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Segmentation Of Pulmonary Lobes Using Marker Based Watershed Algorithm

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Abstract—
This paper presented an automatic segmentations of the lungs, fissures, vessels, and bronchi to segment the lobes. The segmentation will be done by marker-based watershed segmentation. A cost image for the watershed transformation is computed by combining information from fissures, bronchi, and pulmonary vessels. The applied watershed algorithm separates regions with local maxima in between and can be used with an arbitrary number of markers. The lobar markers are calculated by an analysis of the automatically labeled bronchial tree. In pre-processing we remove the noise from the CT lung image. For removing noise here we use the wiener filter. After that we segment the lungs from the original CT image. Then we detect the fissure from the segmented lungs. The fissure will be segmented by the adaptive threshold method. The lobe of the lung will be segmented using marker based watershed segmentation. Through the project we have developed a segmentation algorithm for identifying the fissures and nodules from CT images. The results indicate a potential for developing an automatic algorithm to segment lung lobes for surgical planning of treating lung disease. we can identify the abnormality in the lung image. For identification we extract the statistical features.we will Extract the GLCM Feature. the extracted feature will pass to the SVM classifier.Initially we have to train the classifier by extracted feature. After train the classifier it will predict about the images whether it is normal or abnormal. If the lung is abnormal, it will go to tumor segmentation. After tumor segmentation we analyze about the tumor like Area, perimeter, centroid.

Index Terms—Pre-processing,Fissure detection ,Nodule detection, lung lobe segmentation, Feature Extraction, SVM Classification.

I. INTRODUCTION

THE HUMAN lungs are subdivided into five lobes that are separated by visceral pleura called pulmonary fissure.There are three lobes in the right lung, namely upper, middle and lower lobe. The right upper and right middle lobe are divided by the right minor fissure whereas the right major fissure delimits the lower lobe from the rest of the lung. In the left lung there are only two lobes, the upper and the lower lobe, that are divided by the left major fissure [see Fig. 1(a)]. A characteristic of the pulmonary lobes are separated supply branches for both vessels and airways [see Fig. 1(b)].

Lung lobe segmentation is relevant in clinical applications particularly for treatment planning. The location and distribution of pulmonary diseases are important parameters for the selection of a suitable treatment. Locally distributed emphysema can be treated more effective by lobar volume resection than homogeneously distributed emphysema.

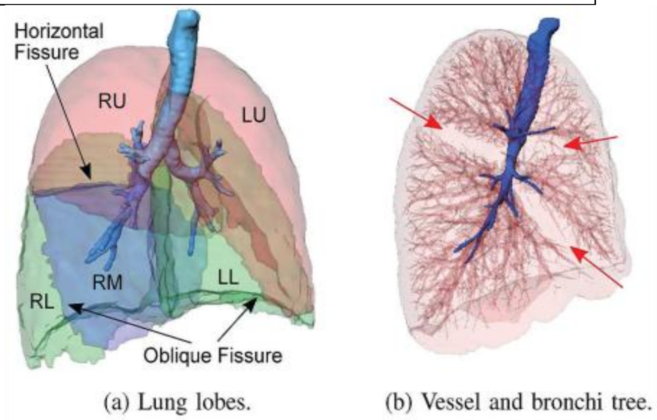


Fig1
Fig1(a)Rendering of lung lobes
Fig1(b)Rendering of Vessel and bronchi tree

Fig 1 Renderings of the anatomy of the lungs. Image (a) shows a rendering of the lungs subdivided into the right upper (RU), right middle (RM), right lower(RL), left upper (LU), and left lower (LL) lobe. Image (b) shows a rendering of

the vessels (red) and bronchi (blue) tree of the right lung. There are no major supply branches at the lobar boundaries (arrows).

Another application is quantitative monitoring of pulmonary diseases such as emphysema or fibrosis. A lobe-wise analysis shows the progression of the disease in more detail. Computed tomography (CT) allows visualization of the lungs within a few seconds. Since typical scans with high anatomical details contain over 400 slices with submillimeter resolution for each direction, manual segmentation is time consuming and there is demand for automatic lung lobe segmentation methods.
The segmentation of pulmonary lobes is challenging because of anatomical variation and incomplete fissures. On the one hand, pathologies can deform the lobes and make the fissures unrecognizable. And on the other hand, even in patients with normal lung parenchyma the fissures are often not complete.

II. METHOD

A lobe segmentation method is developed which combines anatomical information from the lungs, vessels, airways, and lobar fissures to obtain the lobes using a watershed-based segmentation method.

A)Pre-processing

The noise in the image is the Gaussian noise. Gaussian is the natural way of modeling noise. Therefore Wiener filter is used for removal of noise in CT image. Wiener filer gives an estimate of the original uncorrupted image with minimum mean square error and the estimate is the non linear function of the corrupted image. Wiener filters of size 3*3 are used to remove the e noise present in the CT image. After applying wiener filter. We obtain the noise removed Image.
The wiener filter was proposed by Nobert Wiener .Its purpose is to reduce the amount of a noise in a signal. This is done by comparing the received signal with a estimation of a desired noiseless signal. Wiener filter is not an adaptive filter as it assumes input to be stationary. It takes a statistical approach to solve its goal. Goal of the filter is to remove the noise from signal. Before implementation of the filter it is assumed that the user knows the spectral properties of the original signal & noise. Spectral properties like the power functions for both the original signal and noise. And the resultant signal required is as close to the original signal. Signal and noise are both linear stochastic processes with known spectral properties. The aim of the process is to have minimum means-square error. That is, the difference between the original signal and the new signal should be as less as possible.

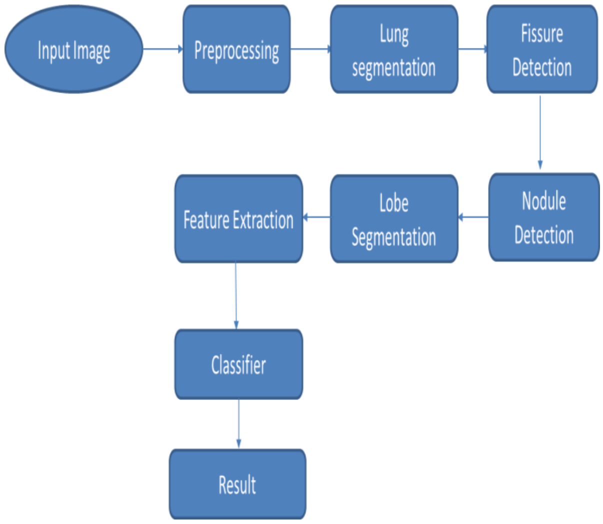


Fig 2: System architecture

B)Lung segmentation

In this module we segmenting left and right lung from the CT image by the use Adaptive threshold algorithm. First we choose the seed point in the CT image. From the point we find intensity value of the image. We compare the intensity value between the neighboring pixels and current pixel. If the neighbor pixels values are related to the seed value, it will segment from the original image. These similarity pixels will be segment from the CT image. This process is continued until reach the last pixel. Finally the segmented lung will be displayed. Adaptive threshold segmentation is one of the segmentation algorithm. For segmenting lung, the algorithm will be used. A technique which often provides better results is to only use edge points when creating the grey level histogram selects an individual seed points for each pixel based on the range of intensity values in its local neighborhood. This allows for seed point of an image whose global intensity histogram doesn't contain distinctive peaks.
Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. First we have to select a gray-level T between those two dominant levels, which will serve as a threshold to distinguish the two classes (objects and background). Where the value marked as T is a natural choice for a threshold. Using this threshold, a new binary image can then be produced, in which objects are painted completely black, and the remaining pixels are white.

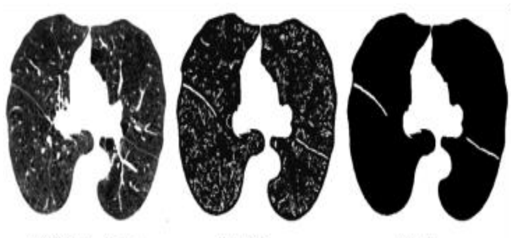
c)Nodule Detection:

FCM is a class of algorithms for cluster analysis in which the allocation of data points to clusters. Fuzzy clustering is the process of dividing data elements into classes or clusters so that items in the same class are as similar as possible, and items in

different classes are as dissimilar as possible. Depending on the nature of the data and the purpose for which clustering is being used, different measures of similarity may be used to place items into classes, where the similarity measure controls how the clusters are formed. Some examples of measures that can be used as in clustering include distance, connectivity, and intensity.
Fuzzy clustering is a class of algorithms for cluster analysis in which the allocation of data points to clusters is not "hard" (all-or-nothing) but "fuzzy" in the same sense as fuzzy logic.

D)Fissure detection:

The fissures are detected by the use of Eigen vector and hessian mat function. Initially we have to identify the sigma values by the frangi filter. Sigma value and images are passed to the hessian mat function. It will find the three values x, y and z. this will passed to the Eigen function. From the values we identify the fissure values of the lung image. Eigen vector and values.Here we detect the fissure by the use of Eigen values. A nonzero vector x is an eigenvector (or characteristic vector) of a square matrix A if there exists a scalar λ such that Ax = λx. Then λ is an eigenvalue (or characteristic value) of A. A matrix acts on a vector by changing both its magnitude and its direction. However, a matrix may act on certain vectors by changing only their magnitude, and leaving their direction unchanged (or possibly reversing it). These vectors are the eigenvectors of the matrix.



(a) Original data. (b) Fissure (c) Fissure

FigD: Fissure detection from the original image

A matrix acts on an eigenvector by multiplying its magnitude by a factor, which is positive if its direction is unchanged and negative if its direction is reversed. This factor is the eigenvalue associated with that eigenvector.

E)Lobe Segmentation:

Watershed transformation is a common technique for image segmentation. However, its use for automatic medical image segmentation has been limited particularly due to over segmentation and sensitivity to noise. Employing prior shape knowledge has demonstrated robust improvements to medical image segmentation algorithms. We propose a novel method for enhancing watershed segmentation by utilizing prior shape and appearance knowledge. In watershed internal markers to obtain watershed lines of the gradient of the image to be segmented. Use the obtained watershed lines as external markers. Each region defined by the external markers contains a single internal marker and part of the background. In watershed, Regions without markers are allowed to be merged.

Instead of working on an image itself, this technique is often applied on its gradient image.(fig E)

- Three types of points

Points belonging to a regional minimum
Catchment basin / watershed of a regional minimum
i.Points at which a drop of water will certainly fall to a single minimum

- Divide lines / Watershed lines

ii.Points at which a drop of water will be equally likely to fall to more than one minimum
iii.Crest lines on the topographic surface.

This technique is to identify all the third type of points for segmentation.

Watershed Algorithm:

A grey-level image may be seen as a topographic relief, where the grey level of a pixel is interpreted as its altitude in the relief. A drop of water falling on a topographic relief flows along a path to finally reach a local minimum. Intuitively, the watershed of a relief correspond to the limits of the adjacent catchment basins of the drops of water. In image processing, different watershed lines may be computed. In graphs, some may be defined on the nodes, on the edges, or hybrid lines on both nodes and edges. Watersheds may also be defined in the continuous domain. There are also many different algorithms to compute watersheds.

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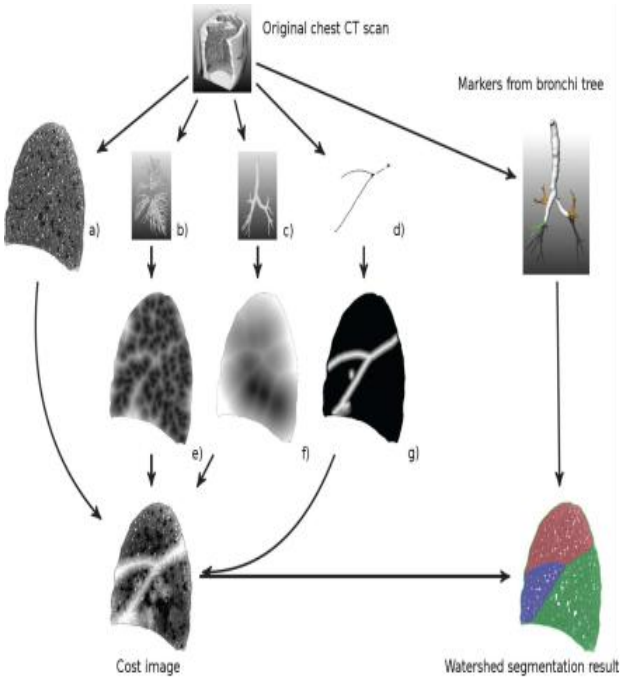

Fig(E)
Implementation of Watershed algorithm

A watershed is a basin-like landform defined by highpoints and ridgelines that descend into lower elevations and stream valleys. Different approaches may be employed to use the watershed principle for image segmentation. Local minima of the gradient of the image may be chosen as markers, in this case an over-segmentation is produced and a second step involves region merging. Marker based watershed transformation make use of specific marker positions which have been either explicitly defined by the user or determined automatically with morphological operators or other ways.

F)Feature Extraction

In statistical texture analysis, texture features are computed from the statistical distribution of observed combinations of intensities at specified positions relative to each other in the image.
A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels, G, in the image. The matrix element is the relative frequency with which two pixels, separated by a pixel distance occur within a given neighborhood, one with intensity i and the other with intensity j.
A number of texture features may be extracted from the GLCM namely, features based on the differences between the gray-level in the candidate pixel and a statistical value representative of its surroundings.

G)Classifier

SVM classifier is the one of the supervised classifier. This is one of the Kernel-based techniques which represent a major development in machine learning algorithms. We provide our feature values to the SVM classifier.The classifier will train about the feature. Finally it will classify about the result. The goal of SVM is to produce a model (based on the training data) which predicts the target values of the test data given only the test data attributes.
SVM maps input vectors to a higher dimensional vector space where an optimal hyper plane is constructed.Among the many hyper planes available, there is only one hyper plane that maximizes the distance between itself and the nearest data vectors of each category.

III. DISCUSSION AND CONCLUSION

In this project, We have presented a fast automatic lobar segmentation method and shown in an extensive series of experiments. The Automatic Segmentation of Pulmonary Lobes from chest CT Scans based on Fissures, Vessels and Bronchi. Initially we remove the noise from the image by using the wiener filter. After filtering we pass this image for lung segmentation. In Lung segmentation it is done based on the adaptive threshold segmentation. In the beginning we convert the image into binary image. From the segmented image we extract the two big regions. The method performs well and is robust against missing fissures. Here we detect the fissure, nodule. Then we segment the lobe from the CT Image. For nodule segmentation we will use adaptive threshold algorithm. For fissure detection we calculate the Eigen vector value of the CT Image. For segmenting the lobe here we will use the watershed algorithm. A cost image for the watershed transformation is computed by combining information from fissures, bronchi, and pulmonary vessels. The applied watershed algorithm separates regions with local maxima in between and can be used with an arbitrary number of markers. The lobe of the lung will be segmented using marker based watershed segmentation. Through this project we have developed a segmentation algorithm for identifying the fissures and nodules from CT images. The results indicate a potential for developing an automatic algorithm to segment lung lobes for surgical planning of treating lung disease. In this project I am extending features below.we can identify the abnormality in the lung image. For identification we extract the statistical features. This feature will pass to the classifier. For classification here we use the SVM classifier. Initially we have to train the classifier by extracted feature. After train the classifier it will predict about the images whether it is normal or abnormal. If the lung is abnormal, it will go to tumor segmentation. After tumor segmentation we analyze about the tumor like Area, perimeter, centroid.

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