IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Towards Pneumonia Detection Techniques: A Review

[1]Jyoti Nayak and [2]Jyoti kansari

[1]Department of Computer Science and Engineering

Raipur Institute of Technology, Mandir Hasaud, Chhatouna, Chhattisgarh 492001, India

Abstract:-Pneumonia infection is a life threating entity which is caused by bacteria, viruses and fungi inflames the lungs making it difficult to breath. Pneumonia is among the most prevalent diseases, and due to lack of experts it is difficult to detect. In this paper we review and compare the detection of pneumonia using different techniques and suggest a revised model for detecting pneumonia, which will then be implemented as part of our future research.

Keywords: Convolutional Neural Network, Deep Learning, Lung X-ray Images, Medical Imaging, Pneumonia Infection.

I. Introduction:

Pneumonia is an infection of the lungs. Almost all cases of pneumonia are caused by viral or bacterial infections. When pneumonia is first diagnosed, there often is no way to be sure if the infection is caused by a virus or bacteria. Therefore your doctor will need to treat it with antibiotics.

There are multiple antibiotics that treat pneumonia. The initial choice of drug(s) is made based on the category of pneumonia you most likely have. The two major categories are community acquired pneumonia (CAP) and health care associated pneumonia (HCAP).

Health care associated pneumonia refers to pneumonia that develops in a person that is in the hospital now or has recently been in the hospital or a nursing home. These pneumonias tend to be more serious. The organisms found in a hospital often become resistant to many antibiotics. Also hospitalized patients are often weakened by other illnesses and are less able to fight off the infection.

II. Literature Review

2.1 Using Image processing based approaches

Sharma et al. utilized traditional image processing based mechanism such as resizing, histogram equalization, region of interest (ROI), and thresholding approaches to identify pneumonia in chest X-ray images [1]. In this work, authors used 40 analog chest x-ray images along with Otsu method to extract the pneumonia infected part. Additionally, healthy ratio area of lung had also been computed.

In the next study, Harsh Agrawal proposed a method for pneumonia detection by using chest x-ray images based on Image processing, deep learning and transfer learning concept.[15]. In this work, author used Morphological Operators and Histogram Equalization. For the dataset they used 5216 chest x-ray images by GLOWM (The Global Library of Women's Medicine). and achieved **96.00% of accuracy.**

2.2 Using deep learning based approaches

In another chest X-ray based study, Chagas et al. had used 6000 chest X-ray images to recognize the pneumonia in internet of things (IoT) domain [2]. It includes utilization of twelve architectures of convolutional neural network combined with Multilayer Perceptron (MLP), Naive Bayes, k-Nearest Neighbor (kNN), Random Forest, and Support Vector Machine (SVM). The proposed model had achieved 94.67% accuracy in pneumonia detection. However, precise segmentation approaches had not been applied and thus have limited performance.

ASNAOUI et al. Compare different Deep CNN approaches such as Inception_V3, MobileNet_V2, DenseNet201, VGG16, Inception_ResNet_V2, Resnet50, VGG19, and Xception to classify pneumonia disease [3]. For comparison they used chest X-Ray & CT dataset which contains 5856 images (4273 pneumonia and 1583 normal). In the proposed study found that finetuned version of MobileNet_V2, Inception_Resnet_V2 and Resnet50 had achieved more than 96% of accuracy and CNN, Xception, VGG16, VGG19, Inception_V3 and DenseNet201 had achieved more than 84% accuracy.

Similarly Rahman et al. used 5247 chest x-ray images including bacterial, viral and normal chest x-rays to differentiate between normal vs pneumonia and bacterial pneumonia by using transfer learning based methods [4]. In this study author used four different pre-trained deep Convolutional Neural Network (CNN) including ResNet18, AlexNet, DenseNet201 and SqueezeNet. The proposed model classify normal and pneumonia images, bacterial and viral pneumonia images, and normal, bacterial and viral pneumonia and achieved 98%, 95% and 93.3% accuracy respectively.

Kadam et al. Utilized deep neural network based on convolutional neural networks and residual network for pneumonia detection using chest x-ray images [5]. In order to identifying optimum differential rates and to achieve more accuracy author used techniques of cosine annealing and stochastic gradient with restarts. The proposed model had reach 92.9% accuracy. 5863 X-Ray images (JPEG) were used form the Kaggle dataset. However, to achieve more precise result number of images can be increased in the dataset.

In another study of pneumonia detection a deep learning based approach Covlutional neural network model has been proposed by Verma et al.[6]. In this study total 5836 chest x-ray images are used along with data augmentation methods to enhance the accuracy in detection of pneumonia infected images. Author used python language for this model. The proposed study obtained training accuracy as 0.9436 with training loss as 0.1378 and validation accuracy of 0.9289 with validation loss as 0.1988.

D.M. Ibrahim et al. Proposed a model based on deep learning which consists chest x ray and CT images for identifying COVID-19, pneumonia, and lung cancer [7]. Combination of chest x ray and CT image is used in this paper because its increases the classification rate. In this study they compared performance of four architecture which are: ResNet152V2, VGG19-CNN, ResNet152V2 + Bidirectional GRU (Bi-GRU) and ResNet152V2 + Gated Recurrent Unit (GRU) and they found that VGG19+CNN model gave the best classification performance (98.05% accuracy) followed by ResNet152V2+GRU, with 96.09% accuracy. ResNet152V2 and ResNet152V2+Bi-GRU obtained 95.31% and 93.36% accuracy, respectively. This is lower than other architecture. In this study VGG19+CNN is recommended as it gave higher accuracy.

V. Militante et al. Used different CNN models with 1024 by 1024 resolution of 26,684 dataset images for the detection of pneumonia disease [8]. In this study author used five different models of CNN: LeNet, ResNet , AlexNet, VGGNet and GoogleNet and they found that VGGNet model achieved 97 % of accuracy rate and ResNet model has lowest accuracy of 74 %. However Inception-v3, shuffle Net, and Mobile Net architectures should also be used for better accuracy rate of pneumonia detection.

In another deep learning based study, four different models were utilized by M. Elshennawy et al. For pneumonia detection which include two pre-trained models, ResNet152V2 and MobileNetV2, a Convolutional Neural Network (CNN), and a Long Short-Term Memory (LSTM) [9]. For the dataset author used publicly available Pneumonia Detection dataset of chest X-rays in Kaggle which consists of a total of 5856 images captured by a digital computed radiography (CR) system. In this study proposed models, ResNet152V2 and MobileNetV2, achieve the best recall values for pneumonia detection, with accuracy rate of 99.44% and 99.43%, respectively. In addition to that the other two models achieved more than 90% of accuracy. However, CNNs and RNNs as bidirectional LSTM architectures and pre-trained models had not been applied which could be improved the result.

In the next study of pneumonia detection author utilized deep learning based methods such as data augmentation, learning rate variation, and annealing [10]. The experiments were based on chest x ray image dataset which consist of 5,856 X-ray images. The proposed model had achieved approximately 94 % of accuracy.

Ibrahim et al. proposed a deep learning based model for the classification of normal CXR, pneumonia, bacterial pneumonia, covid-19 and non covid-19 viral pneumonia[11]. In this work author utilized CXR scan as dataset obtained from public databases. In this study pretrained AlexNet was used for the classification process. The proposed model obtained 94.43% accuracy For non-COVID-19 viral pneumonia and normal CXR images, 91.43% accuracy For bacterial pneumonia and normal CXR images, 99.16% accuracy For COVID-19 pneumonia and normal CXR images, 99.62% accuracy for CXR images of COVID-19 pneumonia and non-COVID-19 viral pneumonia, 94.00% accuracy For the three-way classification and 93.42% accuracy for the four-way classification. However, support vector regression (SVR) and support vector machine (SVM) can also be used with CNN models to improve the result.

2.3 Using machine learning based approaches

Sousa et al. Utilized three machine learning approaches namely: Naive Bayes, K-Nearest Neighbor (KNN), and Support Vector Machines (SVM) for detection of childhood pneumonia [12]. For this study image dataset were used consists of 156 8-bit grayscale images. In the proposed all three classifiers gave different results such as SVM and KNN obtained 77% and 70% accuracy, respectively whereas Naive Bayes produce 68% of accuracy.

Chen et al. used an electronic nose to develop a breath test for ventilator-associated pneumonia.[13]. This study include various machine learning algorithms namely: K-nearest neighbours, Naive Bayes, Decision tree, neural network, Support vector machines, Random forest. proposed had achieved approximately 81 % of accuracy.

In the next study Liu et al. Proposed a model based on machine learning method such as ROI, histogram, feature extraction, histogram arches for differentiating novel corona virus pneumonia from general pneumonia[14]. This study also include ensemble of bagged tree algorithm for classification and achieved 94.16% classification accuracy.

Author	Methods	Features / Strength	Performance Measures
Chagas et al. [2]	CNN	Combined with different learning methods. Validated through medical specialists.	Accuracy=96.03% F1=89.78%
ASNAOUI et al.[3]	CNN	Applied different DL architectures and compare their performances	Accuracy=96% F1=96.67%
Kadam et al. [5]	CNN	Used data argumentation, neural networks,and cosine annealing and stochastic gradient with restarts	Accuracy=92.9%
Verma et al.[6]	CNN	Applied different data augmentation techniques Used Python programming language	Accuracy=92.89%
V. Militante et al.[8]	CNN	Used different models of CNN, AlexNet, LeNet, GoogleNet, ResNet and VGGNet	Accuracy= 97% F1= 98%
Stephen et al.[10]	CNN	Used Keras open-source deep learning framework with tensorflow backend	Accuracy=94%(aprox.)
Chen et al.	Machine Learning	Applied different machine learning algorithms including k-nearest neighbors, Naive Bayes, decision tree, neural network, support vector machines (SVMs) and random forest.	

III. Conclusions

The mentioned approached have either been assisted using traditional image processing or machine learning methods. Some of them have utilized the deep learning based transfer learning model. Though, CNN based mechanism have also been used but due to hidden or complex architecture, the actual performance of the models has not been revealed. Valuable features are the one which may help a system to recognize the pneumonia in X-ray images. But, feature extraction in the mentioned work has not been potentially brought out. Similarly, the design issues of deep learning based model have not been discussed in context of their training and testing behavior. Future scope of this paper is a CNN based model to classify lung X-ray images into normal and pneumonia category which offers less complex design and validated through the qualitative and quantitative assessment scores.

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