AUTOMATIC DETECTION AND DIAGNOSIS OF LUNG CANCER USING ADVANCED NEURAL NETWORK CLASSIFIERS FOR MEDICAL IMAGE PROCESSING APPLICATIONS

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ABSTRACT

Lung cancer is currently one of the most common causes of cancer-related death. Detection, and to provide at an early stage of its development of an accurate diagnosis of potentially cancerous lung nodules increase therapeutic effect, thereby reducing lung cancer mortality. A key obstacle to early detection is the absence of obvious symptoms until the cancer has spread. Diagnosis and the use of non-invasive imaging such as Computed Tomography (CT) screening is a potential solution. However, to achieve accurate automatic analysis of these high-resolution images of the potential need for this approach. Recently, image processing technology has been widely used in several medical fields of detection and treatment levels. For the detection of lung cancer in the image processing there are four different stages are analyzed (i) pre-processing (ii) segmentation (iii) feature extraction and (iv) classification. In the first stage of the process, the Adaptive median filtering and Gaussian filtering techniques are implemented to reduce the noise in the CT images. During the second stage of process, the lung cancer region are separated from the pre-processed image using Versatile Linear Iterative Clustering Algorithm (VLICA) and Suboptimal Clustering Technique (SCT). This process eliminates unnecessary areas of interest. As a solution to this, propose system developed for concentrates is used in segmental nodules, thereby helping radiologists to analyze the disease and detecting various stages of lung cancer. In third stage multi model the different features extraction values are obtained for further classification. The proposed Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) is used to classify the lung cancer region in the digital images. The implemented PALC technique’s performance is examined with different classification parameters like Recall, Precision, and F-measure.
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**Keywords:** Lung cancer detection, Computed Tomography (CT), Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) classifiers.

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### 1. INTRODUCTION

Lung cancer is the most dangerous disease; it is reduced by detecting the affected area using image processing techniques. This technique helps to identify and decrease the development of the affected cancer area. Several factors contribute to the rapid diagnosis of lung cancer, including tumor growth, and late mortality. Due to uncertain efficacy and lack of specific symptoms of screening and rapid progression of the disease, rapid diagnosis is delayed. In the past few decades, these errors are known to slow down the pace in the fight against lung cancer.

![Figure 1](a) CT Lung image  
![Figure 1](b) Lung cancer detection image

Figure 1(b) illustrates the LC image, and it has been considered that common cancers are both familiar and resist control. The disease gives rise to each modification, which requires different methods of treatment available in the medical field. The Computed Tomography (CT) scan, with or without the help of the quick recognition of LC create a Magnetic Resonance Imaging (MRI) images surgery. CT scan is the most preferred method of generating a 3D image for lungs shown in Figure 1(a). If the disease is reduced mortality, early treatment can be to detect. Early detection of cancer has a significant role in preventing the growth and spread of cancer cells. The prior methods are not accurate enough to provide lung cancer diagnosis. Therefore, the development of new methods of premature recognition of LC is significant.

The suggested image processing system has been implemented in four stages: (a) Pre-processing image using adaptive median filter and Gaussian techniques (b) Versatile Linear Iterative Clustering Algorithm (VLICA), Suboptimal clustering technique which separates the lesion image in the pre-processing image (c) To find the different values in the segmented lung image typically, the diagnostic system comprises a conventional image segment and feature extraction using VLICA and SCT. The Feature extraction targets distinguish between variance, entropy, skewness, standard deviation, and quantitative descriptors of energy.
calcification. The accuracy of the proposed system is determined with the True Positive States (TPS) and False Positive States (FPS) rates. The proposed Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) is based on the classification stage, which classifies the nodule patterns. In this area, all the above four-stage techniques are utilized in LC from the bio-medical system.

2. LITERATURE SURVEY

Early diagnosis of lung cancer through computed tomography can significantly reduce pathological-related morbidity and mortality. However, searching for lung nodules is a highly complex task, which affects the success of the screening program [1]. The proposed automatic method to analyse and segment the lungs and classify each lung as normal or cancer. Initially, CT lung images are pre-processed to remove noise. Then, they threshold histogram analysis and morphological operations Segmentation and combining the lung region. Using the selected feature is classified as an integrated support vector machines, K nearest neighbour, and the random forest classifier [2-4]. The reported work has focused on detecting lung nodules from High-Resolution Computed Tomography (HRCT) images based on super pixel density based region segmentation algorithms, followed by the extraction of different morphological features. A support vector machine (SVM) classifier has been trained for nodule detection using shape-based features [5-7].

Improve the accuracy of pre-cancer prediction, which will help determine the type of treatment and the depth of treatment depending on the severity of the disease. In this system, the Adaptive Hierarchical Heuristic Mathematical Model (AHHMM) has proposed a deep learning method [8-10]. Performance comparison is obvious that our proposed model 3DDConvolutional neural network (CNN) realize the art systems in other Lung, sensitivity and false positives per scan (FPS) is the highest achievement[11]. The proposed enhanced Multi-Dimensional Region-Based Fully Convolutional Network (mRFCN) is based on an automatic decision support system for lung nodule detection and classification [12-16]. Promote automated lung cancer detection systems with relatively high accuracy and to detect lung cancer itself in the early stages, leading to widespread use of life-threatening probability [17-19].

Frequency domain algorithm for early detection of lung cancer. The algorithm predicts the distribution within the imaging domain of the scattered field using the field measured around the domain [20-21]. The purpose of this article is to detect lung nodules using a feature extraction technique called Local Triple Co-occurrence Pattern (LTCoP). Using LTCoP features, SVM is trained to detect lung nodules and eliminate non-nodules [22]. An effective lung nodule detection scheme based on multiple sets of patches is proposed from the lung image, which is enhanced by the Frangi filter. By combining two image group, a four-channel convolutional neural network is designed to model knowledge radiology for detecting four levels of nodules [23-25].

1.1. Problem Statement

- One of the main problems of the analysis of lung cancer is an early stage of the process but due to lack of data set and the correlation, it is quite difficult.
- CT images are processed with many image processing techniques but need filters to reduce noise in the obtained images.
- Subsequently, features are extracted from the processed images for comparison and detection processes entirely take more progress. However, the accuracy of these systems is doubtful.
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- Different cases of Lung cancer are one of the main reasons that make treatment so difficult. In the previous method, some current significant issues in the medical imaging sector, mainly to find cancer in CT imaging, are accurate and challenging results.
- Subsequent steps can apply more elaborate techniques that are robust but more time-consuming. Distance between contour and boundary surfaces allow assessing worst-case scenario (maximum region distance between image surfaces) are finding difficult.
- The conventional technique used to remove surface, shading and object features separately is a complicated procedure.
- Conventional segmentation and regional based image analysis are very hard to isolate the masses area into the predefined homogeneous of finding the lung cancer area. Also the classification accuracy ratio is low to find the lung region.

1.2. Objectives

- The advanced filter used in preprocessing helps the area to locate anomalous searches. Also, the various challenges are also solved accurately define the boundaries of the Lung cancer region.
- By using the proposed Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) classification methods micro initial stage the automatic detection of cancer and can minimize the false ratio.
- Perform cancer region recognition using the PALC and CALC algorithms on a generated test samples from input image train the data store on the Lung Image Database Consortium (LIDC)
- To configure and train a classifier by reducing the error rates, training time and thus increasing the state classification accuracy.
- The classification of the result with the features like mean, standard deviation, variance, skewness, entropy used are obtained the result from the segmentation for the accurate.

3. PROPOSED SYSTEM

The Lung cancer Images are categorized according to Masses present in the image different type’s benign, malignant, normal, and most suspicious. Figure 1 shows the methodology adopted in this research work. Overall system proceeds with four stages. First one is acquisition of the image, and second preprocessing of the acquisition image, the third Superior Region of Interest (SROI) also with the clustering based stage segmentation for detection suspicious Lung cancer region, then extracting features from the preprocessing image, selecting more optimal features, classifier to identify an appropriate class of Lung cancer. Form the database train data store on the Lung Image Database Consortium (LIDC) by using the proposed Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) classification algorithms for normal (non-cancerous) are malignant (cancerous) class can be identified respectively. Also it will identified the suspicious mass with various features like precision, recall-measure and accuracy ratio. For all above process the proposed model for the lung cancer will analyzed the affected region in image processing. The Lung CT-Diagnosis, are classified in different stages. Stage-1 nodule size is smaller in size about > 3 mm and ≤20 mm is restricted to the lungs. The nodule size of Stage-2 pulmonary cancer is within the range of 21–30 mm and is spread to surrounding lymph nodes. Stage-1 and Stage-2 are early stages of cancer. In Stage-3, the cancerous cells
are extended to other nearby organs and the size of nodule is approximately between 30 mm and 70 mm. In the last stage (Stage-4) of Lung cancer, the nodule size is more than 70 mm and is spread outside the lungs to other vital organs of body. Stage-3 and Stage-4 are often referred to as advance Stages of cancer. These results demonstrate the potential for the proposed technique in helping the radiologists in improving nodule detection accuracy with efficiency.

![Figure 2 Proposed block diagram for PALC based Lung Cancer detection](image)

3.1. Solution 1 Prognostic Assimilate Learning Classifier (PALC)

The classification accuracy of the Prognostic Assimilate Learning Classifier (PALC) based on the percentage of the number of images that are properly classified to the total number of images taken into consideration, and depends on the type of image that is suspicious for the quality ratio in the cluster. In this part, the features are extracted from the Multi Sub-Space Feature measures the structure of pixels and the lung region are classified via the PALC method. In fact, PALC is a binary classification using two classes of linear boundaries separately. In this method, an instance representing the boundary of the class is obtained by
the optimization algorithm. Many of the training points that are the minimum distance for the decision boundary can be regarded as a subset to define the decision boundary and as a support vector.

Step 1: Read the intensity corrected image.

Step 2: Enhanced images of the correlated images for pre-processing.

Step 3: Calculate the threshold for each iteration of Prognostic Assimilate Learning Classifier (PALC).

\[ T = \max(r(T)) \]

- Where \( r(T) = E(X' - X) \), where \( X \) is the image and \( X' \) is the generalized defeat identification.
- Perform directional anisotropic diffusion
- If convergence reached, then go to step 3, else step 2 is repeated.

Step 4: output de-noised image

Step 5: Back-propagation of error at the output layer, the error between the desired output \( S_k \) and \( Z_k \) output is calculated by:

\[ E_k = Z_k(Z_{k-1})(s_k - Z_k) \]

The error calculation is propagated on the hidden layer using the following formula:

\[ \frac{dx}{dt} = ATg(Fj)Fj \]

Where \( x \) is the image intensities of a filtered image, and \( x \) at time 0 equals the input, unfiltered image. The function \( Fj \) is used to prevent blurring over edges and may be of any decreasing form.

Step 6: Fixed connection weights between the input layer and the hidden layer are corrected by

\[ DW_{ij} = nX, Fj \]

\( DW_{ij} \) is the weight connection between layers of an image, \( x \) is the image intensities, function \( Fj \) is used to prevent blurring over edges and

\[ DY_o = nx, fj \]

\( DY_o \) is the after removing blurring images \( nx \) is the intensities function.

Then change the connections between the input layer and the output layer by:

\[ DW_{kj} = nyjE_k \]

\( N \) is a parameter to be determined empirically.

Where \( E_k \) this energy may be written as the steady-state optimization of the energy functional

Step 7: loops: Loop to set until a stop to define criterion (varied the number clusters).

Step 8: end

3.1.1 Expected Outcomes

- This research is mainly focused on a new methodology for efficient Lung cancer detection by using a novel Prognostic Assimilate Learning Classifier (PALC). Due to distortion, noise, segmentation errors, overlap and occlusion of Lung cancer region in CT images.
The Prognostic Assimilate Learning Classifier (PALC) network is trained to fully represent the input data and minimize the generalization error; then, it learns to forget the irrelevant details by compressing the representation of the input.

Compression through stochastic relaxation: according to the diffusion equation, the relaxation time of layer is increased during training and reduces the input size.

To configure and train a PALC classifier by reducing the error rates, training time and thus increasing the state classification accuracy using MATLAB.

3.2. Solution 2 Contiguous Anisotropic Learning Classifier (CALC)
In this proposed work a Gaussian filtering of the work proposed here takes the detection of images at an early stage of the cancer process and is used for noise suppression and enhancement in Lung cancer images. During the second stage, the Lung cancer area is separated from the pre-processed image. Suboptimal clustering algorithm is used to identify and divide into negative and positive suspicious areas. This process eliminates unnecessary areas of interest. The Positive suspicious mass containing micro-calcified pixels are taken to the training optimal clustering optimal clustering segmentation network. After detecting lung cancer region, the features like mean, standard deviation, variance, skewness, and entropy values are obtained for further classification. The proposed Contiguous Anisotropic Learning Classifier (CALC) was used to classify the lung cancer region using the above feature. The performance of the proposed CALC technique is analyzed in terms of precision, recall and F-measure. Finally, the False Positive (FP) and True Positive (TP) rates for the Lung region were computed to compare the performance of the trained networks.

Step 1: Select the Input image.
Step 2: Apply Gaussian filter for pre-processing

\[
\theta(x_1) = \sum_{n_1 \in Z} h(n_1) \sqrt{2} \theta(2x_1 - n_1)
\]

\[
\gamma(x_1) = \sum_{n_1 \in Z} g(n_1) \sqrt{2} \theta(2x_1 - n_1)
\]

Where,
\(h\) and \(g\) is pair of conjugate mirror filters.
\(\theta\) satisfy the decay conditions.

Step 3: Compute the clustering segmentation method and finds the clustering region’s using Euclidean distance based sub optimal segmentation,

\[d_{ij} = ||x_i - c_j||\]

Using Euclidean distance, for all cluster centers \(C_j, J = 1, 2..., K\) and data object \(X_i, I = 1, 2, 3..., N\).

Step 4: To extract the features from segmentation’s image using Feature extraction method.

Step 5: Find the Mass region \(E^2\) with LVF value between the \(F^N\) and then \(E^N\)

If \(E^2 = \emptyset\) means the mass region value repeat the process from step 2 to step 4 to measure the different mass region values using LVF features in cluster image \(LVF = [F^1, F^2, ... , F^N]\)

Step 6: Apply the Contiguous Anisotropic Learning Classifier (CALC) classification method to train the model.

During training, the output signal \(Y_K\) of each unit is compared with the target value \(T_k\). The error calculation using deep Prognostic nerve associated with this model are updated. The
output of the hidden layer (Zj) and output layer (Yk) is calculated using the equation as follows:

\[ Z_j = f \left( \sum_{i=1}^{n} W_{ji}x_i - \theta_j \right) \]

\[ Y_k = f \left( \sum_{i=1}^{n} W_{ki}Z_j - \theta_k \right) \]

Where, \( W_{ji} \) and \( W_{ki} \) are connection weights, \( \theta_j \) and \( \theta_k \) term, respectively.

Error message hidden layer and output the layer is calculated using the following formula:

\[ e_k = Y_k (1 - Y_k)(T_k - Y_k) \]

\[ e_j = Z_j (1 - Z_j) \sum_{i=1}^{n} W_{ki}e_k \]

Discover the region analysis for every pixel. The output weight and offset value update equations and hidden layers are given below:

\[ W_{kj}\text{(new)} = W_{kj} + aZ_je_j, \quad W_{kj}\text{(new)} = W_{kj} + a\theta_k \]

Step 7: Check the threshold range and find Lung cancer analysis. Arrange the interface components of each pixel and consolidate the area.

Step 8: Go to step 6.

3.2.1. Expected Outcomes

- This research is mainly focused on a new methodology for efficient Lung cancer detection by using a novel Contiguous Anisotropic Learning Classifier (CALC). Due to distortion, noise, segmentation errors, overlap and occlusion of Lung cancer region in CT images.

- The Contiguous Anisotropic Learning Classifier (CALC) are analyzed unnecessary information should be eliminated before performing the recognition process otherwise, the computation time will be increased.

- As compare with the conventional neural formation the proposed CALCs will reduces the size of the neuron function, and improve the processing speed of the system.

- To configure and train a CALC classifier by reducing the error rates, training time and thus increasing the state classification accuracy using MATLAB.

3.3 Performance Evaluation

Performance evaluation refers to accuracy, precision, recall rate and F-score test calculation. The accuracy of measurement is based on the true value or the calculated value is also known, it is a measure of the accuracy of proximity to each other based on calculated. These two types of measurements are mutually constrained. Accuracy is the correct classification of lung nodules by the number of pixels called the total number of pixels for detecting lung nodules. On the other hand, the recall measurement is defined by the total number of lung nodule pixels detected by dividing the total number of lung nodules and the background pixel detection. The formula is below each performance index is presented:

\[ \text{Accuracy} = \frac{\text{TPR} + \text{TNR}}{\text{TPR} + \text{TNR} + \text{FPR} + \text{FNR}} \]

\[ \text{Precision} = \frac{\text{TPR}}{\text{TPR} + \text{FPR}} \]
Recall=$\frac{TPR}{TPR+FPR}$
F-score=$\frac{2*(precision*Recall)}{(precision+Recall)}$

Where; TPR=True Positive Rate, FPR=False Positive Rate, TNR=True Negative Rate, FNR=False Negative Rate

4. CONCLUSION
In this work the initial stage of lung cancer is effectively analyzed the MATLAB simulation 2017b. The CT Images are categorized according to Masses present in the image different type’s benign, malignant, normal, and most suspicious. After get original image, the preprocessing it and reduces the noises, In the second stage to Finding of interest, which can be done by using a Superior Region Of Interest (SROI) detection and clustering region segmentation, based suspicious mass on a CT image. Then extracting features from the CT image, selecting more optimal features, classifier to identify an appropriate class of CT image. Form the database train data store on the Lung Image Database Consortium (LIDC) by using the proposed Prognostic Assimilate Learning Classifier (PALC) and Contiguous Anisotropic Learning Classifier (CALC) classification algorithm for normal (non-cancerous) are malignant (cancerous) class can be identified respectively.

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