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A Survey of Lung Segmentation Techniques

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***Abstract**— Lung diseases are the most common diseases which cause mortality worldwide. Different techniques are available for lung segmentation. Developing an effective computer-aided diagnosis (CAD) system for detecting lung diseases is of great clinical importance and can increase the patient's chance of survival. In the present paper, segmentation techniques and the segmentation results after applying on the X-ray images are discussed. In segmentation, image is partitioned into a meaningful region and the result of image segmentation is a set of segments that collectively cover the entire image and all pixels in the segmented region which are similar with respect to some characteristic such as color, intensity, texture etc. Here some of the segmentation techniques such as edge detection, thresholding, and watershed transform etc. are applied on the chest X-ray image and the effectiveness of each technique is shown with the help of images and properties extracted. This paper overviews the current state-of-the-art techniques that have been developed to implement CAD processing steps. For each technique, various aspects of technical issues are described. In addition, the paper also addresses several challenges that researchers face in each implementation and also outlines the strengths and drawbacks of the existing approaches for lung CAD systems..*

***Keywords**— Computer Aided Diagnosis (CAD), Segmentation, Thresholding, Transformation*

I. INTRODUCTION

This Lung segmentation is an important first step for analysis of lung image and computer aided diagnosis. However, accurate and automated lung image segmentation may be difficult due presence of the abnormalities. Processing of chest x-ray images possess some challenges. For example, for lung segmentation, the strong edges at the rib cage and clavicle region cause local minima for most minimization approaches. Segmenting the lung apex is also a nontrivial problem as it has the changing intensity at the clavicle bone. Additional challenges are segmenting the small costophrenic angle, making allowances for anatomical shape variations such as varying heart dimensions or other pathology, and the x-ray imaging inhomogeneity's. Lung segmentation is basically to extract boundaries of the lungs using different methods available. In this paper we will review different techniques relatively used for segmenting purpose.

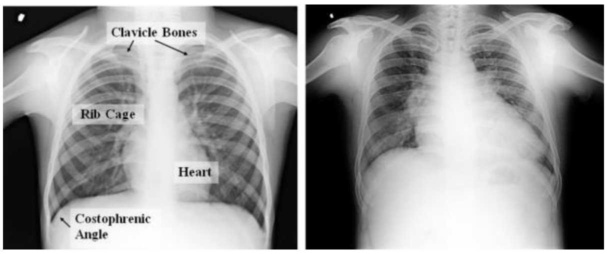


Fig.1 Two X-ray images showing variations

Lung is surrounded by air walls and air sacs. Here we have described different lung segmentation methods. Processing of x-ray chest images poses some challenges such as multiplicative noise, motion during imaging, low contrast, anatomical shape variation due normal anatomy and disease, etc.

II. WORKING

There are various lung segmentation techniques are present. Some of these techniques along with the segmentation input and output are as given below.

- Region growing
- 3-D histogram thresholding
- Watershed Segmentation
- Pixel Classification
- Deformable Model based
- Graph cut segmentation

A. Region Growing Technique:

The Region Growing is a type of technique which belongs to a simple region-based image segmentation. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighbouring pixels of initial seed points and determines whether the pixel neighbours should be added to the region. The process is carried as general data clustering algorithms. [1] The main goal of segmentation is to partition an image into regions. Certain segmentation methods such as thresholding achieve this goal by looking for the boundaries between regions based on discontinuities present in grayscale or colour properties. Region-based segmentation is a technique for determining the region directly. As shown in the figure below:

a)Original Image

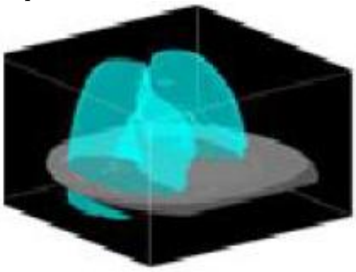
b) Segmented Image

Fig.2 Example of Region Growing Technique

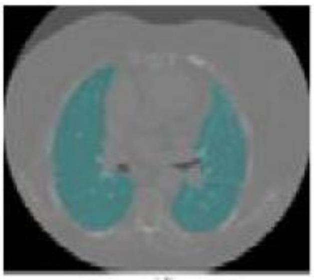
Region growing starts with a seed pixel and the initial region begins as the exact location of seeds points. In this the regions are grown from seed points to adjacent points depending on certain criteria. This is iteratively grown by keep examining the adjacent pixels of seed points. If intensity value with the seed points is same, 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 iterative process until there are no changes in two successive iterative stages. Our primary goal is to segment out lung from dark area which doesn't belong to lungs, so that we must select a set of seed points from dark region. The dark regions of lung parenchyma are tagged before applying region growing. Once the seed pixels are selected, region growing start marking all pixels which lie in the 4-connected neighbourhood. This process is repeated for each pixel until all black pixels (background pixels) are marked. This will delete dark regions from whole image. Result is shown in figure 2 above. For better results important factors to be considered in case of region growing technique is 1.suitable selection of seed points is important. Along with this 2.the value, "minimum area threshold "and lastly 3.more information of the image is better.

B. 3D Histogram Technique:

This technique counts the number of occurrences of data in a column in bins defined by the user. A two dimensional graph is created in the form like number of occurrences vs. bin number or variable value, this is called as two dimensional histogram. Similarly three dimensional histogram counts the number of occurrences of data from two columns in a grid. 3D Histogram Thresholding is used for lung filed segmentation and border refinement performed using SVM classifier.[2] After that the features are extracted using 3D Co-occurrence matrices and irrelevant features are deleted using step-wise discriminant analysis. Final step consist of K-NN classifier which is used to classify the features into healthy, interstitial pneumonia and other lung-diseased patterns. The co-occurrence matrices are used to extract features and the step-wise discriminant analysis was used to select the features[2]. In the final step, K-NN classifier was used to classify the features into healthy, interstitial pneumonia and other lung-diseased patterns. The 3DHistogram thresholding and Border Refinement performed is efficient than using fuzzy segmentation .Fig. below shows the input and output images of the 3D histogram technique.



a)Original Image



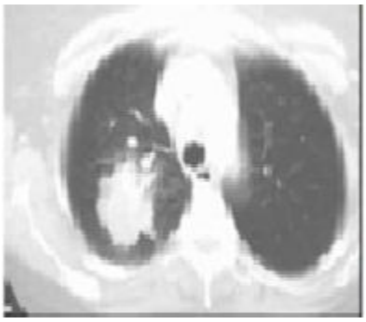
b)Segmented Image

Fig.3 Example of 3D Histogram Technique

The LF segmentation algorithms are used as a pre-processing step in CAD schemes of lung disease. The method consist of a two-stages. The first stage of the algorithm adopts a 3-D histogram Thresholding LF segmentation algorithm combined with an edge-highlighting wavelet pre-processing step .However, the grey-level Thresholding algorithms are unable to correctly segmenting LF, in case of IPs affecting lung borders, since IPs are exhibit as tissue texture alterations. Hence a subsequent supervised texture classification refinement stage is used to deal with LF under-segmentation in this; 3D shape similarity model by defining the two major ingredients is based on the shape histograms as a discrete representation of complex spatial objects. Second stage is an adaptable similarity distance function for the shape histograms which may take small shifts and rotations using quadratic forms [2]. This histogram model naturally is extensible to thematic attributes such as physical and chemical properties. Apart from this in order to account for errors of measurement, a sampling, numerical rounding, quadratic form distance functions are used which are able to take small displacements and rotations into account. For efficient query processing, filter-refinement architecture is used which supports similarity query processing based on high-dimensional feature vectors and quadratic form distance functions. All these experiments demonstrate both, the high classification accuracy of our similarity model, and the good performance of the underlying query processor.

C. Watershed Transformation Technique:

It is a powerful tool for image segmentation. In watershed transformation, the image is considered as a topographic surface. The region with constant grey level of the image represents the altitude. The region with constant grey level constitutes the flat zone of an image. Also region an edge corresponds to high water sheds and low gradient region interiors corresponds to catchment basins.[4]Catchments basins of the topographic surface are homogeneous in the sense that all pixels belonging to the same catchment basin are connected with the basin of region of minimum altitude by a simple path of pixels that have a monotonically decreasing altitude along the path. Such catchment basins represent the regions of the segmented image. By viewing the intensity in an image as elevation and simulating rainfall, it is possible to decompose an image into watershed region[4]. Watersheds are defined as lines separating catchment basin, which belongs to different minima. A watershed can be imaged as a high mountain that separates two regions. Each region has its own minimum and if a drop of water falls on one side of the watershed, it will reach the minimum of the regions. The regions that the watershed separates are called catchment basins.



a)Original Image

b) Segmented Image

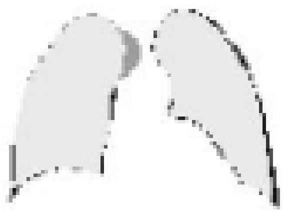
Fig.4 Example of Watershed segmentation

Fig.above shows an example of watershed segmentation. It follows this basic procedure.1) Compute a segmentation function. This is an image whose dark regions are the objects you are trying to segment. 2) Compute foreground markers. These are connected blobs of pixels within each of the objects. then 3) Compute background markers. These are pixels that are not part of any object. 4) modify the segmentation function so that it only has minima at the foreground and background marker locations. And lastly 5) Compute the watershed transform of the modified segmentation function. The watershed algorithm is commonly used within the unsupervised setting of segmenting an image into a set of non-overlapping regions. It is useful for many image segmentation applications. It is simple and intuitive. It can also be parallelized and always produces a complete division of the image. However, it has several major drawbacks like It can result in over-segmentation because each local minimum, regardless of the size of the region, will form its own catchment basin. It is also sensitivity to noise. Moreover, watershed algorithm is poor at detecting thin structures and structures with low signal-to-noise ratio

D. Pixel Classification based Technique:

Classical pixel-based image classification technique automatically categorizes all pixels in an image into land cover classes or themes in a pixel by pixel manner [4]. Usually,the multispectral data are used and spectral pattern present within the data for each pixel is used as the numerical basis for categorization. The classical pixels based are based on the pixel distance neighbour, parallelepiped & the maximum likelihood classifiers. Classification-based segmentation techniques are supervised methods. They require a training phase, in which the training data is manually segmented. Based on the training phase results, the test data is automatically segmented several classification methods are described in the literature [5].They can be categorized in: nonparametric classifiers and parametric classifiers. In the case of the nearest-neighbour classifier, the pixels belonging to the test data are classified in the same class as the pixels with the closest intensity from the training data. The k-nearest-neighbour (kNN) classifier [4] is a generalized nearest-neighbour classifier. In this each pixel is classified into the most appropriate class among its k nearest neighbours considering the weighted majority of its neighbour's votes.

a)Original Image



b) Pixel classified image

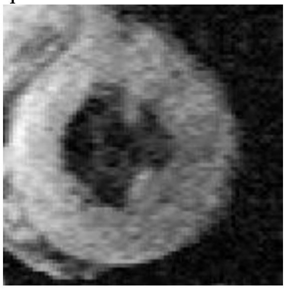
Fig.5 Example of Pixel Classification Method

Parzen windows can be viewed as the generalized kNN algorithm. The algorithm considers all pixels in the voting scheme and assigns their weight using a kernel function. Parametric classifiers assume a probability distribution of data. The disadvantage of classification algorithms is the lack of spatial modelling. So,This problem is raised, when images corrupted by intensity inhomogeneity must be segmented. The accuracy of this algorithm largely depends on the selected training samples. Classification-based techniques were used in [2] where an adaptive fuzzy method was used for lateral skull segmentation. However, classification-based algorithms are generally not effective for X-ray image segmentation [1] due to the intrinsic properties of X-ray images and also because X-rays are affected by noise and may produce over segmentation

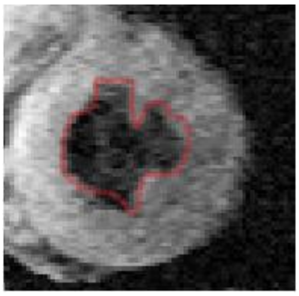
E. Deformable Model Method:

Image segmentation using traditional low-level methods requires considerable amounts of expert interactive guidance. Many limitations of traditional image processing techniques are reduced or even eliminated by using a deformable model. Deformable models are dynamic models based on the idea of moving a curve or shape under the influence of external and internal. Deformable models became very popular and successfully used in image segmentation research areas, after the publication of the paper.

i) Active contour models (ACM): This iteratively will deforms the model and find the configuration with the minimum total energy. The energy function is the sum of the" external energy"[6] also called the image energy and the" internal energy" in an image. The internal energy helps to keep the continuity and regularity of the contour/surface.[6]The external energy used to attract contour points to appropriate image features. So, The algorithm attempts to minimize the sum of these two energies using a set of Euler equations.



a) originall image



b) Segmented Image

Fig.6 Example of deformable model based method

ii) Active Shape Models (ASM): These models also called as snakes work on shapes, learned from training images, and then they try to locate the shape in a test image. A shape is a collection of points and can be represented by a diagram showing the points, or as an n×2 array, where as the n is the number of points and 2 represents the x and y co-ordinates of the points.[8] The distance between two points can be computed as Euclidean distance between them. Snakes were used in and for extracting the contour of the femur from hip X-rays, in for separating the tibia and femur from knee X-rays, in to extract the contours of teeth, or in to segment the hand bones[8],the Active Shape Models have been originally The first stage in the Active Shape Model comprises of training images to learn the shape that has to be found in the test image. In the training phase, aligning different shapes is important to get the mean shape.[8] Aligning shapes is trying to get all the shapes in the same orientation. So, There are several advantages in using deformable models for segmentation: deformable models are robust to artefacts.

F. Graph cut method:

Apart from all these methods given above, graph cut method gives better results compared to all. The proposed system calculates the lung models in a simple and an effective way.

1

2

3

Fig.7 Graph cut method

Figure above 1&2 shows the calculation of lung atlas.Fig.3 shows the lung boundary calculation. However, x-ray chest images contain variable lung shapes. Therefore,the static shape model is not sufficient to describe the lung regions.[7]The next step of our work is to incorporate a dynamic shape model calculation stage into the system. We are planning to employ an image based registration algorithm for this step. A dynamic shape model will try to improve the boundary detection performance of the system. We will also evaluate the method on other x-ray data sets to test its robustness on varying imaging parameters and under the challenges identified earlier[9].Thus, lung boundary detection by this method is based on a simple lung model calculation and a graph cut segmentation algorithm. For our experiments, we used a publicly available chest x-ray data set.so,here accuracy is measured around 91% segmentation accuracy for this set which is comparable to the performance of state-of-the-art algorithms (95%) and human-observer scores (94%).

III. CONCLUSION

In this paper we have tried to cover both early and recent literature related to lung segmentation techniques. Here the evaluation is done in terms of different parameters. Methods presented above gives different results based on different parameters. Out of all these methods Graph cut method gives better results in almost every aspect i.e. accuracy, time requirement ,thresholding etc. It is a robust and accurate method of all but can still be improved in several ways, notably by adding rules to handle exceptional situations. So, the graph cut method is considered to be best method giving better results of all the methods explained above.

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REFERENCES

[1] Sunil Kumar, Ashok Kumar "Lung Segmentation Using Region Growing Algorithm", International Journal of Advanced Research in Computer Science and Software Engineering 4(3), March - 2014, pp. 184-187

[2] Mr. Anup R. Aswar , Ms. Kunda P. Nagarikar, Prof. Pragati D. Pawar,"Texture-Based Identification and Characterization of Pneumonia Patterns in Lung" International Journal of Application or Innovation in Engineering Management Volume 3, Issue 12, December 2014

[3] Mr.Vijay A.Gajdhane , Prof. Deshpande L. M "Detection of Lung Cancer Stages on CT scan Images by Using Various Image Processing Techniques" IOSR, Volume 16, Issue 5, Ver. III (Sep – Oct. 2014), PP 28-35

[4] Manoj R. Tarambale and Nitin S. Lingayat," Computer Based Performance Evaluation of Segmentation", International Journal of Bioscience, Biochemistry and Bioinformatics, Vol. 3, No. 6, November 2013

[5] J. Rahebi , H. R. Tajik , "Biomedical Image Edge Detection using an Ant Colony Optimization Based on Artificial Neural Networks", International Journal of Engineering Science and Technology, 2011

[6] B. Zhao, G. Gamsu, M. S. Ginsberg, L. Jiang and L. H. Schwartz, "Automatic detection of small lung nodules on CT utilizing a local density maximum algorithm", journal of applied clinical medical physics, vol. 4, (2003).

[7] B.V. Ginneken, B. M. Romeny and M. A. Viergever (2001). "Computer-aided diagnosis in chest radiography: a survey", IEEE, transactions on medical imaging, vol. 20, no. 12

[8] Basawraj Amrapur and P.K.Kulkarni "external force for deformable models in Medical image segmentation: a survey "signal & image processing : an international Journal (SIPIJ) Vol.2, No.2, June 2011

[9] Sema Candemir, Stefan Jaeger, Kannappan Palaniappan, Sameer Antani, and George Thoma," Graph Cut Based Automatic Lung Boundary Detection in Chest Radiographs" 1st Annual IEEE Healthcare Innovation Conference of the IEEE EMBS Houston, Texas USA, 7 - 9 November, 2012

