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Automatic Lung Nodule Detection on CT Image Using Region Growing

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Abstract- Computer aided detection and diagnosis (CAD) has been widely used for detecting Lung disorders. Lung nodule is an abnormality that may leads to lung cancer characterized by a small round or oval shaped growth on the lung which appears as a white shadow in the CT scan. Lung nodule detection can be done by performing nodule segmentation through thresholding and morphological operation. The segmentation process consists of four stages: Thorax extraction, Lung extraction, morphological operation and structure identification. In the thorax extraction stage all the artifacts external to the patient's body are discarded and is performed using region growing algorithm to separate the thorax from full CT image. Lung extraction stage is responsible for the identification of lung parenchyma. Morphological operation is done to separate the structure within the parenchyma. Finally the nodule is identified in the structure identification stage using 2-D geometrical features and texture features.

Index Terms- Computer Aided Diagnosis (CAD), Segmentation, Computed Tomography (CT), Region Growing.

I. INTRODUCTION

Cancer is the second leading cause of death, the first being heart disease. Of the cancers, lung cancer is the most common cause of cancer death in the world. Solitary Pulmonary Nodule (SPN) is defined as an X-ray density which is completely surrounded by normal aerated lung. So it is viewed in CT as a small round or oval shaped lesion in the lungs. They have greater radio density than lung parenchyma, so they appear white on images. Around 35% of these are malignant in adults. Lung nodules might indicate a lung cancer and their detection in the early stage can increase the survival rate of patients [1]. CT is considered to be most accurate imaging technique for nodule detection. The detection of lesions in lung CT images is a challenging task in the field of medical imaging. A number of computer aided detection methods have been developed for radiologists in identifying nodule candidates on CT images. It is estimated that 29% of all cancer related deaths are from lung cancer. The overall survival rate for all types ofcancer is 63%. Although surgery, radiation therapy, and chemotherapy have been used in the treatment of lung cancer, the five-year survival rate for all stages combined is only 14%. This has not changed in the past three decades [2]. The purpose of this paper is to develop an algorithm for the early stage detection oflung cancer using segmentation techniques.

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II. PREVIOUS WORKS

Automatic detection of lung nodules is the most studied problem in computer analysis of chest radiographs. Almost all methods rely on a two-step approach-candidate detection and classification [3]. A lot of methods were developed for candidate detection: Hough transform [4], template matching[5], subtraction of median filtered image [6], enhancing of nodules by least asymmetric Daubechies wavelet transform and amplifying intermediate levels before back transformation [7]. The second step, classification, is based on: circularity of region, threshold classifier [8], diameter, circularity and irregularity, threshold classifier followed by ANN [9], template matching with nodule and non-nodule candidates, threshold classifier [10]. Some authors developed the segmentation techniques in medical imaging depending on the region of interest[11]. Some of them are semi-automatic algorithm while others are fully automatic. There are numerous articles regarding lung CT segmentation. Hu et al. [12] describe a method of global thresholding for that purpose. Pohle and Toennies [13] propose adaptive region growing for segmentation of medical images. In this paper we propose an automatic technique using region growing and morphological operation, where the region growing algorithm learns its homogeneity criterion automatically from characteristics of the region to be segmented and region properties are calculated to identify the nodule candidates.

III. METHODOLOGY

The main source of data for implementation of this algorithm is images from publically available early lung cancer action program (ELCAP) database. Our segmentation algorithm is composed of four main stages. Basic algorithm is explained with a flow chart in Fig.1

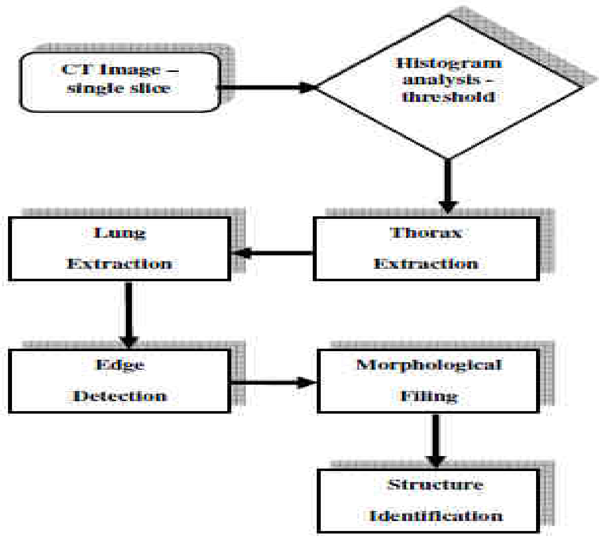

Fig. 1: Block diagram of the proposed method

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A. Thorax extraction

The process is started with thorax extraction .This stage comprises the removal of all artefacts external to the patient's body and can be done by region growing algorithm [14]. Region growing can be categorized as pixel based image segmentation. It starts with a seed pixel.The regions are then grown from these seed points to adjacent points depending on certain criteria

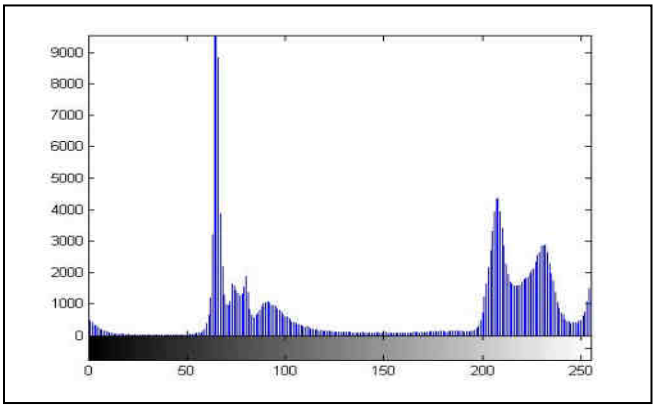

Fig. 2: Histogram plot of the CT image.

The regions are then grown from these seed points to adjacent points depending on certain criteria.In the proposed approach, seed points are four corner points of the image. The similarity criterion for this algorithm is gray level value. The histogram plot of the input CT image has two well defined peeks.The central point that separates the peaks of the histogram is taken as the threshold and the region growing algorithm will identify all the pixel that have values that are smaller than the threshold.

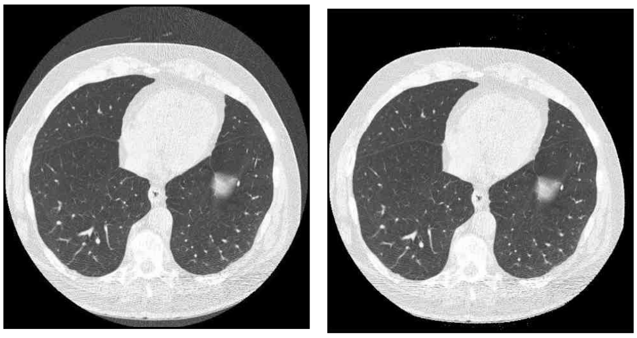

Fig. 3: Thorax Extraction (a) Input image (b) Thorax extracted image.

B.Lung extraction

The main objective of lung extraction is to separate the lung parenchyma and to eliminate thoracic wall and mediastinum. This is achieved using region growing algorithm described in the previous stage. Lung extracted image is shown in Fig: 4.

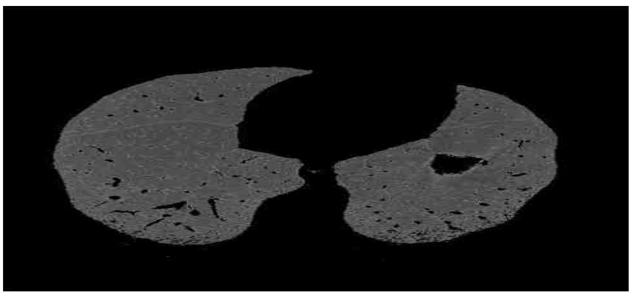

Fig. 4: Lung extracted image

C. Morphological operation

After separating the lung parenchyma through region growing algorithm edge detection is performed. An edge operation is neighbourhoodoperation [15]. Usually operators like sobel, laplacian and zero crossing operators are used for edge detection. Convolution masks are used to implement edge detection operation. In the proposed method, Sobel operator is used.

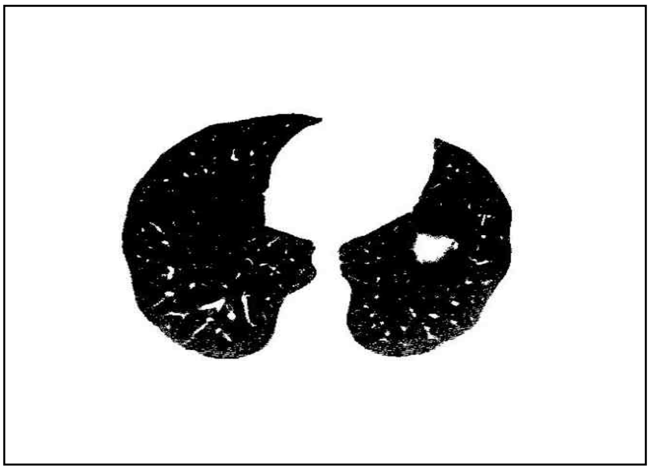

Fig. 5: After morphological operation

After edge detection, morphological binary close operation is applied. The structuring element is a disc of radius 1. Finally edges outside the lung region are filled. Now we get the structures within the parenchyma.

D. Structure identification

This stage identifies the nodule from the structures extracted in the previous stage. 2-D geometric features and 2-D texture features of the extracted structures are calculated and set a threshold to identify the nodule candidate [16]. The 2-D geometric features are area diameter and circularity. The area is obtained as follows:

$$A = \sum_{O \in Om} O \quad (1)$$

Where Om is the image slice of the segmented image O. Diameter D is a maximum bounding box length of Om. The circularity is computed by dividing the area by the squared perimeter of the circumscribed circle as follows;

$$Circ = \frac{A}{4\Pi r^2} \quad (2)$$

In order to increase accuracy, we also use 2-D texture features which consists of mean (m), variance (var), and kurtosis (k) of the nodule candidate image I.

$$m = \sum_{i \in I} i \quad (3)$$

$$\text{var} = \sum_{i \in I} (i - m)^2 \quad (4) \qquad k = \left(\frac{i - m}{\sqrt{\text{var}}} \right)^3 \quad (5)$$

IV. RESULTS

Experiments were done in the images taken from theearly lung cancer action program (ELCAP) database. The ELCAP database contains 50 sets of low dose CT lung scans.All lungs are automatically segmented.

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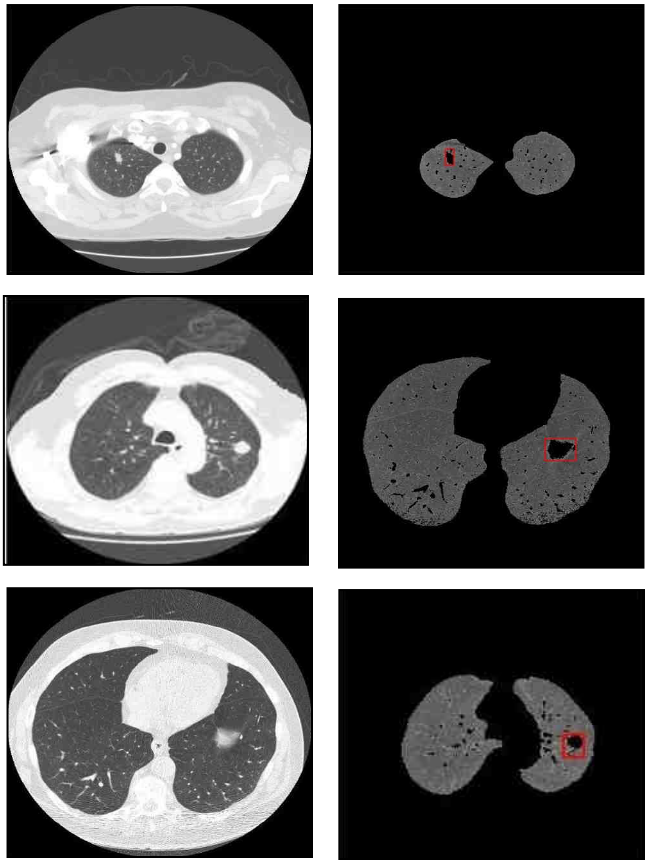

Fig. 6: Results of the proposed method

V. CONCLUSION

The segmentation algorithm starts with region growing to extract the thorax by choosing four corner points as seed points. By applying the region growing process again in the thorax extracted image, the lung portion is separated. Suitable morphological closing operation after performing edge detection helps to identify the structures within the parenchyma. Finally region properties are examined to identify the nodule. Segmentation processof the lungs from thorax CT images are shown to be helpful to radiologists. The proposed algorithm can be used as a preprocessing stage in the classification process of the lung nodule.

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