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A Literature Review on Techniques for Detection of Lung Diseases

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Abstract: Computer aided diagnosis (CAD) is one of the potential technologies in today's medical world that assist doctors to interpret and evaluate medical images in a short time. CAD offers support to medical professionals to make decisions on possible diseases. Various systems and approaches are implemented to serve this technology, and many hospitals have deployed the system for diagnosis of diseases. The detection of the proportion of disease would aid in determining if more in-depth tests are required for confirmation of the condition, hence avoiding risky biopsies. This survey focuses on such methodologies implemented by authors of several works to detect lung infections by analyzing tissue patterns and inflammations in lungs and classifying the same. Along with this, work related to the patient database system is also reviewed and a comparison is made between the works.
Keywords: Computer aided diagnosis, tissue pattern, biopsy

I. INTRODUCTION

Lungs are the primary organs for respiration in mammals and most other vertebrates. Lungs perform gas exchange, i.e, they absorb oxygen from the air and transport it into the bloodstream, as well as release carbon dioxide from the bloodstream into the atmosphere[1]. Lung diseases prevent the lungs from functioning properly, reducing the oxygen capturing ability. Common causes for lung diseases would be bacterial, viral or fungal infections. Genetic defects and exposure to dangerous, poisonous compounds are also factors in some instances. Few lung diseases would spread to other people by sneezing and coughing. Diagnosis of the diseases at the right time helps the patient recover quickly and avoids spreading of infection inside the body and to the people around. Computer aided diagnosis is now one of the most powerful and accurate tools to analyze Chest X-rays, CT Scans or other medical images to detect lung disease. CAD provides additional support to the medical practitioners to take decisions on the confirmation of the infection. This survey on literature works explores some of the methods used to identify the tissue patterns and classification, detecting lung disease and also a work which proposes the patient database system to acquire and manage relevant information from patients for better decisions.

One of the powerful and accurate approaches for CAD is Convolutional Neural Network (CNN). It is a class of deep-learning artificial neural network, developed to recognize and analyze patterns from pixel images. It is playing a vital role in providing accurate results, serving the doctors and healthcare staff to a greater extent. Several other approaches are also serving for CAD, which are explored and compared in this survey.

II. LITERATURE SURVEY

A. *Namrata Bondfale, D.S. Bhagwat, "Convolutional Neural Network for categorization of Lung Tissue Patterns in Interstitial Lung Diseases"*, (ICICCT 2018)

The goal of this work is to classify the tissue patterns of Interstitial Lung Diseases(IDLs) as healthy, reticulate, honeycombing, etc by developing a framework using Convolutional Neural Network (CNN). MATLAB software is used for the detection of tissue patterns. Four steps are performed in the Training Stage. Pre-processing began with downsizing the large, high-resolution input pictures from CT scans or chest X-rays to a predetermined size. Second, for easier analysis, the image was segmented by separating it into numerous segments. Thresholding, Inversion, and Masking are done as a part of Segmentation to get the Region of Interest (ROI). Then, Feature Extraction is done on the segmented information to identify the tissue patterns of ILDs. Finally, the CT scans are stored in a dedicated database. At the testing stage, preprocessing is carried out, followed by segmentation and feature extraction, and then CNN is applied. Based on the extracted information and CNN output, tissue patterns of ILDs are classified. The accuracy is calculated using the HMM technique, which is described as (TP+TN)(P+N), where TP, TN, P, and N stand for True Positive, True Negative, Positive Sample, and Negative Sample, respectively. This system is said to be 82% accurate. In the future, 3D images of 3CT scans can be used, integrating the system with CAD for better diagnosis.

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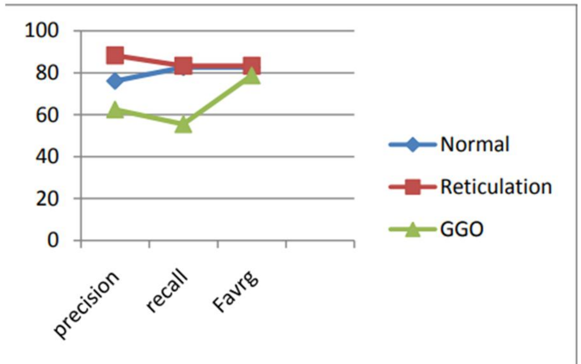

Fig. 1: Precision, recall, and Favrg of Normal and Abnormal samples as a line graph

Method	Accuracy
Li	0.67
LeNet	0.67
AlexNet	0.71
VGG-Net	0.78
Proposed Method	0.82

Table 1: Comparison table of proposed CNN with other CNNs

B. Quang H. Nguyen, Binh P. Nguyen, et al., "Deep Learning Models for Tuberculosis Detection from Chest X-ray Images", (ICT 2019)

The use of transfer learning on medical imaging to identify tuberculosis is studied in this work. ImageNet weights were updated with a better method for transfer learning, which was previously insufficient and ineffective. By training the models in a multiclass multilabel setting, a new technique for capturing low-level features has been developed. In comparison to training from an initial random setting, an efficient technique for training in a data constrained situation and tuberculosis classification has been provided. The detection is based on binary classification, which determines if the X-ray has tuberculosis or not. Two sets of publicly available datasets of Chest X-rays have been used for this work. Training stage uses Shenzhen dataset from Shenzhen People's Hospital and the testing stage uses Montgomery dataset, and different architectures are used for experimentation. The datasets are augmented for training to avoid distortions in the images. Rotations, horizontal flipping and transformations are performed, along with rescaling, before feeding the image into the neural network. Tests on several architectures were conducted and it was observed that performance of Inception ResNetV2 and DenseNet were equally good on the test dataset. DenseNet model was finalized as it performed well for three times lesser parameters than ResNet. Class Activation Mapping(CAM) is done to visualize the image regions having the highest resemblance of the disease. In future, inputs from medical professionals which include patient history, lab reports etc. can also be considered along with the X-rays to improve the final decision.

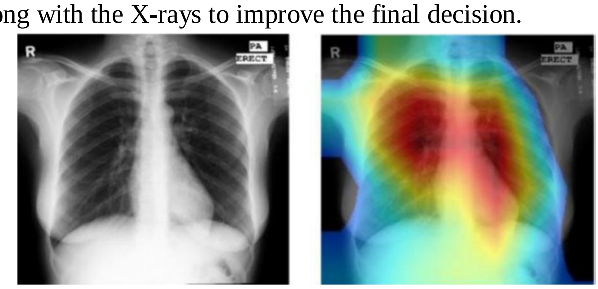

Fig. 2: A test case using CAMs in the identification of normal X-Rays, with an emphasis on clear lung area.

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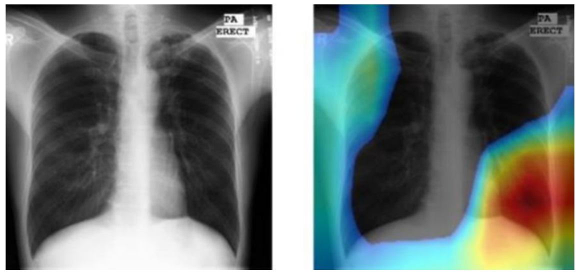

Fig. 3: A test case using CAMs in the identification of aberrant X-rays, with an emphasis on the infected lung area.

C. Enes Ayan, Halil Murat Ünver, "Diagnosis of Pneumonia from Chest X-Ray Images using Deep Learning", (EBBT-2019)

This paper examines the diagnosis of Pneumonia, that can only be determined by a professional radiologist using a chest X-ray. The disease's appearance in chest X-ray images might be obscure for a variety of reasons, and it can be mistaken for other disorders. Thus, computer-aided diagnosis systems are needed to guide clinicians. The authors use two renowned convolutional neural network models, Vgg16 and Xception, to identify and diagnose Pneumonia.In addition, in the training stage transfer learning and fine-tuning are used. When the results of two networks are compared on data with varied measures, the Xception model outperforms the Vgg16 model in diagnosing pneumonia (pneumonia precision 94%,91% respectively). The Vgg16 model has shown better execution over the Xception model (with accuracy 87%, 82% respectively) in diagnosing normal cases. A combination of these neural network models, Xception and Vgg16 or a hybrid model will work best in diagnosing pneumonia from chest X-ray pictures.

	Accuracy	Sensitivity	Specificity
Xception	0.82	**0.85**	0.76
Vgg16	**0.87**	0.82	**0.91**

Table 2: Results of two networks by accuracy, sensitivity, and specificity metrics

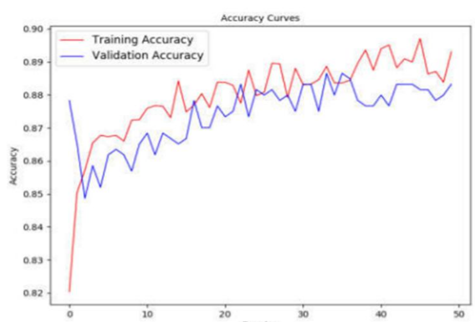

Fig. 4 : Vgg model's accuracy

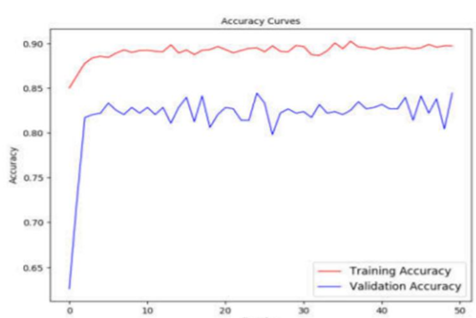

Fig. 5: Xception model's accuracy

D. Ali Serener, Sertan Serte, "Deep learning to distinguish COVID-19 from other lung infections, pleural diseases, and lung tumors", Medical Technologies Congress (2020)

The research and the groundwork of this system is focused on detecting COVID-19 and eliminating the possibilities of all other lung infections. The system works on image processing of the X-ray and segmenting the processed image to six different neural networks such as AlexNet, MobileNet-v2, DenseNet-121, VGG and ResNet-50. The models are trained using the Caffe deep learning framework and the ImageNet database of chest X-rays. Based on the results from all the different neural networks, the condition of the patient is distinguished from other pleural infections.Chest radiographs are utilised to develop deep learning models to differentiate COVID-19 from other pleural illnesses, infections, and lung mass. Every 20 chest radiograph image was trained to discriminate COVID-19 from each of the three diseases using four distinct types of chest radiographs of the same or comparable infection. In differentiating COVID-19 from pleural effusion, MobileNet-v2 and AlexNet infrastructures have been deployed. ResNet-18 and AlexNet architectures are used to distinguish Covid-19 from Pneumonia. DenseNet-121 is used for detecting lung mass anomalies. The results from these have been tabulated and deployed to make one specific model analysis to suit all the kinds of detection. ResNet-18 architecture is then considered the most accurate and efficient in separating COVID-19 from pleural effusion,lung mass and pneumonia. The system would further focus on elaborating the detection of other ailments apart from COVID-19. Manifestation of the ailment could also be introduced to the system along with the detection.

Network	Accuracy	Sensitivity	Specificity
MobileNet-v2	0.75	1.00	0.67
AlexNet	0.93	1.00	0.87
ResNet-18	0.78	0.97	0.69
ResNet-50	0.79	0.95	0.71
VGG	0.79	0.95	0.71

Table 3 : Distinguishing COVID-19 from pleural effusion

Network	Accuracy	Sensitivity	Specificity
MobileNet-v2	0.74	0.85	0.78
AlexNet	0.66	0.41	0.74
ResNet-18	0.76	0.65	0.79
ResNet-50	0.75	0.59	0.80
VGG	0.75	0.62	0.79

Table 4 : Distinguishing COVID-19 from Lung mass

E. LiuLiu Fu, Ling Li, "A Smart Decision Making System for Managing Patient Database", 2016

The suggested system gives healthcare professionals useful recommendations and assists them in gathering more clear feedback about patients in order to improve appointments, to narrow the gap between patient needs and offered or delivered services. Since the study concentrated on a decision-making module for smart scheduling. For the storage of data (MySQL) is used as a local database. There are two phases to it. The first phase is a new global scheme that entails developing a new overall classification system. The method will be based on the physicians of the personal preferences. The second phase is to analyze and merge the record of the updated patient. Automatic classification utilizes the support vector machine technique. The framework consists of a Web-based point of interaction that empowers individuals to make and change classes like making due files. Furthermore, the local database may be deployed in the cloud since cloud databases offer affordability, security, accessibility, collaboration, and sharing.

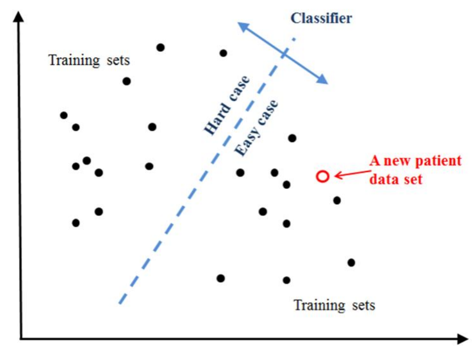

Fig. 6: Classification of new patient database

III. COMPARISON TABLE

Author and Year	Title	Remarks
Namrata Bondfale, D.S.Bhagwat (ICICCT 2018)	Convolutional Neural Network for categorization of Lung Tissue Patterns in Interstitial Lung Diseases	The approach is to deal with automated diagnosis for computed tomography images.. The CNN framework is used to classify lung tissue patterns into various categories. MATLAB software is used for the detection of tissue patterns. For training and evaluation, the system uses a dataset of 100 HRCT images acquired from various radiology clinics. Accuracy achieved was 82%.
Quang H. Nguyen , Binh P. Nguyen , Son D. Dao (ICT 2019)	Deep Learning Models for Tuberculosis Detection from Chest X-ray Images	This system investigates the impact of transfer learning on medical imaging in the identification of tuberculosis. It is an approach for transfer learning that is superior to the conventional method of employing ImageNet weights. It's a new way to get low-level features by training models in a multiclass multilabel circumstance and a better technique to train in a data-constrained environment like the healthcare industry.
Enes Ayan, Halil Murat Ünver (EBBT-2019)	Diagnosis of Pneumonia from Chest X-Ray Images using Deep Learning	Implementation of computer aided diagnosis system for diagnosing pneumonia to assist clinicians. It is a comparison of Xception and Vgg16 CCN models' performance on the detection of the disease.In the training stage, fine-tuning and transfer learning were used. When it came to predicting pneumonia cases, the Xception network outperformed the competition (94%). However, the Vgg16 network is greater in accuracy for detection of normal cases than the Xception network (87%).
Ali Serener, Sertan Serte (2020)	Deep learning to distinguish COVID-19 from other lung infections.	Analyzing how they can distinguish COVID-19 from other lung anamolities. The system works on image processing of the X-ray and segmenting the processed image into six different neural networks.Based on the results from all the different neural networks, the condition of the patient is distinguished from other pleural infections. ResNet-18 architecture is then considered the most accurate and efficient in separating COVID-19 from pleural infections, effusion, pneumonia and lung mass
LiuLiu Fu, Ling Li (2016)	A Smart Decision Making System for Managing Patient Database	The objective is to smartly schedule the incoming/forthcoming patients in an effective way. To sort similar patients gathered together, thereby facilitating the medical proprietor. It comprises a Web-based interface that enables people to create and change classes like making due indexes. Support vector machine is used to automatically classify. For the storage of data (MySQL) is used as a local database.

IV. CONCLUSION

From the survey of existing methodologies and the techniques used to detect lung infections, it is clearly observable that the models have to be trained with a lot of sample X-ray images. The techniques have been effectively proven to be accurate, quick and deployable. The detection of ailments without visible symptoms has been made easier. The reach of the systems to the medical practitioners has led to further research paths on deep learning models. Categorizing the ailments has led to simpler diagnosis and quicker treatment procedures. Accuracy rate of the systems is reliable to judge the ailment and clear the suspicion, testing of various other infections. Image processing, though a part of the system, is not used intensively to capture the anomaly. There is still a paved path for the improvement of the detection of specific ailments by different deep learning models. The distinction of different diseases can be improved upon. And the rate of manifestation of the ailments can be further looked into. Models can be merged and hybrid models can be trained for better performance and results. Apart from X-rays, other scanning reports can be used to detect the ailments.

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DECLARATION

We, the project team hereby declare that the details enclosed in the manuscript is true and correct to the best of our knowledge and belief. In terms of Competing interests and Conflict of Interests, we have ensured we have not produced any work as our own but we have used the research to draw our own comparison analysis. Our work does not need any assistance with respect to funding as all the tools and resources used are through open source, open access and institutional access. We have received the ethical approval from our institution regarding the content of the paper and we are willing to give our approval for the publishing of the paper. We are glad to give our consent to participate in the journal and publish our manual in the same.

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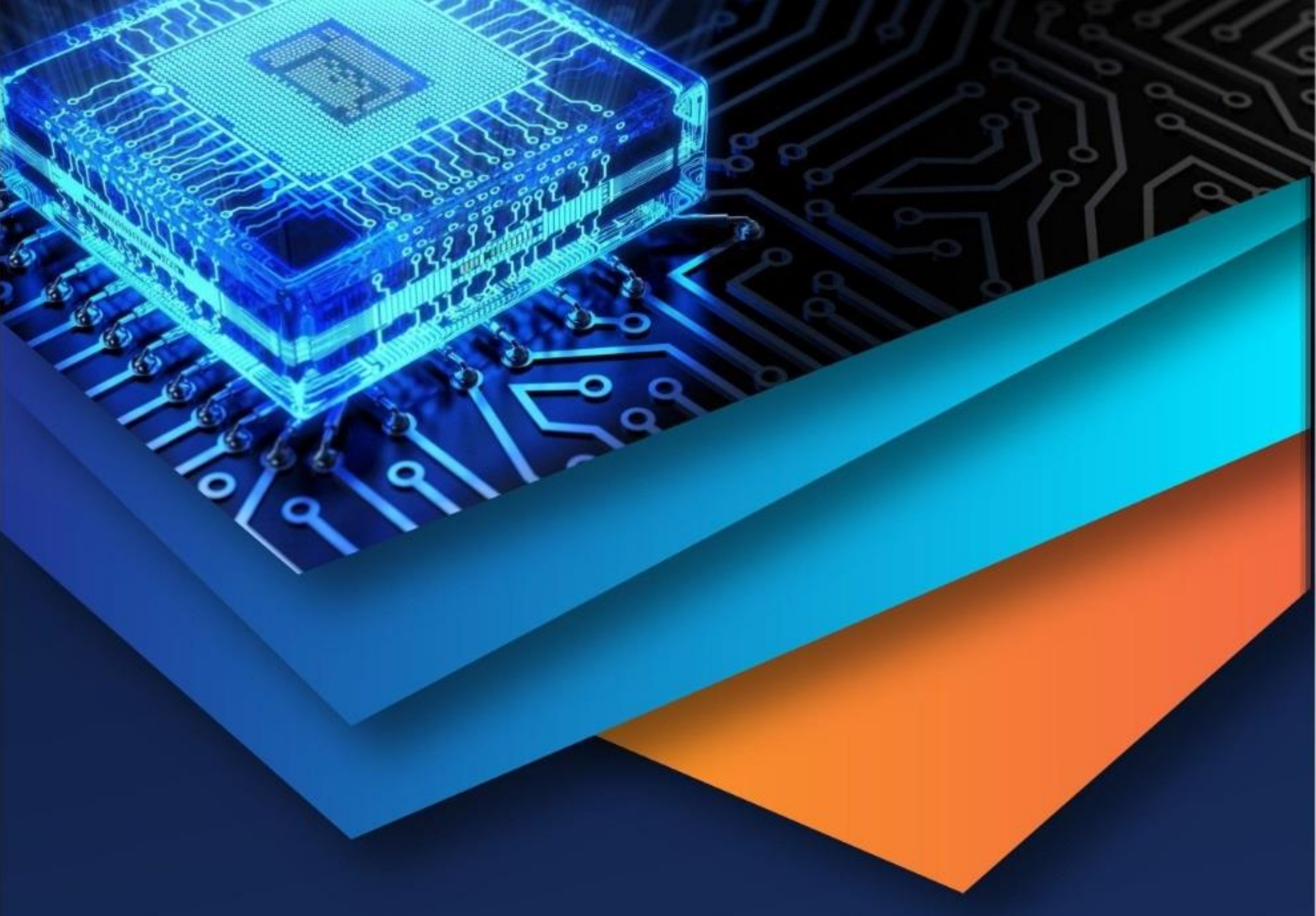

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