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# LITERATURE REVIEW ON X-RAY BASED PNEUMONIA DETECTION USING MACHINE LEARNING AND DEEP LEARNING METHODS

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**ABSTRACT—** Artificial intelligence has proven to be an effective way in the detection of many diseases. This study presents a literature review of artificial intelligence techniques used in the detection, classification and visualization of pneumonia disease in lungs using radiographs of chest. In this review, different reliable databases were searched including research gate, ELSEVIER, Applied sciences and IEEE. Pneumonia is a fatal sort of malady on the off chance that we truly couldn't care less. If we don't diagnose it in its early stages it can be responsible for 50000 deaths every year [59]. There are two kinds of pneumonia: viral and bacterial. Many researchers have done their research for the identification of pneumonia using machine learning and deep learning methods. This study gives you an overview of the machine and deep learning methods proposed previously for the pneumonia detection. The review is structured based on Deep learning, transfer learning and machine learning methods using chest x-rays images for the early identification of pneumonia. The main objective is to find the limitations of the previous studies and suggestions for the future work.

**Keywords—** Artificial intelligence, classification, mask-RCNN, CNN, deep learning, transfer learning.

## I. INTRODUCTION

Pneumonia is actually a lung infection mainly caused due to variety of organisms like viruses bacteria etc. when this infection caught the victim the wind pipe (air sacs) of patient become inflamed and pus filled up in air sacs. All over the world pneumonia is at the top of those diseases which are causing death over the world. Every year more than 50000 people mostly old age become dying because of pneumonia [59]. All this is due to the lack of early diagnosis of disease. Therefore it's not possible to recognize or identify the disease by just looking at the X-Ray there were many methods and techniques introduced in the previous studies by the help of Artificial intelligence [1-58].

Artificial Intelligence (AI) is a vast field of machines equipped for performing task that commonly provide human knowledge. It is the pledge to reproduce or generate human knowledge in machines.

With mechanized location, radiologists see pictures dependent on perusing need which velocities detailing and improves persistent results. With the expansion of recovery benefits, the AI pulls comparable pictures from a database for survey when it experiences strange or complex cases.

Mostly the chest X-Ray is being used all over the world for the detection of that infection by applying different methods on it. In this paper we have presented a review on the all AI methods and techniques used in detection of pneumonia. AI is a vast field and all the methods related to AI are working on medical imaging are giving amazingly good results. For example digital image processing is a very efficient and reliable method in the classification and identification of the disease. Mask-RCNN, Deep learning, neural network, Transfer learning, CNN are being discussed in this paper. If we put a look on these techniques deep learning is used extensively than other ones and its accuracy rate is also higher as well as Convolutional neural network that inputs a chest X-beam picture and gets the probability of pneumonia beside a heat map restricting the zones of the picture generally characteristic of pneumonia [13]. Except these there is much computer software that helps in automatic recognition of pneumonia and the utilization of PC calculations in the field of AI to robotize the way toward acquiring the most precise analysis, which could diminish the chance of blunders and misdiagnosis that can prompt undesirable outcomes [14].

### 1.1 Background

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Symptoms of pneumonia were first portrayed by the Greek doctor Hippocrates around 460 BC. Despite of the reality that it conveyed numerous names and was frequently distinguished as a normal illness, in the 19th century scholars identified by their research that it is not only infection however a disease itself. It is a lung disease. It causes the air sacs of the lungs to top off with liquid or discharge. It can go from mellow to serious, contingent upon the sort of germ causing the disease, your age, and your general wellbeing. Most commonly used data for the detection of pneumonia used is X-ray as well as Ultrasound images also helps in this regard. In spite of these CT images are also used but CT images take more time CXT and there is not enough CT scanners available in the underdeveloped countries. That's why CXT is the cheapest way of detecting pneumonia. There are mostly two types of pneumonia bacterial pneumonia and viral pneumonia.

The difference between normal and infected X-ray are shown below respectively

The difference between normal and infected X-rays are shown below respectively.

**Figure 2**

**Figure 1** [images are taken in the real time from Nishtar Hospital Multan]

**Bacterial pneumonia**

In bacterial type of pneumonia lungs inflammation occurs due to bacterial infection and it could be in one lung, both lungs or could be in a section of lung. In viral type of pneumonia air sacs are infected and patient feels difficulty in his wind pipe.

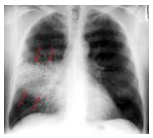

**Figure 4 Bacterial** **Figure 3: viral**

**Viral Pneumonia**

Infection that is caused by virus is called viral infection and the pneumonia caused by virus called viral pneumonia. Viral type of pneumonia commonly caused by flue or even cold. Viral pneumonia spreads in three parts viruses caught the upper part of repertory system first and then enter into your lungs and then effects victim's lung.

**Symptoms**

Muscle pain, fever, dry cough, loss of appetite, throat get sore and headache are the early symptoms of pneumonia. Always in these types of conditions we should don't get panic and take normal medicine which is our first mistake.

**1.2 Datasets**

The dataset that are used and processed by previous works had their worth as discussed below.

**Kaggle dataset**

Kaggle is a website that allows user to use their dataset work on it and explore it for future research. In this dataset there are three folders named train, test and val as well and their sub folders contains two types which are of normal and pneumonia images [14].5216 images included for training and 624 images included for the purpose of training. Grayscale images 64x64 dimensions are given [15].

**Guangzhu women and children Medical Centre**

A pediatric CXT dataset has been presented by the centre of Guangzhu to improve the development in the department of disease detection. Patients routine care clinical data of 1 to 5 years old gathered as well and their quality has been checked for the quality control and all the low quality data also unreadable data has been detected [3]. In [6] dataset contains 5232 images including 1345 of normal category 3883 were of infected with pneumonia.

5232 images were used in [31] where 2538 were bacterial pneumonia and images of viral pneumonia were 1345.

**Indiana kit**

In [16] dataset was used collected trough Indiana university and medicine school and that dataset contains 7470 X-Rays.

**Kit dataset**

In that dataset from the total of 10484 images there were 3828 were abnormal cases and 7020 image data was normal images data.

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**Kermany dataset**

For the evaluation and testing of the proposed methods dataset of kermany were used [24]. That was a scanned dataset of pediatric patients. 5856 total images were used. This dataset included its own test sets of 234 normal and 390 of infected images [37].

## II. LITERATURE REVIEW

This survey is categorized into two major AI divions machine learning and deep learning. Further methods of machine learning and deep learning are explaining below.

Machine learning is a subfield of artificial intelligence (AI). The goal of machine learning generally is to understand the structure of data and fit data into models that can be seen and utilized by people. In machine learning tasks are by and large characterized into supervised and unsupervised. These classifications depend on how learning is gotten or how criticism on the learning is given to the framework created [21].

There are two main machine learning methods

1. **Supervised learning methods**

Supervised learning method trains algorithm which are based on examples and labelled data the unsupervised method come up with no labelled data [21].

There are following supervised learning methods which we have discussed over:

- Support vector machine
- Linear Regression
- Logistic Regression
- Naïve Bayes
- Linear discriminant analysis
- Decision Tree
- K-nearest neighbor algorithm
- Neural Networks
- Similarity learning [60]

2. **Unsupervised learning method**

Following are the unsupervised methods form which we have discussed some in our survey:

- K-means for clustering problems
- Apriori algorithm for association rule learning problem
- Principle component Analysis
- Singular Value Decomposition
- Independent component analysis [61]

Deep learning is a subset of machine learning where artificial neural networks, calculations motivated by the human brain, gain from a lot of information. Additionally to how we gain for a reality, deep learning count would play out a task on and on each time tweaking it a little to improve the outcome so that teaches the computers to do what falls into place without any issues for people [21].

Learning from the Deep Learning perspective is a technique for developing the activities dependent on information and experience. Deep Learning is an artificial intelligence and machine learning subgroup which grows the yield of innumerable machine learning applications like AI [57].

There are following deep learning methods used in different researches:

- Convolutional Neural Network (CNN)
- Recurrent Neural Network (RNN)
- De-noising auto encoder (DAE)
- Deep belief Networks (DBN's)
- Long Short Term memory (LSTM)

**Deep learning**

As we know deep learning is very well known method in used in AI. There are many researchers in [1,5,7,9,10-16] who works for pneumonia detection using deep learning methods. Jae Hyun Kim et al takes advantage and used commercial deep learning in their research. An exploration on Clinical approval of a deep learning calculation for identification of pneumonia on chest radiographs in crisis division patients with intense febrile respiratory disease was proposed by Jae Hyun Kim et al (2020). Deep learning calculation is being utilized in this exploration to identify the pneumonia in crisis office patients. 377 sequential patients dataset were gathered and the calculation applied on their X-beam to recognize the pneumonia. This examination results that the proposed

calculation works productively and get pneumonia obvious on the chest x-beams [36].

### 1.1 Artificial Neural Network

For the identification of pneumonia there were numerous strategies presented yet Kh Tohidul Islam et al dealt with two models of ANN with deep transfer learning. They show that utilizing two individual pretrained models as highlight extractors and preparing an artificial neural system on these highlights is a compelling method to analyse pneumonia. CXR pictures dataset were utilized to perform tests of the recommended mode. This examination results by utilizing the linked highlights of these systems as sources of info, the presentation of customary classification strategies can be improved. Later on work creator propose we can utilize same methodology for other sickness like diabetes [20]. Shubhangi Khobragade et al (2016) were working on the major lung disease getting methods from artificial intelligence. Using AI techniques lung segmentation their feature extraction and classification has been done in this research. Chest radiographs data was used to apply the simple image processing techniques and after that AI techniques were applied to detect the lung disease automatically. This study concludes that pattern recognition techniques and other image processing techniques are very good to use in. There were some limitations in this research on which future work can be done because this proposed system was not compatible with the changes in position and size of chest x-rays [39]. Paul S. Heckerling et al (2014) presented their research in which they prove that genetic algorithms can adapt ANN to detect pneumonia because genetic algorithms utilizing an assortment of coding, recombination, mutation, and fitness-based selection systems developed ANN with boundaries improved for community-acquired pneumonia. For this research they use dataset of emergency department patients [43]. ]. As well as machine learning methodologies implemented on the mobile phone apps to assist the physicians in the diagnosis process. Andrew Elkins et al presented their research and developed an app by using an artificial neural network to assist the physicians in their diagnostic. That is a simple and easily portable way in diagnostic process but that is not enough for the serious some situations [47].

### 1.2 Convolutional Neural Network

In the previous researches Bing Chuan Li et al (2019) introduced a frame work for detecting pneumonia on chest X-Ray by suppressing the non-pneumonia area and reducing noise to detect pneumonia. For this datasets were obtained from 8,964 pneumonia labelled chest X- Ray images and the remaining 20,025 non-pneumonia chest X- Ray images. The study results the end to end identification model can undoubtedly be deceived to predict all the more bogus positive examples because of the variety and complexity of CXR pictures [1].

Pneumonia is a disease which kills around 50000 [59] people each year globally therefore adequate treatment and cure for this is must be made important for precaution of the unnecessary deaths [60]. Therefore Sabyasachi Chakraborty et al presented their work in which they analysis on the chest x-rays by distinguishing the spatial situation of the initiations that prompted the discovery of pneumonia in chest X-rays. The dataset contains 5856 chest X-ray images of different directions. By using these dataset the Convolutional neural network designed their work in which the use Adam improvement algorithm which tends to much time and computationally proficient than different algorithms. This research tried to obtain some of the state of the art results for the detection of pneumonia using chest X-rays. For the detection purpose convolution neural network architecture was leveraged which allowed us to obtain the spatial significance of the data in the images to correctly classify the chest X-rays to be prone of pneumonia or not [5].

Compressed sensing is used in different medical imaging and a deep learning framework that empower detection of pneumonia more accurately Sheikh Rafiul Islam et al (2019) presents a paper in which they suggest a compressed sensing based deep learning framework for automatic detection of pneumonia on X-Ray images to insist the medical practitioners. All the datasets used for this work was obtained from kaggle which contains 5863 X-Ray images of two categories. This study shows that the working of DL in CS framework minimize the needed observations for detecting pneumonia

with wanted accuracy compared to the conventional method [7]. Cadrin et al proposed an architecture that was based on deep Convolutional neural networks. The RSNA pneumonia detection of 2018 were diverse several common features were seen. The two solutions given in this paper leveraged transfer learning. The datasets were given by Institutes for health clinical centre. These study results effective applications of modern deep learning techniques as well as insights into the labelling process of the image data were critical for success in the RSNA pneumonia detection challenge [10]. George Thomas et al (2018) discloses to us that how might we identify pneumonia by utilizing CNN techniques just as group the viral bacterial pneumonia based on perception and assessment in CNN. For usage of this technique Pediatric CXRs dataset were utilized. This examination results that by applying CNN-put together choice emotionally supportive network with respect to the dataset we can identify and recognize various kinds of pneumonia [11].

However "Željko KNOK" et al build up a model of insightful framework that gets X-Ray pictures as information and this proposed model handled the information picture and in yield the conceivable recognition of pneumonia will return. The dataset to assess this model was gathered from Kaggle site. This proposed functionality embedded by move learning system dependent on effectively characterized neural system design. This examination results amazingly great outcomes on the approval dataset. The model was later coordinated with the advances used to fabricate web applications utilizing the Flask structure [14]. After that a research proposed Convolutional neural system to identify pneumonia by utilizing X-beam pictures. Rachna Jain et al as of late in (2020) introduced this exploration where they prepared the system which can group the pictures into pneumonia and non-pneumonia classification. Dataset for the usage of this model were gathered from Kaggle site. The system is utilized progressively application. This investigation results that the introduced models are profoundly precise and steady. The moderator points later on to improve the precision of grouping of their introduced models. Accuracy recall and F1 performance models were used [15].

Because of the trouble in distinguishing pneumonia Ashitosh Tilve et al (2020) utilize distinctive PC supported procedures just as give a model to defeat this issue. Creator recommends that procedures utilizing AI calculations have end up being more dependable. Creator attempts to take care of this issue by making a model for a solitary malady which is pneumonia and the utilization of a dataset with the nearness and nonappearance of a solitary ailment to stay away from bogus recognition. In that way image processing, t-SNE, VGG16 were applied and accuracy were 93.6% [16]. Numerous individuals at any of their age level can contract pneumonia infection so we should need to foresee it on its beginning phase. M. Togacar et al (2019) proposed their examination to manage this issue. Creator utilized Convolutional neural system as an element extractor of X-Ray pictures. This investigation results to improving the arrangement precision of pneumonia. Dataset comprised of Chest X-beam pictures of volunteer patients on which the analyses were performed on [17].

In 2020 Ansh Mittal et al proposed their exploration on the issue of pneumonia identification. The primary goal of the creator is to tell that the patient is experiencing pneumonia or not by applying calculation and arrangement methods on the patients CXR pictures. The mix of convolutions and cases is utilized to acquire two models that beat all models recently proposed. The dataset for experiments were gathered from Mendeley CXR picture to checkout climate the proposed techniques are substantial, solid or not [18]. After surveying many methods and techniques Alaa M. A. Barhoom et al (2019) used different deep learning method to ease the doctors in decision making of pneumonia while working with chest X-rays. Deep learning algorithms based on neural networks were implemented to detect pneumonia. X-Ray image dataset was used to implement the organized trained model. This study concludes outperformance is mostly due to the deep framework of CNN that uses the power of extracting different stage features, which resulted in a better generalization ability. As well as in the future addition of more data augmentation techniques can increase the productivity of training and use larger datasets to increase accuracy results [21]. Min-Jen Tsai et al (2019) introduced their examination on pneumonia location utilizing Machine learning. Creator proposed a calculation which was 144 layers Convolutional neural system prepared on chest X-Rays. Chest X-beams information were

gathered to put on the proposed calculation. Exactness pace of this examination was 80.90%. This examination infers that the proposed strategy is more solid and precise than past techniques [22].

Gaobo Liang et al (2019) were dealing with the finding of pneumonia. They proposed a deep learning system that joins remaining idea and enlarged convolution for the finding of kid pneumonia picture arrangement. ermany et al. dataset was utilized in this examination for try reason which means it combines residual thoughts and dilated convolution. Programmed indicative instrument was come about because of this examination which can arrange the ordinary and pneumonia pictures of youngsters naturally. This strategy can likewise be utilized to improve the neighbourhood clinical pictures in conclusion process as well as it can avoid the loss of feature space information [24].

Sarang Mahajan et al (2019) proposed their research on pneumonia discovery by transfer learning approach. They applied their work on two kinds of informational collection and look at them for the outcomes. The datasets were utilized ImageNet dataset and CheXNet dataset. They think about the two outcomes from pre prepared and after prepared. This investigation finishes up following a few focuses.

- A good tuned CNN provides better results than a CNN trained trough scratch.
- The proposed model only detects pneumonia not the subtypes.
- Classifiers quality can be increased.
- Because the focus is on the classification there is no segmentation for detection of pneumonia [25].

By dissecting chest radiographs and utilizing a multichannel Convolutional neural system Abdullah-Al Nahid et al (2020) proposed their exploration on pneumonia identification. In this research author attempts to analyze the pneumonia by utilizing the principle strategies of advanced picture preparing and transfer learning. On account of utilizing the dataset of pictures picture process takes lead job in that kind of exploration. Dataset was gathered from prestigious chest X-beam picture archive and examinations were performed on it. In the outcomes creator presumes that the huge picture contains more data than a little picture. In any case, picking the bigger pictures can expand your dataset size. The outcomes are better than the past recognized framework for pneumonia since it consolidates two unique arrangements of highlights extricated from each preparation picture. Loss evaluated trough Binary Cross Entropy and kullback- Leibler Divergence value [27]. By utilizing ResNet based transfer learning Naseem Ansari et al proposed their research on identification of pneumonia. In this exploration creators attempts to retrain the pre prepared ResNet 50 model by applying on two diverse dataset and utilizing deep learning. RSNA dataset with multiple times more pictures was utilized in the entire procedure. Precision pace of this examination is 96.76%. This investigation presumes this is precise model yet some improvents should likewise be possible in such manner [28].

Nishit Pareshbhai Nakrani et al (2020) proposed their examination on the discovery of pneumonia by utilizing deep learning techniques and 3CNN layers. The principle goal of creators was to make a classifier which can distinguish pneumonia from the chest-Xray of patients. They picked the dataset for this reason from the Kaggle site. The three diverse prepared models can recognizes the pneumonia from the frontal perspective on X-beam which was proposed in this exploration. This exploration presumes that this research can better social insurance framework [29]. A Convolutional neural system was created by PeterT. Habib et al (2020) for the forecast of pneumonia and usage were done on the X-Radiography pictures. The target of the creator was to identify pneumonia on the computational model consistent schedule to spare lives. For this respect AI calculation was utilized to distinguish the visual side effects. 5844 X-beam pictures were utilized for the investigation. Result accuracy for this research was 84%. This examination finishes up the proposed model is acceptable however we can work more on it [30].

The issue of pneumonia identification was tended to and fathomed out by Ara Abigail E et al (2020). Creator utilized dataset of chest X-Ray pictures on which they applied their recommended locally adaptive regression kernel (LARK) descriptors. That was a calculation based which was utilized in blend with the novel help vector machine classifier. This

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research finishes up compelled to a paired order and ANN and ResNet used for the experiment. By utilizing this technique creator propose that later on used to distinguish the viral and bacterial pneumonia because it can increase colour space, increase in contrast and artificially lightening of the image [31].

Zuherman Rustam et al (2018) chipped away at pneumonia location by aspiratory roentgen grouping. The strategy utilized for this examination was Convolutional neural system. Creator said that this technique is the best strategy for the characterization of X-beam. Since pneumonia is being recognized trough pictures of X-Ray. That is the reason their characterization is must to identify climate pneumonia is viral or bacterial. Dataset was gathered trough Women and Children's Medical Centre. This examination reason that the proposed strategy precisely recognize pneumonia however this exploration provides the future guidance for different analysts that they can add high processor to improve the exactness rate and make it more proficient [33].

Deep learning were also used in [41] for end to end detection of pneumonia as well as lung cancer by Venkata et al (2020). By using deep learning approach author proposed ESPLDUDL system that provides end to end detection and by author this method is cost effective method for the lung organ diseases mainly pneumonia and lung cancer. For future research this method can be used in other lung diseases. Maria Syed used the techniques of AI i.e deep learning and computer vision to aid the understanding of how the practical work was done and at the same time finds and explains different methods to introduce a functional Convolutional neural network. All the drafted out information was depends on the analysis. For this regard author used two approaches in 1st approach building a whole one and in the 2nd one author used pre-trained neural network to apply transfer learning method on it [48].

Working with pneumonia we should have to known about that pneumonia have further types which are

- Viral pneumonia
- Bacterial pneumonia

CAD system was used to identify the category of pneumonia. The method was dependent on two sections lung region identification and 2nd was pneumonia category classification using deep Convolutional neural network (DCNN). This general approach can be applicable on other diagnostic purpose such as medical classification task [49].

State of art system for the task of pneumonia detection introduced by Raheel Siddiqi which was depends on 18-layer deep sequential Convolutional neural network. In this research author performs experiments on publically available pediatric chest X-ray images dataset. There was larger number of apaches used for the better accuracy results in proposed 18 layer model which can classify the normal and pneumonia affected X-rays. Further arrangement exactness improvement might be conceivable by altogether exploring the utilization of transfer learning and fine tuning techniques [53].

Pneumonia Detection through X-Ray Using Deep Learning is a web application which is utilized to identify the presence of Pneumonia from dataset of chest X-ray tests. Striking order execution is accomplished utilizing strategies that depend entirely on transfer learning draws near or customary handcraft techniques. Khan Maseeh Shuaib et al built a Convolutional neural organization (CNN) model that extract highlights from a given chest X-ray picture then it groups it to decide whether an individual is affected with pneumonia. Author said proposed framework is good to utilize and is convenient and can be utilized anyplace with a functioning internet connection. It tends to be utilized anyplace and there is no compelling reason to stand by in ques. The outcomes are precise and are anticipated extremely quickly. The framework can likewise foresee various phases of pneumonia and which part may have pneumonia in future [55].

By employing six models of CNN on chest X-Rays Sammy V. Militante et al predicted and recognized pneumonia affected and unaffected persons. This work also implements Adam as optimizer for the adjustment of learning rate and 500 employed epochs for all models.

The six models performed well on distinguishing pneumonia and think about the incredible cycle in diagnosing and identifying pneumonia which benefits the clinical experts in giving a high quality medical support of their patients. For future examinations, a transformation of other Convolutional neural network architectures like Inception-v3, shuffle Net, and Mobile Net architectures for pneumonia recognition must

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be executed and the enhancement of hyper-boundaries ought to likewise be considered to improve the accuracy of the model [57].

**Table summary of deep learning Methods**

| No | Author | Year | Methods | Dataset | Results | Future directions/ Limitations |
|---|---|---|---|---|---|---|
| 1 | Bing Chuan Li | 2019 | CNN | 8,964 pneumonia labelled CXR images | End to end detection of pneumonia. | More validation labels identify false positive samples. |
| 5 | Sabyasachi Chakraborty, Satyabrata Aich, Jong Seong Sim, and Hee-Cheol Kim | 2019 | Convolutional neural network | 5856 chest X-ray | Spatial detection of pneumonia | Adam can also be used to rained the data of other subjects and multiple X-Rays. |
| 7 | Sheikh Rafiul Islam, Santi P. Maity, Ajoy Kumar Ray and Mrinal Mandal | 2019 | Compressed Sensing(CS) based deep learning framework/ CNN | kaggle | 97.34% accuracy. Efficient, better than conventional method. | Method can be further used to localize the area of interest like tumour cells. |
| 9 | Heewon Ko et al. | 2019 | Mask R-CNN and RetinaNet | Subset of NIH | Detection of pneumonia. | |
| 10 | Alexandre Cadrin-Chênevert | 2019 | CNN | (RSNA) Pneumonia Detection Challenge. | Detected and labeled images. | This model is only tested on specific dataset |
| 11 | Sema Candemir, Incheol Kim, George Thoma, and Sameer Antani. | 2018 | CNN based Novel visualization between viral and bacterial pneumonia. | Pediatric CXRs | Reduced bias and improved generalization . | Model can learn more effectively with a sparse collection of complex data |

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|---|---|---|---|---|---|---|
| 12 | Ilyas Sirazitdinov, Maksym Kholiavchenko, Tamerlan Mustafaev, Yuan Yixuan, Ramil Kuleev. | 2019 | RetinaNet And Mask R-CNN | Publically available RSNA Pneumonia detection challenge dataset. | Detection with age | Can use other directions rather than x-rays, meta information can be important for further experiments. |
| 13 | Pranav Rajpurkar, Jeremy Irvin, Kaylie Zhu, Brandon Yang, Hershel Mehta1, Tony Duan. | 2017 | CheX Net/ CNN | ChestX-ray14 dataset released by Wang et al. | Detects pneumonia frontal-view chest X-ray. | Only frontal view Chest X-rays used for detection. |
| 14 | Željko KNOK, Klaudio PAP, Marko HRNČIĆ. | 2019 | CNN/ Transfer learning | Kaggle site | Accurate detection trough model. | Internet required every time while using this. |
| 15 | Rachna Jain, Preeti Nagrath, Gaurav Kataria, V. Sirish Kaushik, D. Jude Hemant. | 2020 | Convolutional Neural Network | Kaggle site | Large number of images processed very quickly to detect pneumonia. | By fine tuning of every parameter the model accuracy can be improved |
| 16 | Ashitosh Tilve, Shrameet Nayak,Saurabh Vernekar, Dhanashri Turi, Pratiksha R. Shetgaonkar, Shailendra Aswale. | 2020 | ANN/ CNN | Indiana, Kit, | Speed and accuracy increased. | There is a problem of false disease detection with this model. |
| 17 | B. Ergen, Z. comert, . Togacar. | 2019 | CNN, SVM | Chest X-ray images of volunteer patients. | 99.41 | Investigation of this approach can be done on different datasets. |
| 18 | Sheikh Rafiul Islam, Santi P. Maity, Ajoy Kumar Ray, Mrinal Mandal. | 2019 | CNN | Mendeley CXR image | 95.90%, | |
| 19 | Ansh Mittal, Deepika Kumar, Mamta Mittal, Tanzila Saba, Ibrahim Abunadi, Amjad Rehman and Sudipta Roy. | 2020 | CapsNet | Mendeley CXR image | 97.34% | It can be extended by a general automatic computerized system by localizing the region of interest. |

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|---|---|---|---|---|---|---|
| 20 | Kh Tohidul Islam, Sudanthi Wijewickrema, Aaron Collins, Stephen O'Leary. | 2020 | ANN | CXR image | Improved pneumonia Diagnosis. | This method can be test on other databases |
| 21 | Alaa M. A. Barhoom, Prof. Dr. Samy S. Abu Naser | 2019 | CNN | X-ray Images | 100.0 % accuracy approximatel y. | If we add more data augmentation techniques in this method efficiency can be increased |
| 24 | Gaobo Liang, Lixin Zheng | 2019 | CNN | Kermany et al. | 96.7%, | Method can be applied on image analysis of CT and MRI |
| 25 | Sarang Mahajan, Urmil shah, Rucha tambe. | 2019 | Deep CNN model | Kaggle site | 88.78% | This research could not segment the particular part effected by pneumonia. |
| 27 | Naseem Ansari, Ahmed Rimaz Faizabadi, S. M. A. Motakabber, Muhammad Ibn Ibrahimy. | 2020 | Deep convolutional neural network | RSNA, Kermany et al. | 96.76%, | Accuracy can be improved using ResNet-101 or ResNet-152 |
| 28 | Nishit Pareshbhai Nakrani, Jay Malnika, Satyam Bajaj, Harihar Prajapati and Vivaksha Jariwala | 2020 | Convolutional Neural Network classifier. | Kaggle | Trained 3 different CNNs which detect pneumonia from frontal-view chest X-ray images. | Different categories of pneumonia can be used |
| 30 | Victor Hugo C. de Albuquerque, Robertas Damaševicˇius, Catarina Moreira, Prayag Tiwari. | 2020 | transfer learning | Guangzhou Women and Children's Medical Center | 96.4%. | |
| 31 | Ara Abigail E. Ambita, Eujene Nikka V. Boquio, and Prospero C. Naval, Jr. | 2020 | SVM | chest x-ray images | 98% | Including GPU and other machine learning techniques accuracy can be increased |
| 33 | Zuherman Rustam, Rivan Pratama Yuda, Hamimah Alatas, Chelvian Aroef. | 2019 | Convolutional neural networks (CNNs) | Women and Children's Medical Center, Guangzhou | 97% | Processor was not good and the image data was also concise |
| 34 | The DeepRadiology Team | 2018 | CNN, Couple Net, Bounding Boxes | CXR images | winning solution in the RSNA Pneumonia Detection Challenge | For unparalleled automation with computer vision and deep learning technology this research can be improved |
| 35 | Jason R. Andrews, Jin Young Kim, Gun Ha Kim, Jin | 2020 | Commercial deep learning (DL) algorithm | 377 patients dataset | DL algorithm showed fair diagnostic | Needs to validate the results by multiple observer |

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**LC INTERNATIONAL JOURNAL OF STEM**
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| | | | | | | |
|---|---|---|---|---|---|---|
| | Young Kim, Jae Hyun Kim. | | | | performance for detecting pneumonia | |
| 36 | Juan Eduardo Luján-García, Cornelio Yáñez-Márquez, Yenny Villuendas-Rey and Oscar Camacho-Nieto | 2020 | transfer learning | Kermany et al | Classification and labeling | An automatic parameter-tuning method with proposed method |
| 39 | Malena Correa, Mirko Zimic, Franklin Barrientos, Ronald Barrientos, Roberto Lavarello. | 2018 | ANN | Ultrasonix SonixTouch images. | 90.9% sensitivity and 100% specificity | require further testing with a larger number of children involved |
| 40 | Dimpy Varshni , Kartik Thakral, Lucky Agarwal | 2019 | SVM, Transfer Learning, Random Forest | ChestX-ray14 | Beneficial in analyzing chest X-ray images | Using similar domain pre-trained CNN model and classifier can be developed |
| 41 | Venkata Tulasiramu Ponnada, S.V. Naga Srinivasu | 2020 | CNN | X-Rays | Detect pneumonia and lung cancer | Leverage this system can address the majority of lung organ disease detection. |
| 47 | Andrew Elkins, Felipe F. Freitas, Verónica Sanz | 2019 | ANN | ChestX-ray14 dataset | Diagnosis trough app | After 15 minutes of in activity the server goes to sleep |
| 48 | Maria Syed | 2018 | CNN | ChestX-ray14 | 96.6% | Tools can be updated and can be more efficient |
| 49 | Xianghong Gu, Liyan Pan, Huiying Liang, Ran Yang. | 2018 | SVM | public datasets | 0.8234±0.0014 | This method can be applicable in other medical fields for classification |
| 53 | Siddiqi.R | 2019 | CNN | pediatric chest X-ray images | | Model's yield is lower than expected |
| 55 | Khan Maseeh Shuaib | 2020 | CNN | medical datasets | 84%, interpretable, reliable | Algorithm can detect other diseases |
| 57 | Sammy V. Militante, | 2020 | CNN | Radiological Society of North America (RSNA) | 97% | Adaptation of other CNN architecture can improve accuracy |

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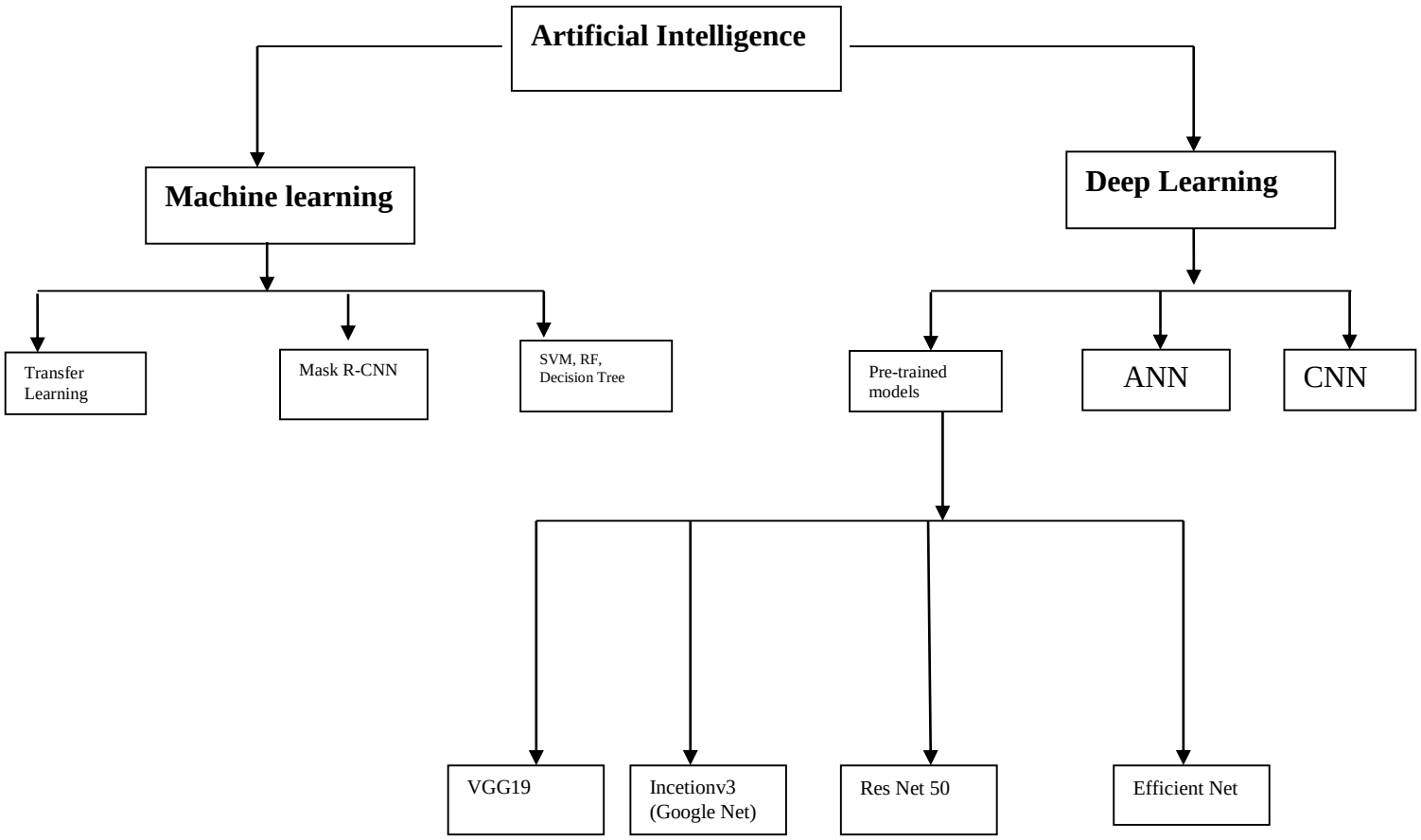


**Taxonomy of literature review**

### 1.3 Pretrained CNN methods

Dimpy Varshni et al used pretrained CNN models with supervised classifier algorithms in the state of art of pneumonia detection. They used ChestX-ray14 dataset that was released by Wang et al. Author said that the limitation with their model was that there is no history of the inclusive patient considered in the presented evaluation model and only frontal Chest X-Ray were used for the experiments. The presented work will help out to predict the pneumonia at early stage [40].

Early diagnosis of a disease is the basic need of this era for this regard Katie Shpanskaya et al proposed an algorithm to detect pneumonia from chest X-ray. Publically available dataset were used to apply the proposed algorithm. Extended ChexNet used here to classify multiple thoracic pathologies. The suggested algorithm detects pneumonia from frontal view chest X-ray images also detect multiple diseases outperforms previous state of the art on ChestX-ray14 [13]. Sheikh Rafiul Islam et al (2019) et al proposed their research on the automatic detection of pneumonia. Author suggests a compressed sensing based deep learning framework to detect the pneumonia to help out the medical practioners. Experiment on Mendeley CXR image dataset was performed using the proposed methodology of this research. This study concludes that automatic computerized system using CNN methods could be used to detect pneumonia which is proposed here in this research and in the future proposed method maybe extended as a generalized automatic computerized system to assist the medical field. Network which was used was a simple multilayer network with Convolutional and 3 fully connected layers and there was a reconstruction model for compressed sensing Image [19].

In 2018 the radiography group proposed their exploration on distinguishing proof of pneumonia by utilizing chest radiographs. Open source profound learning technique was

being utilized in the article recognition which incorporates worldwide and neighbourhood includes discovery capacity. 3000 chest radiographs were remembered for the test procedure. This investigation reasons that three elements are significant in the method of pneumonia location

- An architecture which includes local and global context.
- Use a good sense for background and foreground.
- Accuracy [35].

Heewon Ko et al proposed a research for pneumonia detection. In which they proposes a method to detect lung opacities which can be identified as pneumonia on chest Radiographs (CXR) using all of deep Convolutional neural networks. The R-CNN and retina Net methods were applied to pneumonia detection. The dataset for this Experiment is a subset of the NIH dataset. All the approaches used in this paper were based on Mask R-CNN and Retina Net to detect lung opacity in CXR. This will leads to pneumonia detection [9]. CNN was very good method to use but some other techniques can work better as like in 2018 “Ilyas Sirazitdinov” et al proposed their examination based on two neural systems Retina Net and Mask R-CNN for pneumonia discovery and limitation. This proposed technique was applied on dataset of 26,684 pictures from Kaggle pneumonia discovery challenge. The outcomes close from this investigation we can acquired right analysis of cases with vulnerabilities and murkiness district and liquid maintenance of pneumonia [12].

Zuherman Rustam et al (2018) chipped away at pneumonia location by aspiratory roentgen grouping. The strategy utilized for this examination was Convolutional neural system. Creator said that this technique is the best strategy for the characterization of X-beam. Since pneumonia is being recognized trough pictures of X-Ray. That is the reason their characterization is must to identify climate pneumonia is viral or bacterial. Dataset was gathered trough Women and Children's Medical Center. This examination reason that the proposed strategy precisely recognize pneumonia however this exploration provides the future guidance for different analysts that they can add high processor to improve the exactness rate and make it more proficient [34].

## 2. Machine Learning

By extracting some specific features from images we can find out several things like disease detection etc. Cosmin et al used this feature selection technique to detect the pneumonia with the help of natural language processing system. In this research author used statistical feature selection because that is just the most informative highlights from the feature space significantly improves the performance over a gauge that utilizes all the highlights from a similar component space. Extricating the statement esteem for pneumonia articulations further improves the framework execution.

Basically the presented model is a machine learning model which can detect pneumonia. Machine learning methods are also used in [2,3,6,8]. Author describes that only small informative part of an image feature can give you better results [58]. The aim of this research was to compare the machine learning methods including Naive Bayes, K-Nearest Neighbor (KNN) and Support Vector Machines (SVM). Rafael et al used 3 different methods on PneumoCAD dataset including feature testing, robustness testing and feature selection.

After all these experiments and test according to author SVM shows better results than other two methods. In conclusion the SVM classifier created most exact outcomes and has demonstrated to be steadier with preparing information variety. In addition it beats the best outcome from past work and even outperforms the analysis precision of clinical inhabitants [45].

### 2.1 Transfer Learning

Dwindle T. Habib et al (2020) introduced their examination on pneumonia identification. Creator needs to rearrange the identification procedure with the goal that the specialists can without much of a stretch utilize the framework. By utilizing idea of move learning this exploration proposed a system dependent on profound realizing which will future aides in pneumonia location. Dataset from ladies and youngsters clinical focus was utilized in this exploration. After ramifications of the recommended strategy this examination exactness rate was 96.4%. This investigation infers that by utilizing a related engineering and move learning approach

pneumonia location should be possible [31]. For the classification and visualization of pneumonia Juan Eduardo Luján-García et al (2020) proposed a research in which they using transfer learning method an tried their best to detect the pneumonia. An automatic tool is being prepared with the help of transfer learning method to detect the pneumonia patient's x-ray. When they insert x-ray tool detects the x-ray weather this x-ray is of pneumonia patient or of normal patient. For this purpose they use the dataset from Kermany site. This research concludes that proposed tool can detect the affected x-ray and labelled it with pneumonia affected and normal with normal label [37].

Deep learning and transfer learning are performing vital role and helpful for researchers to find out the new things so that they help out community. By using deep learning and transfer learning Inderpreet Singh Walia et al presented their research to detect the pneumonia which is causing 15% deaths of the children only except others. In their research they used 10 layers of Convolutional neural network as well as there were three dense layers too. And activation function they used was swish activation function. Author achieved 98.5% training accuracy. In further discussion author suggested that the presented model can be improved if we will use different some transfer learning methods and hyper parameter and tuning parameters [52].

However detection of pneumonia using different medical techniques becomes very challenging. Any wrong detection could lead to serious consequences in medical treatment. Naghia Duong Trung et al (2019) proposed a deep learning method to automated detection of pneumonia. This will improves the current computer vision methods based on the use of deep learning to more effectively diagnose the presence of pneumonia in X-ray images. For the experiments dataset were collected trough chest X-rays of one to five years old from Guangzhou Women and Children's Medical Center Guangzhou. This study results a deep Convolutional neural network combining with the idea of transfer learning and applied it on a critical task of radiography image classification [3].

In that way Catarina Moreira et al (2019) introduced a framework that was actually a novel deep learning framework for the detection of pneumonia using the concept of transfer learning. In this approach features from the images are extracted by use of different neural network models which were pertained on the image Net which than took care of in to a classifier for forecast. For the evaluation of this research the data sets were collected from Guangzhu women and children Medical Centre. This contains total 5232 images. Correct diagnostics requires in depth knowledge of radiological features see able in Chest X-Rays. This study gives different architectures to extract features. These features were passed to the classifier to respective models and the output was collected from individual architecture [6]. Pneumonia can be detected and cure by many methods because this is an acute respiratory disease. Transfer learning can improve learning and detection because in this method pretrained methods used and retrained for further inventions. Sagar Kora Venu used transfer learning by tuning of other methods and reduces the time and minimizes the errors in the way of detecting pneumonia form X-Rays. This study proposes a weighted normal outfit model by fine-tuning the deep transfer learning designs to improve the classification execution measurements, for example, accuracy, precision, recall, and f1 score to recognize pneumonia from chest X-beam pictures [51].

Deep learning and transfer learning are performing vital role and helpful for researchers to find out the new things so that they help out community. By using deep learning and transfer learning Inderpreet Singh Walia et al presented their research to detect the pneumonia which is causing 15% deaths of the children only except others. In their research they used 10 layers of Convolutional neural network as well as there were three dense layers too. And activation function they used was swish activation function. Author achieved 98.5% training accuracy. In further discussion author suggested that the presented model can be improved if we will use different some transfer learning methods and hyper parameter and tuning parameters [52].

Human helped analysis has its own constraints like the accessibility of a specialist, cost, and so forth and consequently an automatic technique for the identification of pneumonia from x-Xray is a need. Gaurav Labhane et al provides their services in the field of pneumonia detection trough X-Rays.

They developed neural network models to detect the pneumonia by applying this model on the chest X-Rays. With the help of CNN and transfer learning methodologies four models were developed named as a basic Convolutional neural network (CNN), VGG16, VGG19 and InceptionV3. Further testing and training of these models were performed on pediatric pneumonia dataset.

Author said pediatric pneumonia could be effectively detected using chest radiographs using CNN and deep learning technologies. That's why author used those technologies which can easily detect pediatric pneumonia with higher accuracy. Neural Networks were utilized to create models for proficient extraction of highlights from x-ray picture and anticipate the presence or absence of pneumonia. Likewise in this research the testing information was expanded by information augmentation techniques and hence the models were tried on a more prominent number of pictures when contrasted with a couple of different methodologies [54].

**2.2 Mask RCNN**

By using deep learning based approach Joel.J.P. C Rodrigous et al (2019) presented a model for detecting pneumonia which was based on Mask-RCNN also this method used in [2, 8, 9, 23]. Mask RCNN is a deep neural network which integrates global and local features for pixel wise segmentation. The problem followed by this model consists of binary classification of chest X-Ray on three various classes of lung opacities such as opacity, no opacity and not normal. The wide issue in this was the difference in quality X-Rays in terms of brightness, resolution and position region of interest. For the modelling of this type of task this paper describes an algorithm that can detect the visual signal in medical chest radiographs. In short this study results an approach for identifying pneumonia and understanding how the lung image size plays an important role for the model performance [2]. Computer aided detection can improve the radiologist diagnostic capabilities by getting radiologist to another opinion CAD system can be developed by different techniques including deep Convolutional architecture. Al Mabrok et al developed architecture such as residual network and mask-RCNN in classifying and detecting pneumonia. To develop this architecture the dataset they use were Kaggle RSNA pneumonia detection challenge dataset from the radiological society of North America. This study results that residual network shows better performance than mask RCNN [8].

Pneumonia identification trough weighted democratic gathering by CNN model was presented by Heewon Ko et al (2019) in their proposed research. In this technique lung opacities were distinguished and afterward these indentified pneumonia by essebmlence of profound Convolutional neural system. Dataset was gathered trough subset of the NIH datasets. This examination results the organize qualities and certainty of lung obscurity on anticipated jumping boxes for every patient. By consolidating different classifier effectiveness of this technique illustrated [23].

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**Table summary of deep learning Methods**

| No | Author | Year | Methods | Datasets | Results | Limitations/ Future directions |
|---|---|---|---|---|---|---|
| 2 | Joel.J.P. C Rodrigous | 2019 | Mask-RCNN | Radiographs | Identification Detection. | Model can be improved by adding new layers and used in other medical imaging with deep learning. |
| 6 | Victor Hugo C. de Albuquerque, Robertas Damaševicˇius, Aditya Khamparia, Catarina Moreira | 2020 | CNN, Transfer learning, Computer aided diagnosis. | Guangzhu women and children Medical Center | Simplify process, improve management of disease. | Deep learning methods can also be used to improve the diagnosis relative to traditional methods |
| 8 | Abdullah Faqih Al Mubarok et al. | 2019 | Mask RCNN | Kaggle RSNA | Residual network is better in performance than mask-RCNN. | This architecture can be proved best by using complex network structure and also unbalance dataset. |
| 3 | Nghia Duong-Trung, Tuyen Tran Ngoc, Hiep Xuan Huynh | 2019 | Transfer learning | Guangzhou Women and Children's Medical Center Guangzhou. | 98.0% accuracy, improved and efficient. | A specific focus on binary of pneumonia and normal can develop the model. |
| 23 | Heewon Ko, Hyunsoo Ha, Hyunsoo Cho. | 2019 | Mask RCNN | subset of the NIH dataset | Ranked as a 21st place out of 1499 in RSNA Pneumonia Detection Challenge | |
| 31 | Ara Abigail E. Ambita, Eujene Nikka V. Boquio, and Prospero C. Naval, Jr. | 2020 | SVM | chest x-ray images | 98% | Including GPU and other machine learning techniques accuracy can be increased |
| 37 | M Y Santoso, A M Disrinama, H N Amrullah. | 2019 | expert system based on ANFIS | X-ray images | Early detection of pneumonia. | |
| 45 | Rafael T. Sousa, Oge Marquesb, Fabrizzio Alphonsus A. M. | 2013 | Machine learning, SVM, Naive Bayes | digital camera images | 68%. | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| | N. Soares, Iwens I. G. Sene. | | | | | |
| 51 | Sagar Kora Venu | 2020 | Transfer learning | Kermany et al | 98% accuracy | |
| 52 | Inderpreet Singh Walia | 2020 | Transfer learning, CNN | Radiograph images | 98.5% | By freezing transfer learning algorithm layers and use of different algorithm work can be extended |
| 54 | Gaurav Labhane | 2020 | CNN, transfer learning | Guangzhou Women and Children's Medical Center. | 97% | |
| 58 | Cosmin Adrian Bejan, Fei Xia, Lucy Vanderwende and Mark M Wurfel | 2012 | Machine learning, feature selection | narrative reports for 426 patients | Extract information from narrative reports | Performance will be improve if a feature added which can extracts the assertion value of all pneumonia expressions |

## III. DISCUSSION & CONCLUSION

This survey is on the pneumonia detection using x-ray images. Review is structured based on machine learning, deep learning and transfer learning of Artificial intelligence. A lot of limitations were found such as: models yield were lower than expected, need to validate the results from the observer, only frontal view Chest X-rays used for detection which can affect the results accuracy, internet requirement etc.

In future it is recommended to develop hybrid model based on machine learning and deep learning methods. It is also recommended to perform image segmentation before applying deep learning and machine learning methods as well as including GPU and other machine learning techniques accuracy can be increased in future. We also recommend using of different layer combinations in deep learning methods.

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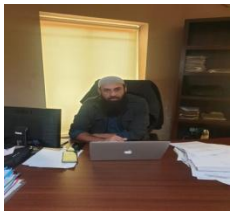

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