Enhanced Lung Cancer Detection Using Hybrid Neural Networks and MRI Image Processing

G.NAGA SAILAJA[1], SK.MUNWAR ALI[2]

[1]PG Scholar, Dept. of E.C.E, Eswar College Of Engineering, Narasaraopet, Palnadu Dt.

[2]Asst Professors, Dept. of E.C.E, Eswar College Of Engineering, Narasaraopet, Palnadu Dt.

Abstract: In this research, we propose a novel modular neural network approach for the accurate detection of lung cancer in humans. The study utilizes MRI scans of patients, which are processed through advanced image processing techniques and neural network models to determine the presence of lung cancer. To enhance the quality of MRI images for analysis, a gray scale conversion is applied, making the images suitable for further evaluation. A neural fuzzy classification algorithm is employed to assess critical image features such as contrast and energy key indicators in lung cancer detection. Additionally, a feature extraction algorithm is used to calculate the image entropy. By analyzing the extracted features entropy, contrast, and energy the system can effectively classify whether a patient is affected by lung cancer.

Key Words: Modular Neural Network, MRI Image Processing, Feature Extraction Algorithm, Lung Cancer Detection.

1. INTRODUCTION

In recent years, the needs for computational methods which can automatically and efficiently diagnose the diseases have been increased in an enormous way. These methods can be applied to a large number of diseases like blood cancer, lung cancer, and pneumonia and so on. In this paper we have worked on lung cancer with the use of neural networks. Neural Networks has the capability of resembling the human brain. We can implement neural networks in this field so that it can analyses various aspects and can able to make the correct decision.[1] increases the accuracy of the output will also be very high. According to NCBI, in India nearly 6.9% of new cancer case is constituted by lung cancer and it also contributes about 9.3% of total deaths caused by all forms of cancer.[7] The rise of Lung cancer has been significantly increased in India. According to the stats by cancer.org the chances of getting lung cancer for male is 1 in 15 and for women it is 1 in 17. So, the lung cancer is to be identified as early as possible and needs to be treated. Computer-aided detection (CAD) is a method proposed by JIA Tong et al. [1] to detect

As the dataset for the neural network

Doi:10.48047/ijiee.2025.15.6.14

lung nodules early on from CT scans. This study made use of several methods, such as lung parenchyma segmentation, nodule candidate detection, feature extraction, and classification. They've used methods like the Hessian matrix, the Gaussian filter, and the adaptive threshold segmentation. Gomathi et al. [2] published a technical paper titled "A Computer Aided Diagnosis System for Detection of Lung Cancer Nodules Using Extreme Learning Machine," in which they proposed a CAD system that employs the fuzzy Possibilities C Mean (FPMC) algorithm for segmentation, with the goal of improving diagnostic precision. After segmentation, cancer nodules are classified using a technique based on rules. [2] Due to its superior classification, Extreme Learning Machine (ELM) is utilized for the learning process. Here modified neural network has been used for the identification of lung cancer. In their paper "Geometrical and Texture Feature Estimation of Lung Cancer and TB Image Using Chest X-ray Database," Patil et al. [3] describe the development of an Active Shape Model (ASM) technique for lung field segmentation. In medical image analysis, segmentation is essential for determining whether or not a patient has a disease based on a photograph [21]. Texture was also analysed using the Gray Level Co-occurrence Matrix (GLCM) method.[4] The method is applied to the Small-cell and Non-small-cell types of lung cancer pictures, as well as the TB database. We are using the feature detection technique for the image classification and then we are using the neural fuzzy classification for the calculation of contrast and energy .From the below sections we can come to know the process of identification of lung cancer.

2. Literature Review

Lung Cancer Detection Using Image Processing

Lung cancer remains one of the leading causes of mortality worldwide, and early detection is crucial for effective treatment. Computed Tomography (CT) imaging is the most commonly used method for lung cancer diagnosis [23]. The integration of medical science and computing has led to the development of Computer-Aided Diagnosis (CAD) systems, which assist doctors in analysing lung CT images through automated algorithms. One such approach involves the use of cellular learning automata for the automatic detection of lung cancer. Since raw CT images contain unwanted data and noise, pre-processing techniques such as Gabor filtering and region growing are

Doi:10.48047/ijiee.2025.15.6.14

applied to enhance important features. After pre-processing, key features of lung nodules are extracted, and cellular learning automata are trained to detect lung cancer [22]. Experimental results demonstrate that this approach reduces error rates and improves diagnostic accuracy.

3. Existing System

Lung Cancer detection presents a significant challenge in the medical field due to its asymptomatic nature in early stages and the complexity of accurately diagnosing it using traditional methods. Despite advances in imaging techniques and biopsy procedures, there remains a substantial need for more precise and early detection methods to improve survival rates and treatment outcomes. Current diagnostic practices often involve subjective interpretation of medical images and invasive procedures, which can lead to delayed diagnoses and increased patient discomfort. This problem is compounded by the high variability in tumor appearance and the presence of overlapping features with other lung conditions. The accuracy can be improved using appropriate classifier which will remove the accuracy problem in the work. We, by understanding the complexity of the work have used a much more reliable classifier which use proper classification i.e. SVM [25]. We have used the classification not only considering the threshold of the classification system [24]. We have considered the data set correlation which helped in improvement of results. We have used the data correlation to select the best feature for the classification process in the system.

DRAW BACKS

- Lung conditions introduce artifacts that complicate segmentation.

4. Proposed System

These limitations highlight the need for automated and precise segmentation methods. This study aims to develop an Artificial Neural Network (ANN) model for automated tumor segmentation in Lung Cancer imaging. The proposed ANN model will be trained on a comprehensive dataset of annotated lung images, learning to identify and delineate tumor boundaries accurately. By leveraging deep learning techniques, the model aims to achieve high segmentation accuracy, consistency, and robustness across diverse imaging conditions.

4.1 Lung Cancer detection using ANN Data collection: A total number of 25 data managed to be collected. In which 15 are the cancerous

Doi:10.48047/ijiee.2025.15.6.14

and the remaining 10 are noncancerous. No additional information on the CT scan images are obtained, thus the medical status and the background of the images are left as the task to be analyzed in order to choose the suitable images to be used for the project. Preprocessing of Images often get corrupted by noise when collected from various sources, affecting their quality. To address this, a median filter is initially applied to enhance the signal-tonoise ratio. Unlike averaging filters that use the mean of surrounding pixels, median filtering replaces each pixel with the median value of its neighborhood. This approach is more effective at removing outliers and noise while preserving image edges and sharpness.

The following example demonstrates the effectiveness of an averaging filter and median filter (med lt2) in removing salt-andpepper noise. This type of noise appears as random pixels set to either black or white, representing the extremes of the data range.

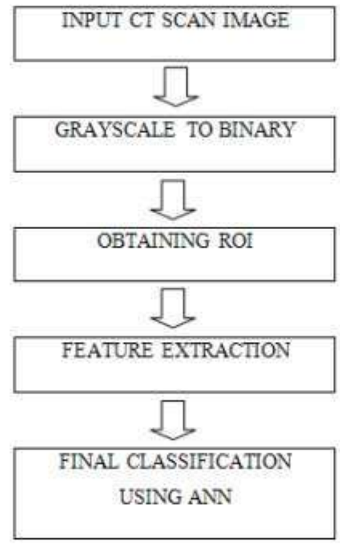


Fig 1: Proposed Implementation **Gray scale to Binary conversion**

Image binarization is a subclass of image segmentation as it divides an image into segments based on the value of pixels to a threshold value. The simplest of all the thresholding techniques is partition of the image using a single global threshold.

Edge segmentation

Edge preservation is an image processing technique to recover degraded and blurred images resulted while reducing the negative effect of noise in images. It can be a preliminary step toward better binarization and object segmentation. In our project edge detection algorithm, on the noise removed image, to mark the edges of the cells. It was observed that

Doi:10.48047/ijiee.2025.15.6.14

edge detection produced best results in case of sharp images where as in blurry images the accuracy of edge detected is reduced. Since the cells are circular in shape we expected the edge detected to be circular and complete.

- Apply sobel Edge Detection: Use the edge function in MATLAB to apply the Canny edge detection algorithm. • Apply Canny Edge Detection: Use the Convolve image f(r, c) with a Gaussian function to get smooth image f^(r, c).

f^(r, c) =f(r,c)*G(r,c,6) • Apply first difference gradient operator to compute edge strength then edge magnitude and direction are obtained as before.

- Apply non-maximal or critical suppression to the gradient magnitude.
- Apply threshold to the non-maximal suppression image.

Gradient Calculation: Compute the gradient of the smoothed image to find the strength and direction of edges. NonMaximum Suppression: Suppress nonmaximum pixels, which help to thin the edges by keeping only the local maxima in the gradient magnitude. Edge Tracking by Hysteresis: Apply edge tracking by using two thresholds, a high threshold and a low threshold. Pixels with gradient magnitudes above the high threshold are considered strong edges, and those between the high and low thresholds are considered potential edges. Edge pixels are connected if they form a continuous path above the high threshold. a second order derivative defined as

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

It has two effects, it will smooth the image and it computes the Laplacian, which yields a double edge image. Locating edges then consists of finding the zero crossings between the double edges. The digital implementation of the Laplacian function is usually made through the mask below,

0	-1	0
-1	4	-1
0	-1	0

G_x

-1	-1	-1
-1	8	-1
-1	-1	-1

G_y

The Laplacian is generally used to found whether a pixel is on the dark or light side of an edge.

Apply high and low thresholds to determine strong and weak edges:

If G(x, y) >High Threshold, it's a strong edge pixel.

If Low Threshold< G(x, y) <High

Doi:10.48047/ijiee.2025.15.6.14

Threshold, it's a weak edge pixel.

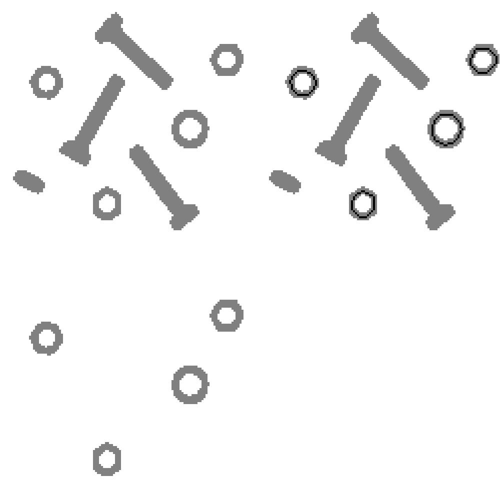
If G(x, y) <Low Threshold, it's not considered an edge pixel. These equations are used iteratively across the entire image to detect edges. The following two steps background extraction and lung cancer cell separation are all somewhat based on this fact.

$$B(x, y) = \{1, \text{ if } I(x, y) >= T \\ 0, \text{ if } I(x, y) < T\}$$

In this case, if the intensity I(x, y) at a pixel is greater than or equal to the threshold value T, it is set to 1 (white), indicating foreground. If it is less than the threshold, it is set to 0 (black), indicating background. **Morphological operation**

The various algorithms that we have described for mathematical morphology can be put together to form powerful techniques for the processing of binary images and gray level images. As binary images frequently result from segmentation processes on gray level images, the morphological processing of the binary result permits the improvement of the segmentation result. In medical image segmentation, especially for detecting cancerous regions, erosion and dilation are two fundamental morphological operations used to refine binary segmented images.

- **Erosion** removes small noise and shrinks the boundaries of segmented regions. When applied to a cancer-segmented image, erosion helps eliminate small, irrelevant white patches (false positives) and isolates actual tumor areas more clearly.
- **Dilation** does the opposite by expanding white regions, which helps reconnect broken parts of the cancer region and enhances visibility of cancerous structures.



a) Binary image b) Skeleton after filter c) Objects with holes

Fig 2: Isolation of objects with holes using morphological operations.

Filling holes in objects- To fill holes in objects we use the following procedure

Doi:10.48047/ijiee.2025.15.6.14

which is Segment image to produce binary representation of objects

Texture analysis refers to the characterization of regions in an image by their texture content. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky, or bumpy as a function of the spatial variation in pixel intensities. In this sense, the roughness or bumpiness refers to variations in the intensity values, or gray levels.

Neural networks have been effectively applied across a range of problem domains like finance, medicine, engineering, geology, physics, and biology. From a statistical viewpoint, neural networks are interesting because of their potential use in prediction and classification problemsAn artificial neural network is an information processing system which has certain performance characteristics similar to biological neural networks. Neural network consists of a large number of simple processing elements called neurons. Each neuron connects to other neurons by means of directed communication links, each with an associated weight. The weights represent information used by the network to solve a problem. Below Fig. shows the basic design of a simple multilayer neural network. In general, multilayer ANNs can have more than one hidden layer.

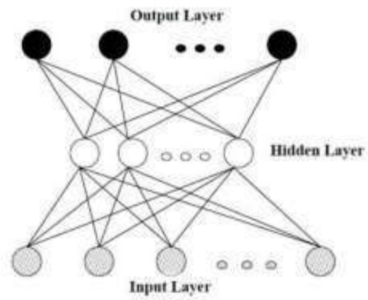


Fig 3: A basic multilayer neural network. Input Layer: As the name suggests, it accepts inputs in several unlike configures provided by the programmer.

Hidden Layer: The hidden layer presents in-between input and productivity layers. It performs all the calculations to find hidden skin tone and patterns.

Output Layer: The input goes from side to side a series of transformations using the hidden layer, which finally outcome in output that is conveyed using this layer. The artificial neural network takes input and computes the slanted sum of the inputs and includes a bias. This computation is represented in the form of a convey function.

$$\sum_{i=1}^{n} Wi * Xi + b$$

The weighted total is used as an input to an activation function, which determines the

Doi:10.48047/ijiee.2025.15.6.14

output. Activation functions decide whether a node should be activated or not, allowing only the activated nodes to reach the output layer. Various activation functions are available, each suited to different types of tasks.

We have explained the process of training the neural network. After training, the resulting output is a trained model with extracted features. Once an image is converted to grayscale and resized, it is evaluated using the trained model. Based on the training results, different regions of the image are classified according to predefined class labels. This classified information is then stored and utilized for further decisionmaking.

5. RESULTS & DISCUSSION

The experiments are done using MATLAB R 2013a tool. Lung Cancer dataset available collections of quality controlled lung cancer images. For the implementation of the proposed method, spatial domain, and frequency domain of 30 dermoscopiclung lesion images have been obtained respectively by applying ANN to classify cancer or not .

Fig 4: MAT GUI for the proposed project

The above image shows a MATLAB GUI (Fig 4) for a project titled "Lung Cancer Detection by Using Artificial Neural Network." It includes buttons for loading lung images, performing preprocessing steps like histogram equalization, segmentation, filtering, and dilation, and extracting features like entropy, contrast, and energy. The interface also incorporates neuro-fuzzy classification for analyzing and categorizing the images.

Fig 5: Selecting the Lung scan Image for processing

This shows the file selection process within the MATLAB GUI, where the user can

Doi:10.48047/ijiee.2025.15.6.14

choose a lung scan image (Fig5) for analysis.

Fig 6: Neuro-fuzzy classification to identify patterns feature extraction

The above image (Fig 6) shows the interface includes functionalities like image input The system integrates neuro-fuzzy classification to identify patterns and assist in diagnosis. It represents a key step in medical image analysis for lung cancer detection.

The above image (Fig 6) displays an enhanced MATLAB GUI for lung cancer detection. In addition to the previously mentioned steps, it includes a "Filtered Image" section, which represents the output after applying image filtering techniques to reduce noise and highlight significant features in the CT scan.

Fig 7: Results after edge segmentation and

Lung cancer detection using edge segmentation and feature extraction with Artificial Neural Networks (ANN) enhances accuracy in identifying malignant regions.

Edge segmentation helps in isolating tumor boundaries from lung scans, improving feature extraction. Key features such as shape, texture, and intensity variations are analyzed to differentiate cancerous and non-cancerous regions.

6. Conclusions & Future work

This study presents a Computer-Aided Diagnosis (CAD) system for detecting cancerous cells in CT scan images using a four-stage approach: pre-processing, ROI extraction, feature extraction, and classification. Pre-processing enhances image clarity by adjusting contrast, applying

Doi:10.48047/ijiee.2025.15.6.14

thresholding, and removing noise. The Region of Interest (ROI) is then identified, and features are extracted using These features are input into an Artificial Neural Network (ANN) trained to differentiate between cancerous and non-cancerous cases. During testing, the system compares new image features to trained data to determine a match and provide a diagnosis. This CAD system supports radiologists in early cancer detection, enhancing accuracy and enabling timely treatment.

Future work: Artificial Neural Networks (ANNs) offer great potential for advancing lung cancer detection. Future developments may include integrating ANNs with deep learning models for higher accuracy, using multimodal data for better diagnosis, and creating real-time, interpretable tools to support early detection. Lightweight models could also enable deployment in remote and mobile healthcare environments.

REFERENCES

[1] D. Cascio, R. Magro, F. Fauci, M. Iacomi, and G. Raso, "Automatic detection of lung nodules in CT datasets based on stable 3D mass-spring models," Comput. Biol. Med., vol. 42, no. 11, pp 1098–1109, 2012, doi: 10.1016/j.compbiomed.2012.09.002.

[2] M. Javaid, M. Javid, M.Z.U. Rehman, and S.I.A. Shah, "A novel approach to CAD system for the detection of lung nodules in CT images," Comput. Methods Programs Biomed., vol. 135, pp. 125–139, 2016, doi: 10.1016/j.cmpb.2016.07.031.

[3] A. Halder, S. Chatterjee, D. Dey, S. Kole, and S. Munshi, "An adaptive morphology based segmentation technique for lung nodule detection in thoracic CT image," Comput. Methods Programs Biomed., vol. 197, p. 105720, 2020, doi: 10.1016/j.cmpb. 2020.105720.

[4] T. Yanagihara and H. Takizawa, "Pulmonary nodule detection from X-ray CT images based on region shape analysis and appearance-based clustering," Algorithms, vol. 8, no. 2, pp. 209–223, 2015, doi: 10.3390/a8020209.

[5] W.J. Choi and T.S. Choi, "Automated pulmonary nodule detection based on three-dimensional shape-based feature descriptor," Comput. Methods Programs Biomed., vol. 113, no. 1, pp. 37–54, 2014, doi: 10.1016/j.cmpb.2013.08.015.

[6] P. Badura and E. Pietka, "Soft computing approach to 3D lung nodule segmentation in CT," Comput. Biol. Med., vol. 53, pp. 230–243, 2014, doi: 10.1016/j.compbiomed.2014.08.005.

[7] B. Chen et al., "Automatic segmentation of pulmonary blood vessels and nodules based on

Doi:10.48047/ijiee.2025.15.6.14

local intensity structure analysis and surface propagation in 3D chest CT images," Int. J. Comput. Assist. Radiol. Surg., vol. 7, no. 3, pp. 465–482, 2012, doi: 10.1007/s11548-011-0638-5.

[8] J. Gong, J. Yu Liu, L. Jia Wang, B. Zheng, and S. Dong Nie, "Computer-aided detection of pulmonary nodules using dynamic self-adaptive template matching and a FLDA classifier," Phys. Medica, vol. 32, no. 12, pp. 1502–1509, 2016, doi: 10.1016/j.ejmp.2016.11.001.

[9] A. Teramoto and H. Fujita, "Fast lung nodule detection in chest CT images using cylindrical nodule-enhancement filter," Int. J. Comput. Assist. Radiol. Surg., vol. 8, no. 2, pp. 193–205, 2013, doi: 10.1007/s11548-012-0767-5.

[10] N. Camarlinghi et al., "Combination of computer-aided detection algorithms for automatic lung nodule identification," Int. J. Comput. Assist. Radiol. Surg., vol. 7, no. 3, pp. 455–464, 2012, doi: 10.1007/s11548-011-0637-6.

[11] S. Sivakumar and C. Chandrasekar, "Lung nodule detection using fuzzy clustering and support vector machines," Int. J. Eng. Technol., vol. 5, no. 1, pp. 179–185, 2013.

[12] G.T. Reddy, M.P.K. Reddy, K. Lakshmanna, D.S. Rajput, R. Kaluri, and G. Srivastava, "Hybrid genetic algorithm and a fuzzy logic classifier for heart disease diagnosis," Evol. Intell., vol. 13, no. 2, pp. 185–196, 2020, doi: 10.1007/s12065-019-00327-1.

[13] H.M. Orozco, O.O.V. Villegas, L.O. Maynez, V.G.C. Sanchez, and H.D.J.O. Dominguez, "Lung nodule classification in frequency domain using support vector machines," 2012 11th Int. Conf. Inf. Sci. Signal Process.their Appl. ISSPA 2012, no. July, pp. 870–875, 2012, doi: 10.1109/ISSPA.2012.6310676.

[14] T. Messay, R.C. Hardie, and S.K. Rogers, "A new computationally efficient CAD system for pulmonary nodule detection in CT imagery," Med. Image Anal., vol. 14, no. 3, pp. 390–406, 2010, doi: 10.1016/j.media.2010.02.004.

[15] G.T. Reddy and N. Khare, "Hybrid Firefly-Bat optimized fuzzy artificial neural network based classifier for diabetes diagnosis," Int. J. Intell. Eng. Syst., vol. 10, no. 4, pp. 18–27, 2017, doi: 10.22266/ijies2017.0831.03.

[16] B. Chandrasekaran and S. Fernandes, "Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus. The COVID-19 resource centre is hosted on Elsevier Connect, the company ' s

Doi:10.48047/ijiee.2025.15.6.14

public news and information website," Diabetes MetabSyndr., vol. 14(4), no. January, pp. 337–339, 2020.

[17] N. Deepa et al., "An AI-based intelligent system for healthcare analysis using Ridge-Adaline Stochastic Gradient Descent Classifier," J. Supercomput., vol. 77, no. 2, pp. 1998–2017, 2021, doi: 10.1007/s11227-020-03347-2.

[18] S. Park et al., "Computer-aided detection of subsolid nodules at chest CT: improved performance with deep learning–based CT section thickness reduction," Radiology, vol. 299, no. 1, pp. 211– 219, 2021.

[19] H.-H. Hsu et al., "Performance and reading time of lung nodule identification on multidetector CT with or without an artificial intelligence-powered computer-aided detection system," Clin.Radiol., vol. 76, pp. 626.e23-626.e32, 2021.

[20] S.Y. Choi, S. Park, M. Kim, J. Park, Y.R. Choi, and K.N. Jin, "Evaluation of a deep learning-based computer-aided detection algorithm on chest radiographs: Case–control study," Medicine (Baltimore)., vol. 100, no. 16, p. e25663, 2021.

[21] Kacheru, G., Bajjuru, R., & Arthan, N. (2019). Security Considerations When Automating Software Development. Revista de Inteligencia Artificial en Medicina, 10(1), 598-617.

[22] Bajjuru, R., Kacheru, G., & Arthan, N. (2022). AI for intelligent customer service: How Salesforce Einstein is automating customer support. BULLET: Jurnal Multidisiplin Ilmu, 1(05), 976987.

[23] Kacheru, G. "The role of AI-Powered Telemedicine software in healthcare during the COVID-19 Pandemic." Turkish Journal of Computer and Mathematics Education (TURCOMAT) 11.3 (2020).

[24] Kacheru, G., Bajjuru, R., & Arthan, N. (2022). Surge of Cyber Scams during the COVID19 Pandemic: Analyzing the Shift in Tactics. BULLET: Jurnal Multidisiplin Ilmu, 1(02), 192-202.

[25] Arthan, N., Kacheru, G., & Bajjuru, R. (2019). Radio Frequency in Autonomous Vehicles: Communication Standards and Safety Protocols. Revista de Inteligencia Artificial en Medicina, 10(1), 449-478.

[1]

Doi:10.48047/ijiee.2025.15.6.14