AI-Driven Lung Disease Detection: A Review of Deep Learning Models, Multimodal Integration, and Resource-Efficient Approaches.

Ankita Agarwal[1], Er. Mahendra Singh[2], Dr Sovan Mohanty[3]
[1]*M. Tech student, SRMS College of Engineering and Technology, Bareilly*
[2]*Assistant Professor, SRMS College of Engineering and Technology, Bareilly*
[3]*Professor And Head, SRMS College of Engineering and Technology, Bareilly*

***Abstract*—AI (artificial intelligence) has become a powerful tool in medical science, especially in the case of the detection of lung diseases like COVID-19, pneumonia, ILD, tuberculosis, etc. This review paper will focus your mind on learning the CNN based advance Deep Learning Models, which will help you to detect the diseases, predict their progression, using CT scans and X-ray images. These advanced models are multimodal; they include clinical information and laboratory information. Deep learning models achieve high accuracy in classifying diseases and show results after combining imaging data with clinical information. Lightweight model reduces the computational cost and can be used anywhere in areas where there are limited resources. Future directions include the development of a model trained on large datasets and heterogeneous datasets, which means different types of diseases, which will later be segregated. Overall, the paper explains the current state and future potential of AI approaches in lung diseases.**

***Index Terms*—Deep Learning, Convolutional Neural Network (CNN), Lung Disease Detection, Medical Image Analysis, Multimodal Learning, Lightweight CNN, Healthcare I.**

I. INTRODUCTION

Respiratory diseases, including pneumonia, tuberculosis (TB), chronic obstructive pulmonary disease (COPD), and lung cancer, are the most common and leading causes of morbidity and mortality worldwide. For the early diagnosis of these diseases, effective treatment should be given, which will improve patient outcomes. However, traditional diagnostic methods are based on clinical expertise, radiological interpretation, and laboratory testing, which are time-consuming and require lots of resources and are sometimes subject to human error, especially in regions where healthcare infrastructure is limited.

In the past few years, there has been a rapid advancement in AI (Artificial Intelligence), which has opened new possibilities in the field of medical diagnosis. The system, using Machine Learning and Deep Learning Models like CNN (Convolutional Neural Network), is used for structured data analysis. Deep Learning is just like a neural network in the brain that teaches the computer to learn from a large amount of data. In the same way, the brain trains the human brain to learn by doing a task repeatedly.

According to the Health Monitoring Report of WHO's 2024 for the Sustainable Development Goals, Lung conditions like lower respiratory infections, chronic obstructive pulmonary diseases (COPD), and tuberculosis are among the top ten main causes of death for Global Burden of Disease.

Approximately 3.2 million deaths occur because of COPD every year, which is 5% of total deaths in the world, 70% or more of these COPD deaths are attributed to smoking in high-income countries; meanwhile, 30-40% were due to household air pollution in lower and middle-income countries. After COVID-19, lung diseases have increased, due which death ratio of people due to lung diseases, is increased this catches my attention towards this topic. According to the data released in late 2025 and early 2026, there is a significant surge in India in lung disease mortality.

Statistical analysis of data shows that India is facing a significant increase in mortality in late 2025 and early 2026; the data shows that 1.6 million COPD deaths

occurred. The data shows that the WHO European Region affected by CRDs (chronic respiratory diseases) is 136199 people. The data shows that the deaths in the US are estimated to be 124,730 in 2025 due to lung cancer.

In Australia, the deaths of people due to lung cancer is 2172 recorded which is very less as compared to other countries because the atmosphere there is very good air pollution is very low as compared to other countries.

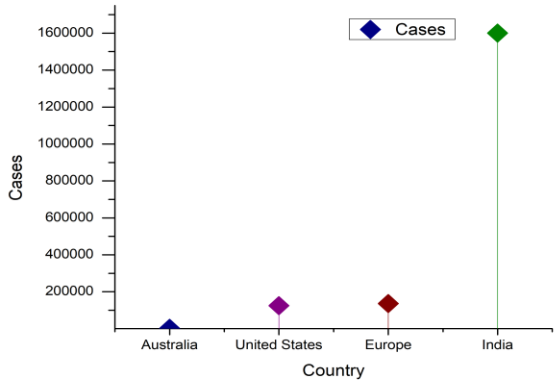

Fig.1- Demographic Presentation of Tb

II. RELATED WORK

Sachin Sharma et al. (2023) proposed the development of a deep learning model that will help to detect respiratory diseases using lung sound analysis. Respiratory diseases include COPD, pneumonia, and bronchitis, and more, which use traditional diagnosis techniques like X-rays and CT scans, which cause exposure to radiation. To overcome these drawbacks, the author proposed an efficient diagnostic approach that uses respiratory sound recordings, which are obtained through an electronic stethoscope. These samples are collected from multiple patients. The proposed model has the ability to reduce the work of the healthcare professionals and improve diagnostic accessibility.

Kieu et al. (2020) proposed the application of deep learning techniques in order to detect lung diseases by using medical images. The main target of this survey is to analyse deep learning approaches used in the detection of lung diseases. The author analysed 98 research papers published between 2016 and 2020. The author wrote a structured taxonomy which is based on 7 factors they are- types of images, feature extraction methods, data augmentation, deep learning algorithms, transfer learning, ensemble techniques, and types of lung diseases. This study also discusses the limited availability of updated data, class imbalance, lack of evaluated methods, and low decision-making models.

Lingga Aji Andika et al. (2020) proposed a deep learning model for detecting pulmonary tuberculosis (PTB) using chest X-ray images. To highlight the limitations of manual diagnosis, the author uses a CNN (Convolutional Neural Network) to classify images into two categories: normal and PTB. The data set used in this paper consists of 663 chest X-rays taken from the National Library of Medicine. This CNN model uses multiple convolutional and pooling layers, which is followed by fully connected layers. The model achieved a training accuracy 99.19%, and a validation accuracy 80.60%. thus the overall accuracy is 84%.

Ethan Dack et al. (2023) proposed the role of AI in the diagnosis of ILD (Interstitial Lung Disease). The author uses CNN (convolutional neural network), which can automatically detect pattern in high resolution CT, which will help to classify the diseases. Some challenges the author faced during the research is availability of data also they the help of a medical expertise in order to segregate the data, high cost of the tools required still exist. Therefore, paper conclude that multiple types of data and latest availability of data will make the future work more impressive.

Qiuli Wang et.al (2020) this paper proposes a framework of deep learning so that automatic pneumonia screening by using chest CT scans can be done. The main goal is to achieve real clinical diagnosis and also to improve the accuracy of screening. The three main components in this paper - Multi-channel CT scan Clinical Diagnosis.

Demographic Data

A CNN model is used to process CT scan. This model improves pneumonia screening and better reflects real-world clinical decision-making compared to image-only models.

Himadri Mukherjee et.al this paper proposed that AI (Artificial Intelligence) will help us to detect Covid-19 by using CT scans and chest X-rays. The author used a CNN with a few layers so that the model can become more efficient. The author has taken both types of images, i.e., CT scans and X-rays, and ensured that the

number of Covid and Non-Covid cases was balanced in this model author achieved the accuracy of 96%, i.e., the model performed so well. This model worked better than Deep learning models like Inception, Mobile Net, and ResNet. This approach can make diagnosis faster and more accessible where medical sources are limited.

Antonio Nadal-Martinez et al. proposed in this paper that AI (artificial Intelligence) will help. The doctors use X-rays and CT scans to detect lung diseases. This study uses two different types of Deep Learning Models. The first one is Direct classification, in which disease is identified in one step, and the second method is Two Stage Approach, in which firstly the normal and abnormal lungs are separated, and then if something wrong is seen in any lung is further considered.

These two methods are trained on a lot of data of images of X-rays and CT scans. The researchers found that the Two-Stage approach works better. This research focuses only on the lung area using visualization tools. This research also says that a small disease area cannot be detected by these models, so a large number of datasets should be required to train such models so that they may be helpful for doctors in the future.

Konstantinos P. Exarchos et.al this paper proposed that how AI is helping to transform the understanding of ILD (interstitial lung disease), which is sometimes difficult to diagnose and treat. This paper reviews that deep learning and machine learning models can be used to detect lung diseases. The AI models use CT scan and X-ray images in order to detect diseases, but the author reviews that additionally the biomarkers such as gene expression or proteins are used to improve the way of treatment. In this paper they have also highlighted the challenges they faced like high quality of datasets difficulties in AI decisions.

III. RESEARCH GAP

We know that AI (Artificial Intelligence) can detect lung diseases like pneumonia, ILD (interstitial lung disease), Covid-19, etc. But even though it can detect them, there are many problems that must be known.

The first one is that they mostly focus on imaging datasets like CT scans or X-rays, while all the other information, like the history of the patient, lung function tests, etc they are totally ignored, due to which the ability to detect diseases very accurately and precisely is not achieved.

Secondly, the models used small, unbalanced or outdated datasets, due to which their reliability is reduced in real-world clinical diagnosis.

Thirdly, some learning deep models are called “black boxes,” which means they do not explain why they have taken such decisions due to which the doctors to lose trust in it causes the adoption of AI to be quite slow in the healthcare field.

Fourth is that AI can perform well to diagnose whether a patient is suffering from lung disease or not, but they do not provide further treatment planning and do not assist in recommending therapies.

Fifth is some studies use advanced methods like generative learning, but limited studies have been done for this, so not practical for real-world use.

IV. METHODOLOGY

After reading these papers, I am proposing that a deep learning approach be followed to detect diseases like COVID-19 and ILD. The model is based on CNN (conventional neural network) multimodal data learning.

Firstly, the data is collected from the hospital, which has the images of CT scans, or u can also take the images of X-rays. These images have the data of both types of patients who are suffering from a disease and who are healthy, so that the model will be able to learn the difference between diseased and non-diseased persons. The model went through the preprocessing technique in which all the images of the data were resized means the dimensions of all the images were uniformized. Also, the noise is removed from the data, i.e., the images that have any other overlapping were removed so that there are no unwanted variations in the data. A CNN based modal in which there are different convolutional layers followed by pooling layers helps to improve the performance of the model. The augmentation process is done to increase the data to train the model. After that, feature extraction is done, which will tell you the minute details of the data, like length, breadth, blob, pixel, etc. Then, the classifier classified the different types of soft diseases like pneumonia, ILD, Covid-19, etc

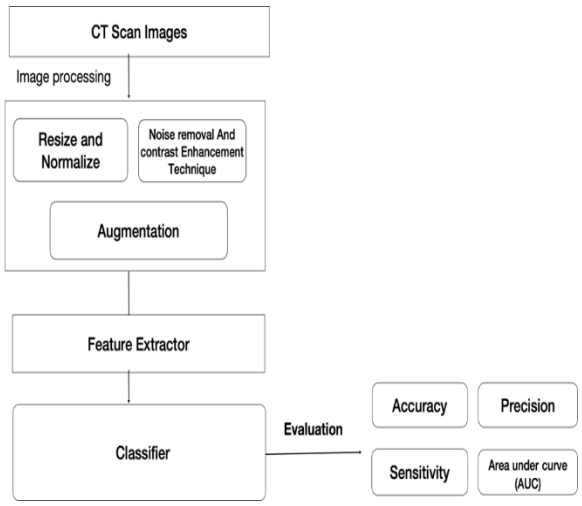

Fig.2- Process Of Methodology

V. DATA COLLECTION

When we take the images from the hospital, they are in the form of DICOM format. They are converted into .jpg format by using a Python program. If you are taking the data from an online source, then you may directly get the images in .jpg form, so there is no use of that Python program. After that, those images are segregated with the help of medical expertise, i.e., there will be multiple images that have different diseases, then many types of diseases are classified, like pneumonia, ILD, Covid-19, etc. There are multiple diseases in one image, and then the filtration is done so that those images are taken that have one disease in one image.

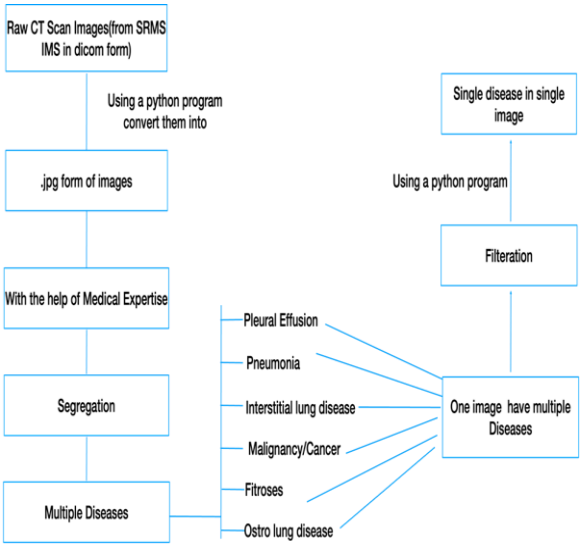

Fig.3 - Steps Followed During Research

VI. RESULT ANALYSIS

According to my proposed methodology, which is based on light weight CNN model, shows good performance when compared to existing approaches. The traditional models were single model means they need only one type of dataset (CT scans or X-ray images). The proposed method says that multimodal learning will give better performance as compared to other models, in which the datasets are combined with clinical information and laboratory information. So, the proposed model will give better performance in many cases when compared to traditional models.

Some models focus on specific tasks like the prediction of the type of diseases and also mortality prediction, so the proposed model will work much better for the classification of diseases and predicting mortality, and also provide guidelines to be followed.

Another point to be kept in mind is computational efficiency; the proposed model is light weight CNN model which require less resources, thus they require less computational cost. Many models are based on resources and cannot be used in low-resource settings. However, the proposed model is also affected by low availability of data, some variations in the quality of images, and these factors are similar to those in other papers also which also need to be improved.

VII. CONCLUSION AND FUTURE DIRECTION

The reviewed studies show that Artificial Intelligence (AI) will help us to detect lung diseases such as pneumonia, ILD, Covid-19, etc. by using Deep Learning Models from which are based on CNN, have high accuracy rate to identify the diseases from the CTScan or X-ray images. These models may help the doctors to make the diagnosis, and also many models combine with clinical information, which will help the doctors provide further diagnosis and clarify the treatment line.

The lightweight models show better efficiency as compared to traditional models will require high computational cost, and the performance level is also very high. Although these studies reveal that there are many challenges, such as the availability of data, unstructured datasets, and performance measurement of the models. In short, we can say that AI cannot be a full replacement of clinical persons but it can be an important and useful tool for medical expertise.

There are many important areas for future research in order to improve the system. Multimodal learning in which imaging datasets combine with clinical information, as well as laboratory information, so that the model will understand the diseases completely. Model explainability should be improved so that doctors can trust AI and follow their guidelines. Future models should be more efficient and require less computational cost so that every hospital can afford them to make the AI era more effective and powerful.

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