Lung Cancer Segmentation and Prediction Techniques Review

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Abstract: Lung cancer is a disease characterized by uncontrolled growth of cell in tissues of the lung. If left untreated, this growth can spread beyond the lungs, even, into other parts of the body [18]. Surgery, radiation therapy, and chemotherapy are used in the cure of lung carcinoma. In spite of that, the five-year survival rate for all stages combined is only 14% [19]. The paper aims to study existing methods to detect the malignant nodules at earliest as well as suggest improvements so as to take corrective action to protect the patients from cancer at most initial stages.

Keywords: Thresholding (TH), Mathematical morphology (MM), Region Growing (RG), Graph cut and water shade, Deformable model

I. INTRODUCTION

Lung cancer is a one of the major reason of death from cancer in the world. Small-cell lung cancer (SCLC) and non-small-cell lung cancer (NSCLC) are the two category . cancer is a state which consists of uncontrollable growth of cell and tissues in affected part. If it is not treated, this growth can spread beyond the lung by procedure of metastasis into nearby tissue or other parts of the body. Surgery, chemotherapy and radiotherapy are the common treatment of cancer. Overall, 15% people diagnosed with lung cancer survive five year after the diagnosis [1].

The early detection of lung cancer can increase overall 5-year survival rates from 14 to 49 percent for patients [2]. Hence, computer-aided diagnosis (CAD) systems using images processing are implemented to find the occurrence of lung cancer cell in a CT-Scan images of patients. The typical CAD system for lung cancer detection mainly consist four phases: segmentation of the lung, detection of nodules, segmentation of nodules and diagnosis. The main aim of this review is to analyze the various nodules detection techniques that are used by present existing CAD for lung nodule detection at early stage. In addition, we also outline the strengths and limitation of the existing approaches.

II. LUNG CANCER SEGMENTATION AND PREDICTION TECHNIQUES:

The exact segmentation of lung nodules is important and crucial. Well segmentation
makes physicians task easy. It plays a crucial role in proper diagnosis and treatment procedure for lung cancer [1]. The segmentation accuracy directly affects many aspects, such as the malignancy classification of lung nodules in CAD for feature extraction. In section of paper we study various segmentation techniques for lung nodules from images.

A. Thresholding (TH)

Thresholding is the most significant tool for image segmentation. Thresholding operation first converts the grey scale image into binary image. A threshold value T is selected in thresholding operation and it assigns two levels to the images that is one is above and the other is below the threshold value. By using the threshold value T, we can separate the object from the background. Then any point \((x,y)\) for which \(f(x,y) > T\) is called an object point, otherwise the point is called a background point. The automatic threshold determination was suggested by Zhao [2] by using K-mean clustering and average gradient and edge compactness.

B. Mathematical Morphology (MM)

To fill in holes and small gaps in the image morphological closing operation is applied on the threshold image. It first reserve the block whose area is the largest and then set the others to zero using 8-connected neighbors. Using the above step binary lung mask is obtained. To Extract the lung edge set a pixel to 0 if its 4-connected neighbors are all 1’s, this leaving only edge pixels. Original Lung CT image is multiplied with the lung masked image to get the final segmented lung region with gray level values as those of original image. An effective method for binary morphological filtering with various combinations of these basic operations was proposed by Kostis [3].

C. Region Growing (RG)

Region growing also classified as a pixel-based image segmentation method since it involves the of initial seed points [4]. It start with a seed pixel, the initial region begins as the exact location of seeds points. The regions are then developed from these seed points to adjacent points depending on certain criteria. This is an iterative growth by keeping examining the adjacent pixels of seed points. If they have the same intensity value with the seed points, it classifies them into the seed points. The difference between pixels intensity and the regions mean is used to classify the similarity of the image into regions. It is an iterated procedure until there are no changes in two successive iterative stages. There are new latest studies on this algorithm that have extended its approach as main component of their segmentation algorithm. Diciott [5] suggested a region growing method by using fusion-segregation criteria using geodesic distances.

D. Graph Cut and Watersheds

A well-known as standard image segmentation techniques are Graph cut and Watersheds. Goodman [6] used Watersheds in their volumetric study. Watersheds
semi-automatic used to first segment each nodule and then by a model-based shape analysis is used to determine anatomical characteristics of all type of nodules.

E. Deformable Model.

Deformable models have been extensively studied and widely used in medical image segmentation, with promising outcomes. Deformable models are curves or surfaces defined within an image domain. These can move under the influence of internal forces, which are defined within the curve or surface, and external forces, which are computed from the image data. The internal forces are intended to keep the model smooth during deformation. The external forces are intended to move the model toward an object edge or other needed features within an image. By constraining extracted boundaries to be smooth and incorporating other prior information about the object shape, deformable models offer robustness to both image noise and edge gaps and allow integrating edge elements into a coherent and consistent mathematical description. Such a edge description can then be readily used by subsequent applications. Moreover, since deformable models are applied on the band, the resulting edge demonstration can attain sub-pixel accuracy, a highly wanted property for medical imaging applications. Kawata [7] reported his works in the literature, on volumetric lung nodule segmentation.

Feature-based classifier extracts features including intensity, shape, size, area etc. of the segmented nodules that may use for classification.

Some most popular feature-based classifiers are as follows:

- Rule-based or linear classifier
- Template matching
- Nearest Cluster
- Support Vector Machine (SVM)
- Linear Discriminant Analysis (LDA)
- Artificial Neural Network (ANN)
- Markov Random Field (MRF)
- Fuzzy Inference System

III. RELATED WORK

In the past, many techniques have been proposed to detect and classify lung cancer in CT images using different procedure. As for example, Camarlinghi et al. [8] used three different computer aided detection techniques for detecting pulmonary nodules in CT scans. Abdulla and Shaharum [9] offered feed-forward neural networks to categorize lung nodules in X-Ray images albeit with only a small number of features such as area, perimeter and shape. Kuruvilla et al. [10] have used six distinct parameters including skewness and fifth & sixth central moments extracted from segmented single slices containing two lungs along with the features mentioned in [11]. They have trained a feed forward back propagation neural network with them to examine
accuracy for different features separately. In Bellotti et al. [12], the authors have offered a new computer-aided detection system for nodule detection using active contour based model in CT images. The paper reports a high detection rate of 88.5% with an average of 6.6 false positives (FPs) per CT scan on 15 CT scans.

Hayashibe et al [13] proposed an automatic method based on the subtraction between two serial mass chest radiographs, which was tested in the detection of new lung nodules. Kanazawa et al [14] presented a system that extract and analyze features of the lung and pulmonary blood vessel regions and then applied defined rules to draw conclusion, which was used in the detection of tumor candidates from helical CT images. Naseer Salman [14] suggested a combination of K-means, watershed segmentation method, and Difference To perform image segmentation and edge detection tasks in Strength (DIS) map was used. Based on K-means clustering technique initial segmentation is obtained. Then two technique is used; the first is watershed technique with new merging method that depends on mean intensity value to segment the image regions and to detect their boundaries. The second is edge strength technique to get an accurate edge maps of our images without using watershed method. In this paper: We resolved the difficult of undesirable over segmentation results produced by the watershed algorithm, when applied directly with raw data images. Also, the edge maps we got have no broken lines on entire image and the final edge detection result is one closed boundary per actual region in the image. It is also obtained that incorrect choice of two edge strength gradient value (T1,T2) (where T1<T2) is very sensitive to get correct result. Incorrect choice of these value gives incorrect image segmentation and edge detection result.

Mori et al [16] offered a technique to extract bronchus area from 3-D chest X-ray CT images, which was utilized in a virtualized bronchoscope system.

Firstly, an improved implicit active contour model driven by local binary fitting energy and the parameters are dynamic and modulated by image gradient information. Secondly, a new technique of filling background based on intensity nonlinear mapping is brought forward to eliminate the influence of background during the evolution of single level set function. At last, a number of contrast experiments are executed, and the results of 3D surface reconstruction show the method is efficient and significant for the segmentation of fine lung tree texture structures [17].

[18] Mohamed Abubakkar Siddique.M, Selva Ganesh. B, Ganesan. R[18] presented an automated system that can detect tumors as well as abnormal lymph node simultaneously in Computerized tomography(CT) thoracic images. After segmentation, Haralick texture feature, Local Binary Pattern, GLCM feature and Discrete Wavelet Transform is calculated. [18] uses ANFIS classifier which uses a hybrid learning algorithm to identify the membership function parameters of single output, Sugeno type fuzzy inference system. Performance of the system is measured in terms of sensitivity, specificity, positive predictive value, negative predictive value and accuracy. The accuracy and precision is
high but the sensitivity value for tumor
detection in lung image is low.

IV. CONCLUSION

The procedures defined are very popular
among commercial semiautomatic softer
packages and used into the medical practice.
The review highlighted that all the proposed
methods from different researcher has
different level of accuracy in different areas.
Region growing algorithm is one of the best
know algorithm in the field of image
segmentation and it also most useful in lung
nodule identification method. It is also
concluded that in future automatic
determination of threshold value should be
done to eliminate the chance of failure in
segmentation Many research for lung
nodules have been going on. And the present
challenges and trends, in this field,
suggested that the search of more effective
and accurate CAD for lung cancer detection
will remain an dynamic research area. Many
researchers has suggested genetic algorithm
based ANFIS classifier can be developed to
accurate detection of lung cancer.

The above proposed concepts if
incorporated in detection of lung nodule
cancer will bring the specificity and
sensitivity to nearly 96% as the features will
be easily detectable after incorporating
above concepts. The change of basic
structure of image however will not affect
accuracy of nodule in any way because of
only change in representation structure is
suggested. Thus this will improve the
efficiency of methods without affecting the
accuracy.

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