SSRG International Journal of Computer Science and Engineering
ISSN: 2348 – 8387 / https://doi.org/10.14445/23488387/IJCSE-V9I5P101

Volume 9 Issue 5, 1-4, May 2022

Review Article

A Comparative Study on Lung Cancer Detection using Deep Learning Algorithms

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Received: 10 March 2022 Revised: 22 April 2022 Accepted: 07 May 2022 Published: 28 May 2022

Abstract - *Because of its aggressive nature and late diagnosis at advanced stages, lung cancer is one of the major causes of cancer-related mortality. Early identification of lung cancer is critical for a person's survival, yet it is a difficult challenge to solve. Cancer identification is crucial for clinical and epidemiologic reasons since it helps to determine subsequent therapy. This paper reviews the performance of various deep-learning techniques in detecting lung cancer.*

Keywords - *Convolution neural network, Machine learning, Deep learning, Recurrent neural network, Deep belief neural network.*

1. Introduction

Lung Cancer (L.C.) is one of the biggest public cost burdens in the world. Comparing all cancer-related fatalities, L.C. contributes more than 25 percent. [1]. Several studies have been undertaken using deep CNN-based deep learning architectures for disease diagnosis. CNN-based models are now being investigated for various applications, including detecting and categorising lung nodules. Fig. 1 illustrates the overall structure for lung nodule identification using Deep Learning algorithms.

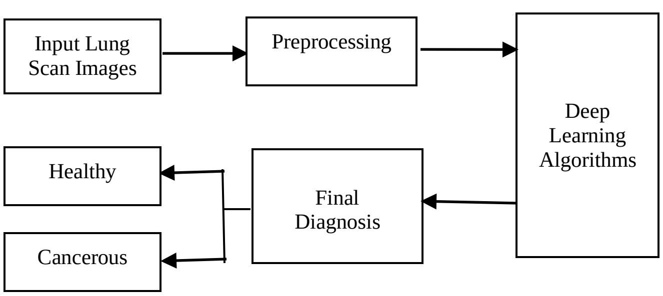

Fig. 1 Overall structure for lung nodule identification using Deep Learning Algorithms

2. Deep Learning Algorithms

2.1. CNN (Convolutional Neural Network)

CNN is the most extensively used deep learning technique in medical image analysis [2]. The neural networks consist of three layers: input, hidden, and output. The input layer fetches inputs, while the output layer produces the outputs. The hidden layer contains the convolution and pooling layers. The pooling layer has used to reduce feature map dimensions and summarize the features found in a specific region of the feature map generated by the convolution layer. Convolution is the outcome of applying a filter to input and getting activation.

2.2. D.N.N. (Deep Neural Networks)

D.N.N.s are composed of an input, an output, and multiple hidden layers in the interior [3]. All layers are made up of neurons modeled after how neurons in the brain process data. Each neuron's weight is adjusted during the training phase using a method known as gradient descent. Nonlinearities are added between layers to match the input and output data. As a result, complex mappings can be modeled using neural networks. After training, the model can classify unseen data. Neural networks can model complex mappings.

2.3. R.N.N. (Recurrent Neural Networks)

R.N.N. [4] is a form of Artificial N.N. that operates on time series or sequential input. R.N.N.s are neural networks that contain hidden states and can use previous outputs as inputs. Assuming that inputs and outputs are independent of one another, the output of a recurrent neural network is dependent on the sequence's previous components.

3. Literature Review

This section contains a review of the literature. To identify lung cancer, relevant material from diverse sources was referred to.

Nasrullah et al. [5] have introduced a based on distinctive deep learning methods with different techniques for detecting malignant lung nodules with high accuracy. Faster R-CNN with capable knowledge of CMixNet and U-

Net features, such as encoder-decoder architecture, was used to detect nodules. for lung cancer calcification, three types of D.N.N. (e.g., CNN, D.N.N., and S.A.E.) have been developed [3]. These networks are used to classify C.T. images, with minor modifications for benign and malignant lung nodules.

Lakshmi et al. [6] suggested a technique that uses transfer learning to detect lung cancer tissues without the need to provide features for image classification. With 93 % and 90 % accuracy, the authors produced results for Modified VGG16 and Modified VGG19 using a transfer learning approach. Nikitha Johnsirani Venkatesan et al. [7] proposed an ideal Convolutional Neural Network model with decreased Gaussian noise for higher classification and training accuracy.

Huseyin Polat et al. [8] investigated two different models: Straight 3D-CNN with traditional softmax and hybrid 3D-CNN with Radial Basis Function (RBF)-based SVM. in the diagnosis of lung cancer; the authors found that a hybrid 3D-CNN with SVM produced better results, with accuracy rates of 91.81 %, 88.53 %, and 91.91 %, respectively, compared with a straight 3D-CNN softmax.

According to Xinrong Lu et al. [9], the Marine Predators Algorithm-based method gives the maximum efficiency with the least error, 93.4 %, 98.4 % sensitivity, and 97.1 % specificity. The authors proposed a new CNN for early lung cancer detection. The marine predator's method is also employed for greater network accuracy and optimal organization.

Giang Son Tran et al. [10] discussed an auto feature extraction and categorization technique of lung candidates as nodule or non-nodule using a unique 15-layer 2D deep CNN architecture. The training process is then enhanced using a focal loss function to improve classification accuracy.

Masud M. et al. [11] used histopathological scans to create a categorization framework for distinguishing between five types of lung and colon tissues (two benign and three malignant). According to the results, the suggested framework can detect cancer tissues up to 96.33 percent of the time.

Michael Horry et al. [12] developed a novel computer vision approach that combines deep learning and decision trees and shows lung cancer malignancy predictions as an interpretable decision tree. The best decision tree model achieved 86.7 percent sensitivity, 80.0 percent specificity, and a 92.9 percent positive predictive value.

Manoj Senthil Kailasam and Meera Devi Thiagarajan[13] discussed a method for deconstructing sub-bands using a “Co-active Adaptive Neural Fuzzy Inference System” (CANFIS) that computes and classifies co-occurrence features, patterns, and DWT.

O. Obulesu et al. [14] suggested the Wilcoxon Signed Generative Deep Learning (WS-GDL) approach for diagnosing lung cancer that combines WS-Rank Gain Preprocessing with Generative Deep Learning. To begin, use test impact examination and information improvement to reduce duplicate and unnecessary traits while extracting many useful and important ones. Using a generator function, the Generative Deep Learning approach was then used to learn the deep features. Finally, a min-max game (i.e., minimizing error with high precision) was presented to diagnose the disease.

Keerti Maithil et[17] discussed the method for image segmentation using Dense U-Net+. Using encoding and decoding structure, U-Net deep learning algorithm works for the semantic segmentation of images.

4. Performance Metrics

Different criteria are utilized to evaluate the performance of the designed deep-learning algorithms for identifying and categorizing lung nodules. The authors used measurements such as specificity (S.P.), sensitivity (S.E.), precision (PPV), accuracy (A.C.C.), F1-score, Receiver Operating Characteristic (R.O.C.) curve, and area under the R.O.C. curve (A.U.C.) in the reviewed publications [15]. Table 1 depicts the performance metrics for D.N.N. approaches.

5. Performance Evaluation

In this paper, Table 2 compares different deep-learning models to detect lung cancer with Accuracy, Sensitivity, and Specificity as a percentage [16].

The performance comparison of various deep learning algorithms has been analyzed with performance metrics such as model accuracy, sensitivity, and specificity, as shown in Fig. 2.

Table 1. Performance metrics for deep learning method

Metric	Definition
Accuracy	the number of correct predictions made is a ratio of all predictions made. (TP + TN)⁄n
Specificity	the proportion of benign lesions successfully diagnosed was determined using the equation: T.N⁄(T.N. + F.P.)
Sensitivity	the proportion of malignant lesions is accurately classified. Computed using the following equation: T.P⁄(T.P. + F.N.)
Receiver operating characteristic (R.O.C.) curve	A figure depicting sensitivity versus specificity at various categorization limits (the higher the curve, the better the model distinguishes between benign and malignant tumors).
The area under the curve (A.U.C.)	This value represents the area under the R.O.C. curve. (A.U.C. = 1.0 implies that the model is perfectly capable of distinguishing between benign and malignant tumors.)
F1-Score	F1 score is the weighted average of the precision and recall F1=2TP/(2TP+FN+FP)

Table 2. Different Deep Learning Algorithms and percentage of Accuracy, Sensitivity, and Specificity

Name of the Authors	Algorithm	Performance Metrics (%)		
		Occur acy	Sensitive vity	Specific city
QingZeng Song et. al.[3]	CNN DNN SAE	84.15 82.37 82.59	83.96 80.66 83.96	84.32 83.9 81.35
Nasrullah Nasrullah, et. al. [5]	2 Deep 3D customized mixed link network (CMixNet)	88.79	94	91
Giang Son Tran et al. [10]	Unique 15 layers 2D deep CNN(Ldc Net)	97.2	96.0	97.3
D. Lakshmi et al. [6]	Modified VGG16 Modified VGG19	93 90	98 80	88 100
Huseyin Polat and Homay Danaei Mehr[8]	Hybrid 3D-CNN with RBF based SVM	91.91	88.53	94.23
Horry, M.; et al. [12]	Hybrid Deep Learning & Decision tree-based Computer Vision Model	85	86.7	80.0
Manoj Senthil et al. [13]	Co-active adaptive neural fuzzy inference System (CA NFIS)	99.2	92.5	98.1
Nikitha Johnsirani Venkatesan , et. al [7]	NG-CNN Algorithm	95	91.39	90.32
Xinrong Lu , et	al. [9] M.P.A. Based Method	93.4	98.4	97.1

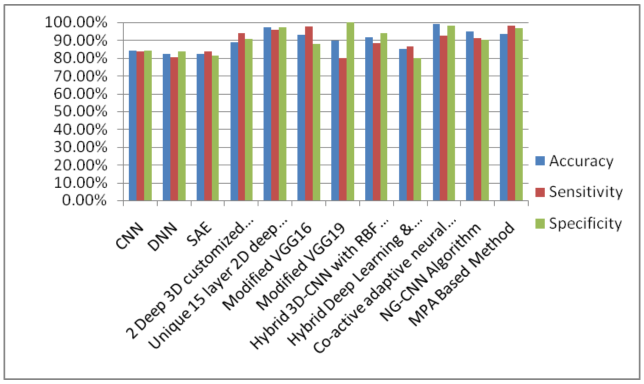

Fig. 2 depicts the model accuracy, sensitivity, and specificity of several Deep Learning methods

6. Conclusion

In this work, we presented different deep-learning algorithms for Lung cancer detection. Different ways of evaluation for these methodologies were examined, along with their relative importance. According to research, Deep learning approaches have resulted in a good performance for lung cancer diagnosis using C.T. images. Deep CNN and Hybrid deep learning techniques were applied in several proposed systems. It is worthwhile to create a new CAD system employing U- Net, Faster R-CNN, Mask R-CNN, YOLO, V.G.G., ResNet, etc. Researchers believe that more datasets and more balanced data can result in better outcomes.

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