A Literature Survey on Lung Lobe Segmentation Methods

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ABSTRACT

Segmentation is the process of dividing image into constituent regions or objects that have similar feature. Medical imaging is the technique that is used to produce images of the human body or parts for clinical purpose. The CT images provide thorough information of structure of lungs, which could be used for better surgical preparation of treating Lung Cancer. In this paper discuss about the literature survey of lung lobe segmentation methods.

Keywords

Thresholding, computer aided diagnosis; segmentation; and thinning

1. INTRODUCTION

Lung cancer is the having an estimated mortality of 161 840 deaths in 2008. Lobectomy or surgical removal of the diseased lung lobes is the preferred option for treating lung cancer. Accurate surgical planning of lobectomy using detailed anatomic information of lung cavities is of utter importance prior to actual procedures. Shows the anatomy of typical human lungs, which have five distinct partitions called lobes. The boundaries of the lobes are lobar fissures. The right lung usually consists of the superior, middle, and inferior lobes separated by the right oblique and horizontal fissures, respectively. The left lung normally has the superior and inferior lobes, separated by the left oblique fissure. In general, the lobes function relatively independent of each other with no major airways or vessels crossing the lobar fissures (some special cases do occur).

For surgical planning, surgeons in clinical settings read stacks of 2-D clinical computed tomographic (CT) images (typically with a thickness of 2.5-7.0 mm) for assessing the spatial relationships among anatomic structures of lung cavities, specifically identifying the diseased lung lobes. As shown in, these CT images offer 2-D views from a single viewpoint and have different shades of gray. Reading then is a highly subjective task and requires strenuous mental work to map anatomic structures from 2-D images onto actual lung cavities in three dimensions. This leads to a heavy workload, long planning time, and low accuracy in the predicted surgeries.

The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. Segmentation refers to the process of partitioning a digital image into multiple regions or sets of pixels. Image segmentation is typically used to locate objects and boundaries in images. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics [1]. High-resolution X-Ray computed tomography (CT) is the standard for pulmonary imaging. CT scanned images have been used for applications such as lung parenchyma nodule discovery, density analysis, and airways analysis for diagnosing early lung cancer [2]. Lung segmentation is a precursor to all of these quantitative analysis applications. In the early and untimely detection of Lung abnormalities, Computer Aided Diagnosis (CAD) of lung CT image has proved to be an important and innovative development. It has been instrumental in supporting the radiologists in their final decisions. The accurateness and higher decision confidence value of any lung abnormality identification system relies strongly on an efficient lung segmentation technique. Therefore it is very important for effective performance of these systems to provide them with entire and complete lung part of the image. In this paper, we propose a system that is able to perform segmentation of lungs images in an automatic/unsupervised way. We have used GA to calculate threshold that segment the lung part from the original image. Edge detection is performed by using morphology and thinning is performed by using Susan thinning algorithm.

2. RELATIVE STUDY

Automatic method for identifying lungs by using gray-level thresholding for the extraction of lung region from CT-Scan image and applied optimal gray-level thresholding to extract thorax area. Later they have used region growing and connectivity analysis for extraction of the exact cavity region with pre-determined accuracy.

Binsheng et al. [3] have used histogram for threshold selection and this threshold is then used to separate the lung from the other anatomical structures on the CT images. Michela Antonelli, et al [7] has used iterative gray level thresholding for lungs segmentation. Samuel et al. [8] have used gray level thresh-holding and Ball- Algorithm for the segmentation of lungs. These techniques has some drawbacks. Some techniques did not perform well in cases when there is overlapping of intensities in lungand surrounding chest wall. This is very serious shortcoming of these techniques which may lead to inaccurate diagnosis of the disease. It can also be observed that the ball algorithm includes the unnecessary areas as the lung region, (not actually the part of the lung) [9]. Thus if such a situation arises, these approaches are most likely to yield poor results. Thus we can say that these methodologies only work partially. Prewitt et al. [10] proposed the mode method to choose thresholds at the valleys on the histogram. Some smoothing of the histogram data is required for the automatic selection scheme, searching for modes, and placing thresholds at the minima between them. Their method relied heavily on the structure of the gray level histogram, which contained peaks and valleys corresponding to gray level subpopulation of the image. Heuristic search method fails to find the two peaks. It is also difficult to find the exact threshold if the valley is flat. However, the bottom of the valley is some thing difficult to locate.

3. LITERATURE REVIEW

[11] M.Gulsan,O Ariyurek,R.Comert and N.Karabalut have offered variability of the pulmonary oblique fissure presented by high-resolution computed tomography. First to evaluate the radiological anatomy of oblique fissures (OFs) on high-resolution computed tomography scans. The configuration of the OFs was generally concave in the upper zones (85.8% on the right and 72.1% on the left) and convex in the middle and lower lung zones (79.3% on the right and 73.9% on the left) and the infra haler portion of the right of (54.2%) and the infra haler portion of the left of was facing medially (89.9%). [12] L.Zhang, E.A.Hoffman and J.M.Reinhardt published Atlas-driven lung lobe segmentation in volumetric X-ray CT images. An anatomic pulmonary atlas encoded with prior information on the pulmonary anatomy, to automatically segment the oblique lobar fissure. Fissure detection is accomplished in two stages: an initial fissure search and a final fissure search. [13]Jiantao Pu, Joseph L Leader, Bin zheng, Friedrich Knollmann, Cart Fuhrman, Frank C Sciurba and David Gur presented a computational geometry approach to automated pulmonary fissure segmentation in CT examinations. First we developed a new automated scheme using computational geometry methods to detect and segment fissures depicted on CT images. Second after a geometric modeling of the lung volume using the marching cubes algorithm, Laplacian smoothing is applied iteratively to enhance pulmonary fissure by depressing non fissure structures while smoothing the surfaces of lung fissures.

[14] Dirk Selle, Bernhard Preim, Andrea Schenk and Heinz-otto Peitgen presented analysis of vasculature for liver surgical planning. To achieve a fast and robust assistance with optimal quantitative and visual information, we present method for a geometrical and structural analysis of vessel systems. The image analysis technique have been evaluated in the clinical environmental and have been used in more than 170cases so far to plan interventions and transplantations. [15] Soumik Ukil and Joseph M.Reinhardt have offered anatomy-guided lung lobe segmentation in X-ray CT images. Accurate identification of the fissures is of increasing importance in the early detection of pathologies and in the regional functional analysis of the lungs. To detect incomplete fissures using as fast-marching based segmentation of a protection of the optimal surface. [16] Eva M van, Rikxoort, Bartjan de Hoap, Sasikia van de voerst, Mathias Prokop, and Bram Van Ginneken proposed automatic segmentation of pulmonary segments from volumetric chest CT scans Lung segmentation based on region growing and standard image processing techniques. Subsequently the lung lobes are obtained by voxel classification where the position of voxels in the lung and relative to the fissures is used as features.

[17] Bianca Lassen, Jan-Martin, Kuhnigk, Hichael Schmidt, Stefan Krass and Heinz-Otto Peitgen presented lung and lung lobe segmentation methods at fraunhafer Mevis. The lung segmentation procedure is fully automated and used as a sequence of morphological operations to refine an initial threshold-based segmentation of the pulmonary airspaces. [18]Eva M.Van Rikxoort, Bran Van Ginneken, Member IEEE, Mark Klik and Mathias Prokop published supervised enhancement filters: application to fissure detection in chest CT scans. Supervised fissure enhancement filler is evaluated two data sets, one of scans with a normal clinical dose and one of the ultra-low does scans. [19] Jingbi Wang, Margrit Betke and Jane P. Ko published pulmonary fissure segmentation on CT. The process is implemented in an adaptive regularization frame work that balances these influences and reflects the casual dependences in the Bayesian network using an entropy measure. The method has a linear-time worst-case complexity and segments the upper lung from the lower lung on standard computer in less than 5 min.

[20]Rafael Wlemkar, Thomas Bulow and Thomas Blaffert have offered unsupervised extraction of the pulmonary inter lobar fissures from high resolution thoracic CT data. This paper suggests high filter response for the fissure and allow sub-sequence segment. First derivatives of the image gray values; second derivatives based filter is slightly lower. [21] Wei Q, MacGregor JH, Gelfand G. proposed automatic recognition of major fissure in human lungs. Lobar fissures are difficult to recognize due to their variable shape and appearance along with the low contrast and high noise inherent in CT. Compared with manual segmentation, the algorithm yielded mean distance of 1.92 +2.07 and 2.07=2.37 mm for recognizing the left and right major fissure respectively. [22] Sciurba FC Ernst A, Herth F J, Strange C, Criner GJ, Marquette CH, Kovitz KL, Chiachierine RP, Goldin J, MCLennan G, VENT study research group published a randomized study of end bronchial values for advanced emphysema. End bronchial values that allow air to escape from a pulmonary lobe. We compared the safety and efficiency of end bronchial-value therapy in patients with heterogeneous emphysema verses standard medical care.

[23]Van Rikxoort EM, Prokop M de Hoop B, Voergever MA, Pluim JP, Van Ginneken B published automatic segmentation

of pulmonary lobes robust against incomplete fissures. The anatomical variation in lobe shape an atlas selection mechanism is introduced the method is evaluated on two test sets of 120 scans in total. [24] Sverzellati N Calabro E, Randi G, La Vecchia C, Marchiano A, Kuhnigk JM, Zompatori M, Spangnolo P, Pastorino U published sex differences in emphysema phenotype in smokers without airflow obstruction. We evaluated both clinical and multi detection computed tomography (MDCT) data of 1,011 heavy smokers recruited by a lung cancer screening project. Males and females respond differently to the type and location of lung damage due to tobacco exposure. In smokers sex influences the relationship between emphysema and clinical features.

[25]Kensaker Mori, Yuichi Nakada, Tokayuki Kitasaka, Yasuhito Suchaga, Hirotsuga, Takabatake, Masaki Mori, Hiroshi Natori proposed lung lobe and segmental lobe extraction form 3D chest CT data sets based on fissure decomposition and voronoi division. We enhance sheet structures on CT images by using Eigen values of a Hessian matrix. Segmental lobe regions are obtained by the voronoi division process using bronchial branch information. [26]Ross Jc, Estepar Rs, Diaz A Weistin cf, Kikinis R, Silverman EK, Washka GR,published lung extraction, lobe segmentation and hierarchical region assessment for quantitative analysis on high resolution computed tomography images. An image segmentation and data representation frame work that enables quantitative analysis specific to different lung regions on high resolution computed tomography (HRCT) datasets.

[27]Ross JC San Jose Estepar R, Kindlmman G, Diaz A, Westin cf, Silverman E.K, Washka GR presented automatic lung lobe segmentation using particles, thin-plate splines and maximum a posteriori estimation. We present a fully automatic lung lobe segmentation algorithm that is effective in high resolution CT datasets in the presence of confounding factors. To performs comparably to pulmonologist generated lung lobe segmentation on a set of challenging cases. [28]Binaca Lassen, Jan-Martin Kahnigk, Eva M Van Rikxoort, and Heinz-otto Peitgen published interactive lung lobe segmentation and correction in tomographic images. We present a modality independent, semi-automated method that can be used both for generic correction of any existing lung lobe segmentation and for segmentation form scratch, it performed with little interaction in a short amount of time.

[29]Van Ginneken B, Baggerman W, Van Rikxoort EM published robust segmentation and anatomical labeling of the airway tree from therasic CT scans. Adaptive thresholds while growing the airways and it is shown that the strategy leads to a substantial increase in the number, total length and number of correctly labeled airways extracted. [30] Van Rikxoort EM, Goldin JG, Galperin-Aizenberg M, Abtin F, Kim HJ, Lu P, Van Ginneken B, Shaw G and Brown MS presented a method for the automatic quantification of the completeness of pulmonary fissures evaluation in a data base of subjected with severe emphysema. The completeness of the fissures was calculated as the percentage of the lobar border defined by a fissure, the automatic fissure completeness were 0.88, 0.91 and 0.83 for the right major, right minor and left major fissures respectively.

[31] F.Ritter, T.Boskamp, A.Homeyer, H.Lauce, M.Schwier, F.Link and H.0 Peitgen published medical image analysis: a visual approach we will usually construct the image processing algorithms using the popular graphical data-flow builder MeVisLab. [32]Kuhingk JM, Dicken V, Zidowitz S, Bornemann L, Kuemmerlen B, Krass S, Peitgen HO, Yyval S, Jend HH. Rau WS and Achenbach T published new tools for computer assistance in thoractic Ct. Partial functional analysis of lungs, lung lobe and bronchopulmonary segments Virtual Institute for Computer Assistance in Clinical Radiology Cooperative Research project; a prototypical software application was developed to assist the radiologist in functional analysis of thoracic CT data. By identifying the anatomic compartments of the lungs. [33] Sluimer I,Prokop M and Van Ginneken B published toward automated segmentation of the pathological lung in CT. In segmentation voxel classification is applied to a certain volume around the borders of the transformed probabilistic mask. Performance of this scheme is compared to that of three other algorithms a conventional, a used interactive and a voxel classification method.

[34]Hebert T.J presented fast iterative segmentation of high resolution medical images. This paper propose a quantized data representation land a quantized EM algorithm for estimating the parameters of a finite mixture density function to be used in a bayed classifier for image segmentation. [35]Priebe CE, Marchette DJ, Roger GW published segmentation of random fields via borrowed strength density estimation. The segmentation is improved through the use of a borrowed strength density estimation procedure where in potential similarities between the density functions for the sub regions are exploited. [36]Fosfate CH, Krim H, Lrving WW, Karl W.C,Willsky AS proposed multi scale segmentation and anomaly enhancement of SAR imagery. A class of multi scale stochastic processes that provide a powerful frame work for describing random processes and fields that evolve in scale, potentially anomalous pixels and regions are enhanced and pinpointed by noting regions whose residuals display a high level of correlation through out scale.

4. DISCUSSION

We can implement these algorithms by using MATLAB environment. In this work, we have studied the performance of different segmentation techniques that are used in Computer Aided Diagnosis (CAD) systems using thorax CT scans. CT lung density is inclined by the factors such as subject tissue volume, air volume, image acquisition protocol, physical material properties of lung parenchyma and trans-pulmonary pressure. These factors make the selection of gray-level segmentation threshold difficult, as different thresholds are likely required for different subjects. The selection of optimal threshold by iterative method is one possible solution. But again due to different density of anatomical structures on each slice as discussed above, there is need of computing the threshold for each slice which is costly from computational point of view. Thus there is a need of refined algorithm which can calculate a single threshold for whole database of a lone patient. Optimal thresholding performs better when lung volumetric differences are inevitable. It is evident through observation that the proposed system produces much smoother results than the schemes than the schemes that have been used earlier. There is also no loss of lung nodules in our proposed method. This is a good advancement for next stage of CAD system employed in lungs nodule detection and classification system. The essence of our segmentation method lies in its ability to fully automatically segment the lungs part from whole CT scan image. Search for higher density structures including nodules scattered in the lungs through sequentially declining threshold level.

5. CONCLUSION

We have described an adaptive method for automatic segmentation of pulmonary parenchyma. The "heart" of the proposed system, FCM that performs the adaptive thresholding process to determine the thresholds and the objective function, was designed based on human heuristics of what a "good" partition should be like. This is just the first step of a CAD system which is still under development. The results we obtained are comparable with those of other known methods. In addition, the proposed system has the advantage that it does not require any human expert intervention, or any a priori information about the input image. The results achieved by applying the method to a database consisting of eight CT scans with a total of more than 240 digital images have been presented.

The next steps we are functioning on are nodule detection and false positive reduction. At the moment, our method is just at an experimental stage and needs to be evaluated through a double blind procedure by a number of radiologists, with comparison with their current method of nodule detection. Medical imaging is the technique that is used to produce images of the human body or parts for clinical purpose. The CT images provide thorough information of structure of lungs, which could be used for better surgical preparation of treating Lung Cancer. This work, proposes a method for Segmentation of Lung lobes and fissures for surgical planning of treating Lung Cancer. Lung is segmented from chest CT using iterative thresholding technique. Further processing is carried out to visualize fissures characteristics and each segment inside the lung. Lung fissures are extracted using canny edge detection. The main modules of this work are Preprocessing, Lung Segmentation by Iterative Threshold method, Morphological Operation, Curvelet transform, Fissure Extraction. Lobe segmentation is carried out by edge tracking and region filling algorithms to differentiate the segments. The segmentation method is automatic and shown good accuracy.

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