



Lung Nodule Detection & Segmentation Techniques Review

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Abstract – *Image segmentation is still an active reason of research, a relevant research area in computer vision and hundreds of image segmentation techniques have been proposed by the researchers. All proposed techniques have their own usability and accuracy. In this paper we are going present a review of some best lung nodule existing detection and segmentation techniques. Finally, we conclude by focusing one of the best methods that may have high level accuracy and can be used in detection of lung very small nodules accurately.*

Keywords – *Computer-Aided diagnosis (CAD), Image segmentation, CT Medical Imagine, Digital Image Processing.*

I. INTRODUCTION

Lung cancer is a one of the major cause of death in the world. The main primary types are small-cell lung cancer (SCLC) and non-small-cell lung cancer (NSCLC). Lung cancer is a state which consists of uncontrollable growth of cell and tissues. If left untreated, this growth can spread beyond the lung by process of metastasis into nearby tissue or other parts of the body. The common treatments include surgery, chemotherapy and radiotherapy. 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% for patients [2]. Hence, computer-aided diagnosis (CAD) systems using images processing are used to extract the presence of lung cancer cell in a CT-Scam images of patients. The typical CAD system for lung cancer detection mainly consist four steps: segmentation of the lung, detection of nodules, segmentation of nodules and diagnosis. The goal of this study is to analyze the various nodules detection techniques that are used by current existing CAD for lung nodule detection at early stage. In addition, we also outline the strengths and drawbacks of the existing approaches.

II. LUNG NODULE DETECTION

Lung nodules detection in complicated, Nodules in CT images show up have relatively low contrast white circular shape and it also overlap with shadows, vessels and ribs.

A. Low-dose Computer Tomography (LDCT)

LDCT is highly effective spot tiny lung nodules. It is also a primary of clinicians for early detection of lung cancer [3]. The LDCT gathers a complete 3D volume of a human thorax in a single breath-hold and it provides very high spatial, temporal and contrast resolution of anatomic structures. The National Lung Screening Trial (NLST) research in 2011 shown, the LDCT screening can avoid more than 8000 lung cancer deaths per year [4].

B. CAD System

Computer-aided diagnosis, generally consist two main stages: selection of candidate nodule and second elimination of false positive nodules.

Initially, Enhancement techniques used to enhance the nodule to separate them from background and it also lead to suppress other false structures. Usually, thresholding is using to separate candidate nodules the background. For different shaped and sized nodules can be detected by using different techniques. 3D Cylindrical and spherical filters are used to detect small nodules, circular and semicircular nodules can be detected by template matching and pattern-recognition techniques such as clustering, [8] linear discriminate functions etc. are used in the detection of lung nodules.

In second step the elimination of false positive nodule can be done by using classification techniques. Feature-based classifier is a one of the most popular classification way. Feature-based classifier extracts features including intensity, shape, size, area etc. of the segmented nodules that may use for classification.

Following are some most popular feature-based classifiers:

- 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)

- Quadratic Discriminant Analysis (QDA)

Classifiers get trained on some rules and after training it classify false positive nodules and eliminate them.

III. WORKS IN LUNG NODULE DETECTION

K Kanazawa [7], Proposed a techniques that segment the nodule using a fuzzy clustering method. For each candidate, they extract some features such as shape, gray-level and a position and then, used rule-based filters to detect the lung nodules on the bases of features they extracted. Suzuki [11] developed a pattern-recognition technique based on an artificial neural network (ANN) called as (Massive Training Artificial Neural Network) MTANN. That addressed one of the limitation of CAD (large number of false-positive detection), it reduced of false positive FPs. MTANN didn't require much training cases. It gets trained with only 10 positive and 10 negative cases. Mekada [9] used maximum distance inside connected components (MDCC) for 3D X-ray CT images to discriminate between nodule regions and normal structures. Its sensitivity as 71% and 7.4 false positive of average in each case study of 242 CT images. Paik [10] proposed a method that used surface normal overlap (SNO) to detect the lung nodules and colon polyps. Their method was tested on more than 8 lung CT datasets and observed varying sensitivities: at 1.3 FPs per dataset, a sensitivity of 80% was achieved; at 5.6 FPs per dataset, a sensitivity of 90% was achieved and so on.

The method used threshold score to separate lesions and other structure. Score was achieved by SNO that describe it on the bases of the shape and geometry of the nodule. These are the some overviews that highlight some impotent factors. It simple tells about the various challenges for future CAD systems for detecting lung nodules, it include the speed, the ability of the system to detect nodules of different shape and size and at different locations.

IV. LUNG NODULES SEGMENTATION TECHNIQUES

The accurate segmentation of lung nodules is important and crucial. Well segmentation makes physicians life easy. It plays a crucial part in proper diagnosis and treatment procedure for lung cancer [12]. The segmentation accuracy directly affects many factors, such as the malignancy classification of lung nodules in CADx for feature extraction. In section of paper we review various segmentation techniques for lung nodules from CT images.

A. Thresholding (TH)

Thresholding is the most simple and popular image segmentation method. It used to create binary image by labeling each voxel by testing whether its intensity greater or less than given intensity value. The automatic threshold determination was proposed by Zhao [13] by using K-mean clustering and average gradient and boundary compactness.

B. Mathematical Morphology (MM)

MM is a most popular segmentation method to process binary and gray scaled images. MM is a theory and technique for the analysis and processing of geometrical structures. An effective method for binary morphological filtering with various combinations of these basic operations was proposed by Kostis [14].

C. Region Growing (RG)

Region growing also classified as a pixel-based image segmentation method since it involves the of initial seed points [15]. It start with a seed pixel, the initial region begins as the exact location of seeds points. The regions are then grown from these seed points to adjacent points depending on certain criteria. This is an iteratively grown by keep 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 deference between pixels intensity and the regions mean is used to classify the similarity of the image into regions. It is an iterated process until there are no changes in two successive iterative stages. There are more recent studies on this algorithm that have extended its approach as main component of their segmentation algorithm. Diciott [16] proposed a region growing method by using fusion-segregation criteria using geodesic distances.

D. Graph Cut and Watersheds

Graph cut and Watersheds are both well-known as standard image segmentation techniques. Goodman [17] used Watersheds in their volumetry study. Watersheds semiautomatic used to first segment each nodule and then by a model-based shape analysis 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 results. Deformable models are curves or surfaces defined within an image domain that can move under the influence of internal forces, which are defined within the curve or surface it, and external forces, which are computed from the image data. The internal forces are designed to keep the model smooth during deformation. The external forces are defined to move the model toward an object boundary or other de-sired 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 boundary gaps and allow integrating boundary elements into a coherent and consistent mathematical description. Such a boundary description can then be readily used by subsequent applications. More-over, since deformable models are implemented on the continuum, the resulting boundary representation can achieve subpixel accuracy, a highly desirable property for medical imaging applications. Kawata [18] reported his works in the literature, on volumetric lung nodule segmentation.

V. CONCLUSION

The techniques described have been very popular among commercial semiautomatic softer packages and used into the medical practice. The review highlighted that all the proposed methods from different research has different level accuracy in different areas. Region growing algorithm is one of the best know algorithm in the field of image

segmentation and also most useful in lung nodule detection. Many studies 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 active research area.

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