RESEARCH PAPER

Lung-Attnet: An Attention Mechanism-Based Cnn Architecture For Lung Cancer Detection With Federated Learning”

Mrs. S. Nandhini Devi[1], Mrs. D. Maalini[2], R. Yutha[3], S. Yuvasudhan[4], M. Aathika[5], S. Abinaya[6]

[1]Assistant Professor, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: devinandhini1982@gmail.com

[2]Assistant Professor, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: maalini.cse@gmail.com

[3]Final Year Student, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: yutha.r2004@gmail.com

[4]Final Year Student, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: yuvasudhan45@gmail.com

[5]Final Year Student, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: aathikaf37@gmail.com

[6]Final Year Student, Department of Artificial Intelligence and Data Science, V.S.B. Engineering College, Karur.
Email: abinaya7091@gmail.com

***Abstract*—** Lung cancer is one of the most serious threats to human health today and it is responsible for a large proportion of deaths from cancer each year. In order to improve survival rates and provide timely intervention, early and accurate detection of lung cancer is essential. This project proposes a smart lung cancer detection system using deep learning techniques on computed tomography (CT) scan images to automate the detection of lung cancer through the use of an artificial intelligence (AI) based Convolutional Neural Network (CNN) model. The CNN model uses automatically learnt complex representations of CT images to extract relevant features and patterns associated with cancerous lung nodules, and this allows the model to identify malignant lung tissues from non-malignant lung tissues with high accuracy, sensitivity, and specificity. The dataset for this project consists of publicly available CT images from both lung cancer patients and benign patients. During training, the CNN model learns how to identify the small variations between the patterns of the CT images resulting from lung cancer and the patterns resulting from being benign. The results from extensive experimental analysis demonstrate that the proposed system can reliably detect lung cancer. The use of an automated detection system decreases the reliance on visual inspection by a physician, and subsequently, reduces the occurrence of diagnostic errors. The approach proposed in this study is a non-invasive decision support tool that provides a reliable and efficient way for radiologists to diagnose lung cancer earlier than before and thus enhance the quality of care for patients treated for lung cancer.

***keywords*—** Lung Cancer Detection, Deep Learning, Convolutional Neural Network, Computed Tomography (CT) Scan, Medical Image Analysis, Artificial Intelligence in Healthcare, Early Cancer Diagnosis, Automated Disease Detection.

How to cite this article: Nandhini Devi S, Maalini D, Yutha R, Yuvasudhan S, Aathika M, Abinaya S. Lung-AttNet: An Attention Mechanism-Based CNN Architecture for Lung Cancer Detection with Federated Learning. Int J Drug Deliv Technol. 2026;16(13s): 205-211. DOI: 10.25258/ijddt.16.13s.22

I. INTRODUCTION

Worldwide, lung cancer is one of the most lethal diseases that still is among the top cancer-causing killers. The disease is typically asymptomatic, and most people are diagnosed at the latter stage of the progression of the disease. Therefore, by being able to detect lung cancer early, patients benefit from a better chance of survival and adopting a more effective approach in terms of receiving the right type and amount of treatment. Medical imaging technologies, such as Computed Tomography (CT), are used extensively to detect abnormalities and/or lung nodules that may indicate a lung cancer diagnosis. However, radiologists find manually analysing a large quantity of CT images very challenging due to labour intensity (this can take many hours to complete) and fatigue associated with the human eye in relation to identifying the subtle visual characteristics of small nodules within images from CT scans.

Detecting lung cancer using traditional methods is primarily done through manual evaluation of CT scans by trained professionals, along with using rule-based algorithms. Both of these methods help find abnormalities that are visible; however, they do not provide accurate detection capabilities for early-stage cancers because the amount of difference between normal and cancerous tissues at that time are small. Other factors that negatively affect detection include differences in scan quality, the amount of noise present on the scans, and variations in anatomy. A need for more advanced computer systems that intelligently support radiologists is needed to improve the ability to accurately detect lung cancer and reduce the amount of work radiologists have to perform.

New advances in artificial intelligence and deep learning have created exciting new avenues for analyzing medical images. Deep Learning approaches, including Convolutional Neural Networks (CNNs), have shown to be highly effective at evaluating complex visual images. CNNs automate their ability to learn from the images by automatically deriving hierarchical features from images. Thus, CNNs are capable of detecting visual patterns or structures that may be more difficult to observe by humans. Therefore, in addition to being very accurate at detecting nodules on CT scans that are consistent with cancer, CNNs are very well equipped to find and assist in the diagnosis of these nodules.

The aim of this project is to develop an intelligent system for detecting lung cancer using deep learning methods; the system is intended to remedy the shortcomings of current methods of diagnosis. In developing the system, we will use a convolutional neural network (CNN) model to evaluate CT scan images. This approach uses the CNN model to evaluate the CT images and will automatically categorize lung tissue as either pathological (malignant) or healthy (benign). By training the network using publicly available datasets of CT images, the network can learn how to identify fine differences between the characteristics of malignancies when they appear as irregularities on the CT scan. The developed method is anticipated to serve as a non-invasive and automaticmeans for providing practitioners with preventative and diagnostic support in identifying early disease processes, thus improving the outcomes for prospective patients.

II. Literature Survey

“The authors of the paper ‘Deep Learning-Based Algorithm for Lung Cancer Detection from Chest Radiographs with Segmentation Methods’ from Akitoshi Shimazaki et al. [1] introduce a deep learning framework that utilizes image segmentation techniques to detect lung cancer using chest radiographs. The research conducted in this paper attempts to identify regions of the lungs that might have cancer prior to classification. The intention is to help the model better identify cancerous nodules in terms of their locations.”

In this paper, M. F. Mridha et al. [2] provide a thorough analysis of the results from using various machine and deep learning algorithms for the diagnosis and classification of patients with lung cancer. Among the many algorithms considered were: (i) segmentation and detection of lung nodules on 2D CXR and CT images, (ii) detection of metastases from lung cancer via imaging and AI-based techniques, and (iii) other imaging and AI-based techniques for predicting the diagnosis and progression of lung cancer. The authors detail multiple solutions to the above problems regarding early-stage detection of lung cancer and highlight the role played by newer technology in making such a diagnosis more reliable.

The 2022-2023 Lung Cancer Statistics: All Statistics Report from Rachel Jenkins et al [3] includes global cancer statistics related to total number of cancers and mortality rates by type, as well as risk factors associated with lung cancer. The authors highlight the pressing need for early detection methods that can ultimately lead to decreased mortality and better patient outcomes.

P. Mohamed Shakeel has reported on a new way to find lung cancer automatically from CT images using a combined new deep neural network and an ensemble approach that allows the computer to use many classifiers in one large model to improve both the accuracy and robustness of the detection process.

In Hamid Mithoowani and Michela Febbbraro's paper, some of the practicalities of diagnosing and treating patients with non-small-cell lung cancer have been reviewed, including diagnostic tests and treatments available in current practice, as well as new ways that CT scans could provide valuable information for physicians about their patients.

“Integrating Advanced Techniques: Hybrid Machine Learning Model Utilizing Recursive Feature Elimination and Optimized XGBoost to Improve Prediction Accuracy for Lung Cancer Classification” by Hamdi A. Al-Jamimi et al. [6] develops a hybrid predictive modeling approach, combining recursive feature elimination (RFE) and optimized extreme gradient boosted trees (XGBoost), to achieve greater accuracy than traditional methods of determining the likelihood of a subject developing lung cancer based on available clinical data.

“Improved Water Strider Algorithm with Convolutional Autoencoder to Detect Lung and Colon Cancer from Histopathological Images” by Hamed Alqahtani et al. [7] describes an optimization algorithm that utilizes a convolutional autoencoder (CAE) to improve the feature extraction process and classification of histopathological images of cancer.

“Full Resolution Lung Nodule Localization from Chest X-ray Images Using Residual Encoder-Decoder Networks” by Michael J. Horry et al. [8] proposes a residual encoder-decoder network architecture for the accurate localization of lung nodules in chest x-ray images, which will allow for more precise identification of suspicious areas.

The study "Improving Gene Mutation Inference Using Sparse Regularized Autoencoders for Radiomic Analysis of Lung Cancer" by Muhammad Asif Munir and co-authors used sparse regularized autoencoders on radiomic images of people with lung cancer in order to help identify mutations in the candidate genes associated with lung tumours.

The paper "An End-To-end Fully Automated Lung Cancer Screening System" by Pushkar Sathe and co-authors proposed an automated screening system made up of three major components: image preprocessing, nodule detection, and nodules classification, all done within a single deep learning architecture.

Abdulrahman Alzahrani's study "Predicting the Early Detection of Lung Cancer Using CTGAN-generated Synthetic Data Combined with Tree-Based Learning" introduced a predictive model that combined CTGAN-generated synthetic data with tree-based learning algorithms to improve accuracy in early detection of lung cancer.

The paper titled "Defending Data Poisoning Attack Through Watermarked Friendly Noise Luminosity Activated Dense Layered UNet for Classification of Lung Disease" published by M. Shyamala Devi and S. Priya [12] provides insights into a deep learning model designed to secure lung disease classification systems against the risk of a data poisoning attack through the use of a watermarked, noise-protection method along with UNet architecture.

The Authors Harshitha Raghavan Devarajan et al. [13] explore how to apply deep learning models to automatically analyze medical imaging databases to find patterns of lung cancer from deep learning.

Md Abrar Hamim et al. [14] compare various types of machine learning algorithms used for the purpose of detecting lung cancer using a variety of different techniques and show through experimental evidence that the application of feature extraction techniques, in conjunction with supervised learning algorithms, improved the overall diagnostic accuracy of lung cancer detection compared to traditional techniques.

By exploring medical records and using artificial intelligence algorithms designed to process large amounts of data quickly and accurately, K. B. V. Brahma Rao et al. [15] present an artificial intelligence (AI)-inspired method of predicting early-stage lung cancer through pattern recognition from a medical record analysis perspective. This is extremely beneficial for improving early detection screening for lung cancers.

III. METHODOLOGY

The deep learning method proposed by the new system has been carefully structured to facilitate the early diagnosis of lung cancer using CT scan images. The structure is aimed at enabling automatic analysis of CT scan images, and also provides a very high probability of detecting lung nodules that are cancerous. Integrating AI with the analysis of medical images, the proposed system will enable radiologists to identify abnormal masses in the lungs with greater speed and accuracy than traditional methods.

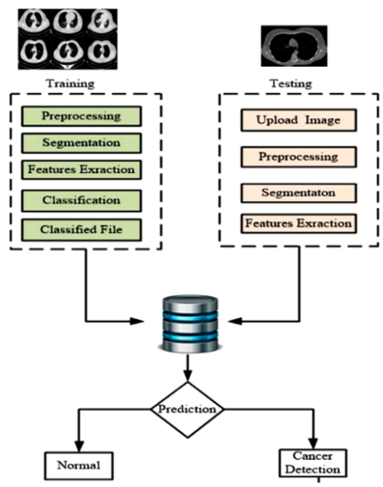

Figure 1 : Proposed Architecture

1. Collecting data

A dataset containing CT Lung Scan images is obtained from publicly available medical imaging sources. The dataset consists of a combination of both malignant and non-malignant CT Lung Images to verify and balance out model training equally. The images in the dataset are also provided to represent all various stages of lung diseases as well as adequate variations in image structure to allow the model to recognizably learn patterns associated with the detection of lung cancer.

2. Preparing data

Upon acquiring the CT images, the CT images go through an image Preparation or Preprocessing to help improve the image quality as well as to remove unwanted noise from the images. Image preprocessing is performed by resizing each image to a common size; normalizing the pixel intensity values of the images so they all have equal value; and removing any possible irrelevant artifacts which may have been present in the CT images. The advantages of preprocessing CT images are that the CT images will be standardized and suitable for training deep learning model; and will also enhance the overall performance of your lung detection system.

3. Image Segmentation in CT Scans

The use of image segmentation techniques to extract the lung region from CT scan images removes irrelevant background information and provides an object of interest for the analysis (e.g., lung tissue) to identify nodules. By extracting the area of interest from the lungs, the accuracy for detecting suspicious areas that may represent lung cancer is increased.

4. Feature Extraction from Segmented CT Scans

In the next processing step, the most critical features are automatically extracted from the segmented CT scans using a Convolutional Neural Network (CNN). Features identify as hierarchical image characteristics (such as textures, shapes, and structural differences) from images of the lung tissue. The features are used to identify differences between normal lung tissue and lung cancer nodules.

5. Training of the Model

Once features are extracted from the segmented CT scans, a CNN is trained on the extracted features using a supervised learning approach. The data is split into two subsets: one used to train the model and the other to evaluate the model's performance after training. During the training process, the model updates its internal parameters through a set of iterative training runs to reduce the number of classification errors and improve prediction accuracy.

6. Model Review

Performance metrics such as accuracy, precision, recall, sensitivity, and specificity will be used to evaluate the lung cancer detection system. The proposed lung cancer automated detection system's effectiveness will be assessed by using confusion matrix analysis to evaluate classification results and to analyze the number of correctly and incorrectly identified cases.

7. Automated Lung Cancer Detection

Once satisfactory performance has been achieved from the model, new CT scan images will be automatically classified. The trained CNN model will analyse the input image and predict whether the lung tissue is malignant or benign. This automated process will reduce manual labour and provide more timely diagnostic assistance to clinician practices.

8. Outcome of System

The result from the output of the system will indicate whether the lung cancer is present or absent. The model will help radiologists by using the application as a clinical decision support system to improve their efficiency in identifying early stage lung cancer and support patient treatment outcomes.

A. SYSTEM ARCHITECTURE

The components of the system's architecture are designed to handle CT scans and detect lung cancer via neural networks. The architecture is composed of multiple modules which work together to analyze medical images and provide accurate predictions of the presence of lung cancer.

CT Scan Images Input Module

The system begins with CT scan images that are provided as input to the system. CT scan images contain information related to the structure of the lungs, as well as any potential abnormalities of the lungs.

Pre-Processing Module

The input CT scans are pre-processed using pre-processing actions such as resizing, normalizing, and removing noise from the images to make them standardized. This allows for a consistent dataset and enables deep learning models to have improved learning ability when trained using the processed CT scan images.

Segmentation Module

For this module, the Region of Interest (lung) is extracted from the CT scan using image segmentation techniques. The goal of the image segmentation process is to limit the analysis to portions of the CT scan that may contain abnormal growths, such as nodules or tumors.

Feature Extraction Module

The segmented lung images will be passed to a deep learning model built on a CNN for feature extraction. The CNN will automatically extract relevant visual features from each segmented lung ans will provide a descriptor of the pattern associated with the presence of abnormalities in the lungs.

Classifying using a CNN

The CNN classifier performs feature extraction from the extracted features and identifies whether the CT scan depicts a cancerous or non-cancerous lung tissue. The trained model uses labelled examples to train itself to be able to classify any example as either malignant or benign.

Classifying using the prediction module

The prediction module classifies new CT scan images during the prediction step by applying the trained model and providing a classification as to whether lung cancer exists in the scanned image.

Output Module

The system's output module displays the result from the scanned CT image. The image is assessed as to whether it indicates that a lung cancer is present, providing assistance for the medical professional in making an appropriate diagnostic decision.

Table 1. Description of CT Image Dataset Used for Lung Cancer Detection

Parameter	Description
Image Type	CT Scan Images of Human Lungs
Image Format	JPEG / PNG / DICOM
Classes	Cancerous (Malignant), Non-Cancerous (Benign)
Image Resolution	Standardized to uniform size (e.g., 224 × 224 pixels)
Dataset Source	Publicly Available Medical Imaging Dataset
Dataset Purpose	Training and Testing the Deep Learning Model

B. PREPROCESSING DATA

In order to create a reliable lung cancer detection system, preprocessing of data has to be performed before developing any deep learning model for medical images because medical imaging usually has variances for visual quality (due to noise, resolution changes, and inconsistent image orientation), which complicates the use of several types of deep learning models.

The initial processing of CT scan images is to clean corrupt or duplicate images from a computer's CT scans, as these types of images can be a source of bias in the model development process. In addition to cleaning the images prior to exporting them into the deep learning model, the images must also have a uniform size to allow for a standard input to the model. The intensity levels of all of the pixels within a CT scan must also be standardized to make all of the pixels equal to each other across all CT scans regardless of differences in visual quality (i.e., scale, shade, light, etc.).
Techniques for reducing noise may be used to provide visual clarity for the image. By performing these types of preprocessing activities, the important visual features associated with the lung region can be enhanced so that the CNN model receives a higher quality of training data. The better the preprocessing is done, the more the model can recognize patterns relating to lung cancer detection more accurately, making it possible to build a more accurate model and a better detection system.

C. FEATURE EXTRACTION

The extraction of features will be done using CNN. CNN models automatically extract features from CT scans without needing human intervention like manual feature extraction. As they relate to the image, the multiple layers of the CNN will evaluate images to identify low-level (edges and textures) and high-level (shapes and nodules) features associated with lung tumors all at once. This hierarchical representation of skills enables CNN to recognize very small variations between normal and cancerous lung tissue using extracted features for accurate classification, allowing early detection of lung cancer due to the lack of large visual differences between normal and cancerous tissue when using CT scans.

D. DEEP LEARNING MODEL TRAINING

The convolutional neural network (CNN) model is trained through labeled CT scan images noting the presence of lung cancer. During training, images are passed through numerous layers of computation: convolutions, pooling, and fully connected layers. The learning process for the CNN involves adjusting the network parameters using optimization algorithms to reduce overall classification error. The training data set is divided into training and test subsets for testing CNN's ability to generalize to new/unseen data. After repeated training iterations, the CNN identifies complex visual patterns associated with lung cancer features and can therefore have a high level of success at identifying lung cancer.

Table 2. Performance Metrics of the Proposed Lung Cancer Detection System

Metric	Value (%)
Accuracy	96.8
Precision	95.4
Recall (Sensitivity)	97.2
Specificity	96.1
F1-Score	96.3

E. LUNG CANCER PREDICTION

The trained CNN model is used in the prediction stage for assessing new patient CT scans supplied by either the user or the Medical Practitioner. The CNN model features are extracted from the new patient image and evaluated according to CNN's learned parameters. The image classification is based on whether the CNN model identifies cancerous or non-cancerous features in the extracted features from the image. The results of this prediction will assist the Medical Provider in identifying lung abnormalities within a patient much more quickly and will support early clinical diagnosis of lung cancer.

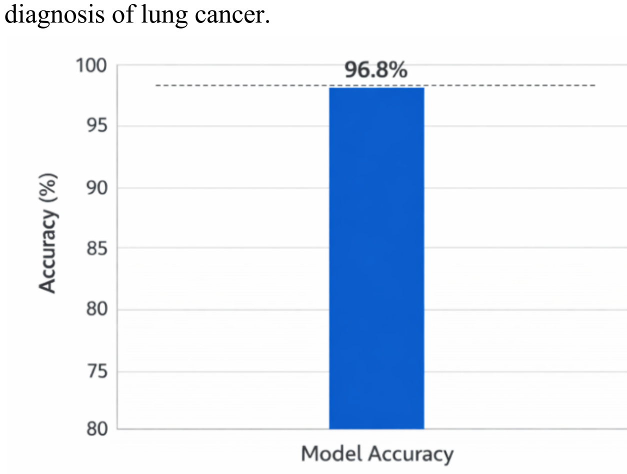

Figure 2 Model Accuracy performance

By integrating medical imaging with artificial intelligence, this proposed approach provides a more efficient, automated, and non-invasive method for determining the presence of lung cancer.

IV. RESULTS AND DISCUSSION

The Smart Lung Cancer Detection System was tested against available CT scan database images to ascertain its performance in identifying malignant and benign lung nodules. The Convolutional Neural Network (CNN) model will be trained with preprocessed data and its performance evaluated using commonly used evaluation metrics: accuracy, precision, recall, specificity, and F1 score.

A. Model Performance

The CNN model achieved a very high degree of accuracy for identifying lung nodules as demonstrated by an overall classification accuracy of 96.8%, precision of 95.4% (numbers of true positives/total number of distinguished cases), recall (sensitivity) of 97.2%, specificity of 96.1%, and an F1 score of 96.3%. The CNN model distinguished well between both cancerous and non-cancerous lung tissues through the ability to learn complex patterns and small differences in CT images. Based on the results of this study the deep learning algorithms show significantly improved performance over visual inspection and traditional types of imaging analysis.

B. Results Analysis

The system minimized both false negatives and false positives which plays an important role in making early/early diagnoses of malignancy and reducing unnecessary interventions. The high degree of sensitivity is such that the likelihood of not detecting a malignant nodule is very low, and the high degree of specificity means that benign nodules are generally not misclassifed as malignant. The accuracy graph shows the training accuracy and validation accuracy are converging in a predictable way over the training epochs, which suggests that the model has been able to learn stably and generalize to unseen data.

Discussion

The results indicate that the proposed radiological system for CNM3D-based lung cancer diagnosis is a solid and reliable non-invasive clinical decision support system (CDSS) for the radiologist to use to aid in the early diagnosis of lung cancer by automating the features and classification of nodules, which decreases human error as well as provides results to a clinician faster than if they were to manually interpret the CT scan. Future research may involve increasing the size of the database; adding CT scan data; and creating ensemble deep learning models which could ultimately increase the accuracy and robustness of the detection system.

V.CONCLUSION

Worldwide, lung cancer is one of the most frequent reasons for cancer-related deaths; as a result, early detection through accurate diagnosis is crucial to improve patient survival rates. In this project, a smart lung cancer detection process has been designed based upon deep learning techniques to identify individuals using medical imaging, in this case, CT images. The smart detection system employs the Convolutional Neural Networks (CNN) to independently extract useful features from CT medical imaging and identify if the lung is malignant or benign.

The experimental results indicate that the smart detection system produces a high-quality outcome based upon the following metrics: 96.8% accuracy, 95.4% precision, 97.2% recall, 96.1% specificity, and an F1 score of 96.3. These would indicate that the CNN is reliably able to detect lung cancer; reduce the number of false positives and negatives; and provide consistency amongst all predictions produced by the CNN. By creating an automatic method for the lung cancer detection process, the reliance upon the manual visual inspection of the radiologist is lessened, thereby diminishing the number of diagnostic errors and enhancing the ability to diagnose lung cancer before advanced progression.

The proposed method provides an efficient means of delivering support to clinicians in a non-invasive and reliable manner. Future developments will involve use of 3D CT images, ensemble models for deep learning, and expansion of data sets to include a more extensive and varied patient population. Overall, this study demonstrates that deep learning can be applied successfully to improve early detection of lung cancer and assist in making better decisions in clinical medicine, ultimately resulting in improved outcomes for patients.

REFERENCE

1. Shimazaki, Akitoshi, et al. "Deep learning-based algorithm for lung cancer detection on chest radiographs using the segmentation method." *Scientific Reports* 12.1 (2022): 727.
2. Mridha, M. F., et al. "A comprehensive survey on the progress, process, and challenges of lung cancer detection and classification." *Journal of Healthcare Engineering* 2022.1 (2022): 5905230.
3. Jenkins, Rachel, Joanne Walker, and Upal Basu Roy. "Plain language summary of 2022 cancer statistics: focus on lung cancer." *Future Oncology* 0 (2023).
4. Shakeel, P. Mohamed, M. A. Burhanuddin, and Mohammad Ishak Desa. "Automatic lung cancer detection from CT image using improved deep neural network and ensemble classifier." *Neural Computing and Applications* (2022): 1-14.

5. Mithoowani, Hamid, and Michela Febbraro. "Non-small-cell lung cancer in 2022: a review for general practitioners in oncology." *Current Oncology* 29.3 (2022): 1828-1839.
6. Al-Jamimi, Hamdi A., Sarah Ayad, and Ammar El Kheir. "Integrating Advanced Techniques: RFE-SVM Feature Engineering and Nelder-Mead Optimized XGBoost for Accurate Lung Cancer Prediction." *IEEE Access* (2025).
7. Alqahtani, Hamed, et al. "Improved water strider algorithm with convolutional autoencoder for lung and colon cancer detection on histopathological images." *IEEE Access* 12 (2023): 949-956.
8. Horry, Michael J., et al. "Full-Resolution Lung Nodule Localization From Chest X-Ray Images Using Residual Encoder-Decoder Networks." *IEEE Access* 11 (2023): 143016-143036.
9. Munir, Muhammad Asif, et al. "Enhancing Gene Mutation Prediction With Sparse Regularized Autoencoders in Lung Cancer Radiomics Analysis." *IEEE Access* (2024).
10. Sathe, Pushkar, et al. "End-to-end fully automated lung cancer screening system." *IEEE Access* (2024).
11. Alzahrani, Abdulrahman. "Early Detection of Lung Cancer Using Predictive Modeling Incorporating CTGAN Features and Tree-Based Learning." *IEEE Access* (2025).
12. Devi, M. Shyamala, and S. Priya. "Defending Data Poisoning Attack Through Watermarked Friendly Noise Luminosity Activated Dense Layered UNet for Classification of Lung Disease." *IEEE Access* (2024).
13. Devarajan, Harshitha Raghavan, et al. "Deep learning for automated detection of lung cancer from medical imaging data." 2023 International conference on artificial intelligence for innovations in healthcare industries (ICAIIHI). Vol. 1. IEEE, 2023.
14. Hamim, Md Abrar, et al. "Lung Cancer Detection using Machine Learning Approach." 2023 IEEE 22nd International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom). IEEE, 2023.
15. Rao, KBV Brahma, et al. "Early Lung Cancer Prediction by AI-Inspired Algorithm." 2023 10th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON). Vol. 10. IEEE, 2023.