

pixels which reduces heavy computation and helps in faster processing. In feature extraction stage, the features were extracted with different alternatives of pre-trained CNN models but here the authors found DenseNet-169 as the excellent model for feature extraction. The moto behind using the DenseNet Architecture as a feature extractor is that as you deeper in network such that more features are extracted [2].

The author O. Stephen et al proposed a convolutional neural network (CNN) model which trained from beginning pneumonia detection using chest X-rays. As it is built from scratch it does not rely on Transfer learning. The designed CNN model can extract and classify whether a person suffers from pneumonia or not. Several Data Augmentation techniques are used to artificially increase the size and quality of the dataset which helps to improve the accuracy and validation of the CNN model. The Convolutional Neural Network model is built and train with TensorFlow backend on the basis of Keras. The model got 95% training accuracy [12].

In 2019, I. Sirazitdinova et al introduced an ensemble of two convolutional neural networks called RetinaNet and Mask R-CNN has been proposed for pneumonia detection and localization. The dataset of 26,684 images is used which is available on Kaggle out of which 25,684 images are used for training and 1000 images are used for testing purpose [14].
Raheel Siddiqui (2019), designed an 18-layer sequential CNN to remedy the pneumonia detection hassle. The X-rays for the training and experiment purpose was from 'Guangzhou Women and Children's Medical Center' [36].

The proposed pneumonia detection algorithm by Bingchuan Li et al (2019) contains three main parts. CXR image pre-processing, Lung ROI segmentation with transmission learning, Designing an automatic detection model for pneumonia in CNN. The SENet design is used to power the complete convolutional neural network architecture. The SE-ResNet34 architecture was introduced as a backbone for feature extraction [15].

Sarang Mahajan et al in 2019, proposed a study to detect pneumonia by using a transfer learning approach. The dataset used was ImageNet dataset and ChexNet dataset. The author found that a fine tunned CNN provides better performance as compared to CNN model trained from scratch. The finely tuned network trained on ImageNet dataset got the better accuracy as compared to CNN model which is developed from the scratch [17].

In 2019, M. J. Tsai et al used machine learning for pneumonia detection. The algorithm proposed by the author has 144 layers convolutional neural system which is trained on chest x-ray images. The dataset contains over 1,00,000 frontal view chest x-ray images. In which all 14 diseases are covered. The accuracy achieved by the algorithm was 80.90% [18].
The Z. Knok et al (2019), built a model that receives X-ray images as information, this proposed model processes the information images resulting in detection of possible pneumonia. The datasets evaluating this model were collected from the Kaggle. This proposed feature incorporated into the motion learning system relies on an effectively characterized neural system design. This study produces surprisingly good results on the dataset. The model was later aligned with the advances used to produce web applications using the Flask Structure [19].
In 2019, A. K. Jaiswal et al, proposed algorithmic approach for identifying potential pneumonia causes is devised by Faster-RCNN. Also tried several other object detection techniques such as You Look Only Once (YOLO3) and U-Net image detection architectures but it fails to produce better predictions, from the tests and found that Mask-RCNN performing better in prediction tasks [37].
In 2019, I. Sirazitdinov et al suggested their evaluation based on two neural networks Retina Net and Mask R-CNN for pneumonia discovery and restriction. On a dataset of 26,684 images from the Kaggle pneumonia discovery challenge, the following methodology was used. Our ability to accurately analyse instances with pneumonia susceptibility, deformation areas, and liquid supply is made possible by the results drawn from this research [25].
In 2019, H. Ko et al, proposed ensemble of model. One-stage detectors such as YOLO and SSD deal with item detection as a simple regression trouble. Two-stage detectors which include R-CNN have complex community structure due to the fact they generate bounding field proposals and subsequent pixels. The dataset for this test is a subset of the NIH dataset, that's available from the Kaggle [35].
Author G. Liang et al (2019) presented an automatic diagnostic device that classifies children's chest X-ray photographs into regular and pneumonia. The proposed technique has been evaluated for extracting texture features related to pneumonia and for appropriately figuring out the overall performance of areas of the image that exceptional imply pneumonia. The dataset used was by Kermany et al. The experimental results of the check dataset display that the recall rate of the method on kids' pneumonia category assignment is 96.7%, and the f1-score is 92.7% [34].

To identify pneumonia more precisely, compressed sensors are used in several medical imaging modalities and deep learning systems. In a 2019 study, S. R. Islam et al persuaded medical specialists to suggest a condensed sensor-based deep learning framework for automatic detection of pneumonia on radiographs. 5863 Images are there in a Dataset. Two-part x-rays are available on Kaggle website. It comprises all of the datasets that were utilised in this work. This work demonstrates that DL employing the CS frame can diagnose pneumonia more correctly with fewer observations than traditional techniques [26].

We should be able to detect pneumonia infection at its beginnings because it can harm many people of any age. M. Togacar et al (2019) proposed their work as a solution to this problem. Convolutional neural network was used by the author to extract features from X-Ray images. This study enhances the accuracy of pneumonia early diagnosis. Chest X-ray images of fully participating patients provided the data set used for the analysis [27].

Then H. Sharma et al (2020) has developed Deep Convolutional Neural Network (CNN) Architecture to extract the features from chest x-ray images and then classifying whether the person is affected with pneumonia or not. Here authors have proposed two CNN Architectures - one with a dropout layer and another without a dropout layer. Both architectures consist of max pooling layers, convolution layers, and classification layers. Max pooling and Convolutional layers are used together as a feature extractor. ReLu activation function is used here. Then the features extracted are fed as an input to the dense layer, duty of dense layer is to classify the images. However, before dense layer here they have used flatten layer. After that, flatten layer flattens feature images and provides a one-dimensional output that a dense layer will accepts. The dataset used by author is taken from the Kaggle. Images are resized to 64×64 so that all the images fed to the CNN should be of the same size. Amongst different models with combination of Augmentation and Dropout, the CNN with dropout layer trained on augmented data performs the excellent than other models [3].

In 2020 Bonaventure F. P. Dossou et al also proposed a modern approach for Intelligent Pneumonia Detection and Integration. The dataset used was from Kaggle [38].

To improve the efficiency and accuracy of diagnostic services, Computer-Aided Diagnostic (CAD) system is developed by Tatiana Gabruseva et al for-pneumonia detection. The dataset used is National Institute of Health Chest X-Ray by US National Institutes of Health Clinical Centre. The accuracy of the model is 96.84% [4].

The author N. Mahomed et al has developed CAD software named CAD4Kids for chest radiography in children. CAD4Kids has got a sensitivity of 76% and Specificity of 80% for detecting primary end point pneumonia on chest X-ray images. The CAD4Kids software was developed between 2015 and 2017 by the PERCH team in South Africa and the image diagnostic analysis group of the Department of Radiology in the Netherlands. These groups performed immersive CAD work on chest radiographs in adults, but not in children below the age of 5 years. CAD4Kids uses texture analysis to assign each lung field location a probability of belonging to the primary endpoint pneumonia region. This CAD4Kids software performed better as compared to Radiologist [9].

In 2020, J. Garcia et al, an automated tool or simply software can be created that uses the pre-trained weights of the Xception network on ImageNet as initialization. This tool got a very good result. While developing a model we generally refer to four main performance measures –Recall, Precision, F-1 Score and Area under the ROC curve and this tool got Recall (0.99), precision (0.84), F-1 Score (0.91) and Area under the ROC curve (0.97). These positive results allow us to consider this tool to detect pneumonia as an alternative in countries which lacks in equipment and specialized radiologists [10].

A Deep Learning framework was proposed by V. Chouhan et al in 2020 to detect pneumonia using a Transfer Learning method. In this approach, various neural network models trained on ImageNet are used to extract features from images, and the output is passed to a classifier for prediction. Here, five different models are created and their performance is analysed. An ensemble model is then proposed that combines the results of all models, which outperforms the individual models, and can finally be used to detect pneumonia. The accuracy obtained by the ensemble model is 96.4% and recall of 99.62% [11].

Here G. Labhane et al has developed CNN model to detect pneumonia. The authors have developed the basic CNN (Convolutional Neural Network), VGG19, VGG16, InceptionV3 were constructed using CNN and transfer learning methodologies. The new capabilities get added to proposed CNN model using transfer learning. The proposed model was trained on paediatric specialty pneumonia dataset which consists of 2992 pneumonia affected chest-x ray images as well as 2972 normal chest x rays. The results obtained were tested on 854 abnormal and 849 normal images. They achieved an accuracy of 92.8% with a sensitivity of 93.2% and a specificity of 90.1% [13].

Author Ansh Mittal et al, in year 2020, proposed a new way for detection of pneumonia. The main goal of the author was to tell whether the person is having the pneumonia or not by applying

the Arrangement methods on the patients CXR images and by using calculations. The dataset which contains the 5857 CXR images were taken from Mendeley and the dataset is divided into two classes - "Normal" and "Pneumonia" [20].

Abdullah-Al Nahid et al in 2020, Used the multi-channel Convolutional Neural System for identification of Pneumonia. The author used the principal strategies of Advanced Picture Preparing and Transfer learning for analysing the Pneumonia. Dataset was taken from Kaggle, provided by Paul Mooney [23].

A research study that used X-Ray images to identify pneumonia then indicated using a convolutional neural network. As of late in (2020), Rachna Jain et al introduced this research, where they created a system that can classify the images into pneumonia and non-pneumonia groups. The Kaggle website was used to collect the dataset used in this model. The system is increasingly used for application. This research shows that the introduced models are extremely reliable and accurate. Later, the mediator makes a point to enhance the grouping of their introduced models [24].

In the year 2020, Venkata et al also used the deep learning for end-to-end detection of pneumonia and also for the lung cancer. The dataset used by the author is taken from the National Institutes of Health (NIH) Chest X-ray. Hence by using deep learning approach the author proposed the System which is Cost Effective according to the Author for detection of pneumonia and also for detection of lung cancer. The accuracy obtained by the system is 90%. In future research this system can be used in other lung diseases also [22].

In the same year (2020), Peter T. Habib et al developed the Convolutional neural network-based system to identify the visual symptoms from Chest X-ray image for pneumonia and from that can make the diagnostic decision. The dataset used by the author is taken from Kaggle which contains 5844 Chest x-ray images of pneumonia affected and of normal person. The accuracy obtained by the system was 84%. The accuracy obtained is acceptable and in future the accuracy can be increased by working more on it [21].

In 2020, T. Rahman et al proposed automatic method for detection of bacterial and viral pneumonia using the digital x-ray images. The dataset used was from Kaggle [39].

The N. Habib et al in 2020 has mainly focused on X-ray Pneumonia Detection with Deep Learning and developed a web application mainly used to identify the presence of pneumonia from a dataset of chest radiographs. In this research the author has use used ensemble-based approach such that VGG-19 and CheXNet are trained to extract features from chest X-Ray images. Build a convolutional neural network (CNN) model that extracts highlights from a given chest x-ray and groups them to determine whether they have pneumonia. The author states that the proposed framework is suitable and convenient for him to use and can be used anywhere with a working internet connection. It's typically used everywhere and there's no compelling reason to wait in queues. Results are accurate. The model achieves an average AUC (Area under the ROC Curve) value of 98.94% [30].

Pneumonia can be detected by many of the different methods. Detection of Pneumonia in early phase has played crucial role in diagnosis of pneumonia as early as possible. in this research S. K. Venu has used transfer learning method for detection of pneumonia. In general, we can say about transfer learning, in which the model is trained on some other problem can be used in some related problem. So, by using transfer learning we can improve learning and detection of model. The author has used transfer learning by Combining of other methods and reduces the time and minimizes the errors in the way of detecting pneumonia form X-Rays. In this research the author has used dataset by Kermany et al. They had trained advanced models such as ResNet152V2, DenseNet201, MobileNetV2, Xception, InceptionResNet so that the classification of pneumonia can be possible more quickly. In this study, author proposed a weighted regular costume model by fine-tuning the design of deep transfer learning to improve the classification performance measures. So that we can get accuracy up to the 98% accuracy for pneumonia detection [28].

In this research Sammy V. Militante et al have mainly focused on correct diagnosis, Misdiagnosis as well as inaccurate treatment and ignoring of this may cause death. They had mainly focused on recognition and prediction of persons which are affected by pneumonia and as well as not affected by pneumonia. Author employed six CNN models namely ResNet-50, VGG-16, GoogleNet, AlexNet, StridedNet, and LeNet with the help of X-Ray image as input. This work also implemented Adam as an optimizer for tuning the learning rate and used 500 epochs for all models. The author has used dataset of Radiological Society of North America (RSNA) in which 28,000 chest X-Ray images are present. Both LeNet and GoogleNet achieved 98% accuracy, VGGNet-16 achieved 97% accuracy, AlexNet and StridedNet models achieved 96%, ResNet-50 model achieved 80% [31].

In 2020, Khan Maseeh Shuaib et al build the CNN (Convolutional Neural Network), in which features are extracted but author mainly focused on best features then it performs grouping such that to decide whether the particular person affected with pneumonia or not. The authors state that the proposed framework is easy to use, convenient, and can be

used anywhere if there is a working internet connection. The author has developed model which is based on web application to detect presence of pneumonia in chest X-Ray images. they had used dataset which is publicly available chest X-ray dataset. The proposed framework was compared with several machine learning methods and found to be more efficient in prediction with an average accuracy of 84% [32].

In 2021, Puneet Gupta has used Vgg16 and Vgg19 transfer learning methods for comparing model accuracy. The author built his CNN model from scratch, trained on her Kaggle dataset of chest X-rays (pneumonia). VGG16 gave 92% validation accuracy and 97% training accuracy. VGG19 yielded 89% validation accuracy and 95% training accuracy. Also, the model we built had a validation accuracy of 93% and gives a training accuracy of about 99%. The architecture follows fully interconnected layers and SoftMax activation. Feature extraction consists of input images, convolution, and max pooling, whereas classification involves fully interconnected layers and outputs [6].

The author D. Zhang et al introduced a simple VGG based model architecture with low number of layers. In addition, the Dynamic Histogram Enhancement technique is used to pre-process the images to address the lack of contrast in chest radiographs leading to ambiguous diagnoses. The dataset used is taken from Kaggle. The performance of the model in pneumonia detection shows that the proposed VGG-based model indeed can effectively classify normal and abnormal X-rays, reducing the burden on radiologists [16].

In 2022, A. Mabrouk et al, proposed a new neural network called ensemble learning, built by training CNN models using transfer learning methods. To achieve this goal, authors trained CNN MobileNet, DenseNet and Vision Transformer methods to detect pneumonia on chest radiographs. The information set become provided through Kermany and Goldbaum and based on a chest X-ray scan photos from pediatric patients from one to 5 years of age at the Guangzhou women and youngster's medical center [40].

The Alassery Fawaz et al (2022) are presenting a prototype of A mobile application that uses neural networks to help medical staff diagnose pneumonia from a patient's chest x-ray. The model created for detection of Pneumonia is created with the help of Create ML, which is a high-level tool used for creating different machine learning models and which eliminates challenges such as choosing the number of layers required for a neural network, initializing model parameters or algorithms used. After training the model we have got the accuracy of approximately 85% [5].

Sr. No.	Year	Author	Methods / Approach	Dataset	Results
1	2018	Xianghong Gu et al [29]	CAD, DCNN	Guangzhou Women and Children's Medical Centre China and JSRT	Classification Of Viral and Bacterial Pneumonia
2	2019	Abdullah Faqih Al Mubarok at al [1]	CNN	RSNA's Kaggle Dataset	Pneumonia Detection
3	2019	D. Varshni et al [2]	CNN	Kaggle Dataset (Chest X-ray 14)	Detection of Pneumonia
4	2019	O. Stephen et al [12]	CNN, Transfer Learning	Kaggle	Detection of Pneumonia
5	2019	I. Sirazitdinova et al [14]	RetinaNet and Mask R-CNN	Kaggle	Detection and Localization Pneumonia
6	2019	B. Li et al [15]	SE-ResNet34, Transmission Learning	Kaggle	Detection of Pneumonia
7	2019	S. Mahajan et al [17]	Transfer Learning	Kaggle	Detection of Pneumonia
8	2019	M. J. Tsai et al [18]	CNN	Kaggle	Detection of Pneumonia, Accuracy – 80.90%
9	2019	Z. Knok et al [19]	CNN/ Transfer learning	Kaggle	Accurate detection through model.
10	2019	S. R. Islam et al [26]	CNN	Kaggle	Identification and automatic detection of Pneumonia
11	2019	B. Ergen et al [27]	CNN	Kaggle	Detect Pneumonia Infection
12	2020	H. Sharma et al [3]	CNN	Kaggle	Classification of Pneumonia
13	2020	Alexandr A. Kalinin et al [4]	CAD	National Institute of Health Chest X-ray	Diagnosis of Pneumonia, Accuracy – 96.84%
14	2020	N. Mahomed et al [9]	CAD	Kaggle	Detection of Pneumonia
15	2020	J. Garcia et al [10]	CNN	Kaggle	Recall (0.99), F-1 Score (0.91), Precision (84.84), ROC curve (0.97)
16	2020	V. Chouhan et al [11]	Transfer Learning	Kaggle	Detection of Pneumonia, Accuracy (96.4%), Recall (99.62%)
17	2020	G. Labhane et al [13]	CNN, Transfer Learning	Kaggle	Accuracy (92.8%)
18	2020	A. Mittal et al [20]	CNN	Kaggle	Detection of Pneumonia
19	2020	A. Nahid et al [23]	CNN, Transfer Learning	Kaggle	Detection and analysis of Pneumonia
20	2020	R. Jain et al [24]	CNN	Kaggle	Identification of Pneumonia
21	2020	F. M. J. Ebiele et al [22]	CNN	National Institute of Health (NIH) chest x-ray	Pneumonia and Lung Cancer detection, Accuracy (90%)
22	2020	P. Habib et al [21]	CNN	Kaggle	Diagnosis of Pneumonia, Accuracy (84%)
23	2020	N. Habib et al [30]	VGG-19, CNN, CheXNet	Kaggle	Detection of Pneumonia, Accuracy (98.94%)
24	2020	S. K. Venu et al [28]	Transfer Learning	Kaggle	Classification of Pneumonia, Accuracy (98%)
25	2020	S. V. Militante et al [31]	CNN	Radiological society of North America (RSNA)	Accuracy (98%)
26	2020	K. M. Shuaib et al [32]	CNN	Kaggle	Detection of Pneumonia, Accuracy (84%)
27	2021	Puneet Gupta [6]	Transfer Learning, CNN	Kaggle	Accuracy (92%)
28	2021	D. Zhang et al [16]	VGG	Kaggle	Detection of Pneumonia
29	2022	Alhazmi Lamia et al [5]	CNN	Kaggle	Detection of Pneumonia, Accuracy (85%)
30	2022	Alhassan Mabrouk et al [40]	CNN	Guangzhou Women and Children's Medical Centre	Detection of Pneumonia

III. CONCLUSION

From the above literature survey, we can conclude that, Deep Learning can really help us in Detection of Pneumonia from chest X-ray images which will help us to start the early treatment for the Pneumonic Patients which will help us in saving many lives. Large numbers of X-ray images can be

processed very quickly to produce highly accurate diagnostic results, helping healthcare systems provide efficient patient care and reduce mortality. Most of the authors have used Deep Learning approach for Detection of Pneumonia. Also, many authors have used Transfer Learning approach for Detection of Pneumonia. The future scope for the Pneumonia Detection Models can be like Highlighting the Area from the Chest X-ray image where the symptoms of the Pneumonia are present and also from that area it is possible to get the Percentage of the Affection or the Percentage of Area affected.

REFERENCES

[1]. Abdullah Faqih Al Mubarok, Dominique Jeffrey A. M., Ahmad Habbie Thias, IEEE 2019, "Pneumonia Detection with Deep Convolutional Architecture".
[2]. D. Varshni, K. Thakral, L. Agarwal, R. Nijhawan, A. Mittal, IEEE 2019, "Pneumonia Detection Using CNN based Feature Extraction".
[3]. H. Sharma, J. S. Jain, P. Bansal, S. Gupta, IEEE 2020, "Feature Extraction and Classification of Chest X-Ray Images using CNN to Detect Pneumonia".
[4]. Alexandr A. Kalinin, Tatiana Gabruseva, Dmytro Poplavskiy, IEEE 2020, "Deep Learning for Automatic Pneumonia Detection".
[5]. Alhazmi Lamia, Alassery Fawaz, Hindawi 2022, "Detection of Pneumonia Infection by Using Deep Learning on a Mobile Platform".
[6]. Puneet Gupta, "Pneumonia Detection Using Convolutional Neural Networks", International Journal for Modern Trends in Science and Technology, Vol. 07, Issue 01, January 2021.
[7]. J. Anthony G. Scott, W. Abdullah Brooks, J.S. Malik Peiris, Douglas Holtzman, and E. Kim Mulholland, The Journal of Clinical Investigation April 2008, "Pneumonia Research to Reduce Childhood Mortality in the Developing World".
[8]. P. Rajpurkar, J. Irvin, K. Zhu, B. Yang, H. Mehta, 2017 "CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning".
[9]. N. Mahomed, B. V. Ginneken, Rick H. H. M. Philipsen, J. Melendez, D. P. Moore, S. A. Madhi, Springer 2020, "Computer aided diagnosis for World Health Organisation-defined chest radiograph primary-endpoint pneumonia in children".
[10]. J. Garcia, C. Marquez, Y. Rey, and O. Nieto, Applied Sciences 2020, "A Transfer Learning Method for Pneumonia Classification and Visualisation".
[11]. V. Chouhan, S. Singh, A. Khamparia, D. Gupta, P. Tiwari, Applied Sciences 2020, "A Novel Transfer Learning Based Approach for Pneumonia Detection in Chest X-ray Images".
[12]. O. Stephen, M. Jain, U. Maduh, D. Jeong, Hindawi 2019, "An Efficient Deep Learning Approach to Pneumonia Classification in Healthcare".
[13]. G. Labhane, R. Pansare, S. Maheshwari, R. Tiwari, A. Shukla, IEEE 2020, "Detection of Pediatric Pneumonia from Chest X-Ray Images using CNN and Transfer Learning".
[14]. I. Sirazitdinova, M. Kholiavchenkoa, T. Mustafav, Y. Yixuanc, R. Kuleeva, B. Ibragimov, Elsevier 2019, "Deep neural network ensemble for pneumonia localization from a large-scale chest x-ray database".
[15]. B. Li, G. Kang, K. Cheng and N. Zhang, IEEE 2019, "Attention-Guided Convolutional Neural Network for Detecting Pneumonia on Chest X-Rays".
[16]. D. Zhang, F. Ren, Y. Li, L. Na and Y. Ma, Electronics 2021, "Pneumonia Detection from Chest X-ray Images Based on Convolutional Neural Network".
[17]. S. Mahajan, U. Shah, R. Tambe, M. Agrawal, B. Garware, IEEE 2019, "Towards Evaluating Performance of Domain Specific Transfer Learning for Pneumonia Detection from X-Ray Images".
[18]. M. J. Tsai, Y. H. Tao, IEEE 2019, "Machine learning based common radiologist-level pneumonia detection on Chest X-Rays".
[19]. Z. Knok, K. Pap, M. Hrncic, Research Gate 2019, "Implementation of Intelligent Model for Pneumonia Detection".
[20]. A. Mittal, D. Kumar, M. Mittal, T. Saba, I. Abunadi, A. Rehman, S. Roy, Sensors 2020, "Detecting Pneumonia using Convolutions and Dynamic Capsule Routing for Chest X-ray Images".
[21]. P. Habib, A. M. Alsamman, S. E. Hassanein and A. Hamwieh, Bio Science 2020, Volume 3, "Developing Convolutional Neural Networks-Based System for Predicting Pneumonia Using X-Radiography Image".
[22]. F. M. J. Ebiele, T. A. Narh, S. R. T. Djiokap, E. P. Adzri, M. Atemkeng, 2020, "Conventional machine learning based on Feature Engineering for detecting pneumonia from chest x-rays".
[23]. A. Nahid, N. Sikder, A. K. Bairagi, Md. A. Razzaque, M. Masud, A. Z. Kouzani and M. A. P. Mahmud, Sensors 2020 "A Novel Method to Identify Pneumonia through Analyzing Chest Radiographs Employing a Multichannel Convolutional Neural Network".
[24]. R. Jain, P. Nagrath, G. Kataria, V. S. Kaushik and D. J. Hemanth, 2020, "Pneumonia Detection in Chest X ray Images using Convolutional Neural Networks and Transfer Learning".
[25]. I. Sirazitdinov, M. Kholiavchenko, T. Mustafaev, Y. Yixuan, R. Kuleev, B. Ibragimov, Elsevier 2019, "Deep Neural Network ensemble for pneumonia localization from a large-scale chest x-ray database".
[26]. S. R. Islam, S. P. Maity, A, K. Ray and M. Mandal, IEEE 2019, "Automatic Detection of Pneumonia on Compressed sensing Images using Deep Learning".
[27]. B. Ergen, Z. Comert, M. Togacar, Elsevier 2019, "A deep feature learning model for pneumonia detection applying a

combination of mRMR feature selection and machine learning model".

[28]. S. K. Venu, 2020, "An ensemble-based approach by fine-tuning the deep transfer learning models to classify pneumonia from Chest X-ray images".

[29]. X. Gu, L. Pan, H. Liang, R. Yang, 2018, "Classification of Bacterial and Viral Childhood Pneumonia Using Deep Learning in Chest Radiography".

[30]. N. Habib, Md. M. Hasan, Md. M. Reza, M. M. Rahman, Springer Nature 2020, "Ensemble of CheXNet and VGG-19 Feature Extractor with Random Forest Classifer for Pediatric Pneumonia Detection".

[31]. S. V. Militante, N. V. Dionisio, B. G. Sibbaluca, IEEE 2020, "Pneumonia Detection through Adaptive Deep Learning Models of Convolutional Neural Networks".

[32]. K. M. Shuaib, S. A. Shahid, A. A. Javed, M. Zaid, 2020, "Pneumonia Detection through X-Ray Using Deep Learning".

[33]. Jameson Merkow, 2018, "Pneumonia Detection in Chest Radiographs".

[34]. G. Liang, L. Zheng, Elsevier 2019, "A transfer learning method with deep residual network for Pediatric pneumonia diagnosis".

[35]. Heewon Ko, Hyunsoo Ha, Hyuna Cho, Kiwon Seo, Jihye Lee, IEEE 2019, "Pneumonia Detection with Weighted Voting Ensemble of CNN Models".

[36]. Raheel Siddiqi, 2019, "Automated Pneumonia Diagnosis using a Customized Sequential Convolutional Neural Network".

[37]. Amit Kumar Jaiswal, Prayag Tiwari, Sachin Kumar, Deepak Gupta, Ashish Khanna, Joel J.P.C. Rodrigues, Elsevier 2019, "Identifying pneumonia in chest X-rays: A deep learning approach".

[38]. Bonaventure F. P. Dossou, Alena Iureva, Sayali R. Rajhans, Vamsi Sai Pidikiti, 2020, "An Approach to Intelligent Pneumonia Detection and Integration".

[39]. Tawsifur Rahman, Muhammad E. H. Chowdhury, Amith Khandakar, Khandaker R. Islam, Khandaker F. Islam, Zaid B. Mahbub, Muhammad A. Kadir, Saad Kashem, Applied Sciences 2020, "Transfer Learning with Deep Convolutional Neural Network (CNN) for Pneumonia Detection using Chest X-ray".

[40]. Alhassan Mabrouk, Rebeca P. Díaz Redondo, Abdelghani Dahou, Mohamed Abd Elaziz and Mohammed Kayed, Applied Sciences 2022, "Pneumonia Detection on Chest X-ray Images Using Ensemble of Deep Convolutional Neural Networks".