IJCSE International Journal of Computer Sciences and Engineering Open Access
Review Paper Volume-4, Issue-5 E-ISSN: 2347-2693

Lung Nodule Detection Methods

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Available online at: www.ijcseonline.org

Received: Apr/21/2016 Revised: May/04/2016 Accepted: May/18/2016 Published: May/31/2016

Abstract— *Lung nodules are small masses in the human lung and are usually spherical however they can be distorted by surrounding anatomical structures such as vessels and adjacent pleura. There are different methods evolved for the detection of lung nodules. In this paper, different techniques that are used for the detection of lung nodules are introduced.*

Keywords—Juxtra-Pleural;Nodule;Pleural-Tail;Vascularized;Well-Circumscribed

I. INTRODUCTION

Cancer is well-known disease that causes death in both men and women and it is necessary to understand the survival rate of lung cancer which is extremely poor Approximately 20% of cases with lung nodules represent lung cancers therefore, the identification of potentially malignant lung nodules is essential for the screening and diagnosis of lung cancer. At present, the classification from Diciotti et al. is the most popular approach and it divides nodules into four types: well-circumscribed, W with the nodule located centrally in the lung without any connection to vasculature; vascularized, V with the nodule located centrally in the lung but closely connected to adjacent vessels; Juxtra-pleural, J with a large portion of the nodule connected to the pleural surface; and pleural-tail, P with the nodule near the pleural surface connected by a thin tail [1]. The difficulty of early detection for this disease is a main reason why lung cancer has the highest mortality rate. Like most cancers, survival rate depends on how early cancer is detected. Unfortunately, it is a long and difficult process for the physician to detect the presence of this disease. One of the most important and difficult tasks the radiologist has to carry out consists of the revealing and diagnosis of cancerous lung nodules from chest radiographs. Some of these lesions may not be detected due to the fact that they may be invisible by the underlying anatomical structure, or the low-quality of the images or one-sided and variable decision criterion used by radiologists. The rest of paper is organized as follows section II describes the work done in lung nodule detection, section III describes the various lung nodule detection methods, section IV gives the final conclusion.

II. WORKS IN LUNG NODULE DETECTION

K Kanazawa, proposed a techniques that segment the nodule using a fuzzy clustering method [2]. For each candidate, they extract some features such as shape, gray-level and a position and then, used rule-based filters to

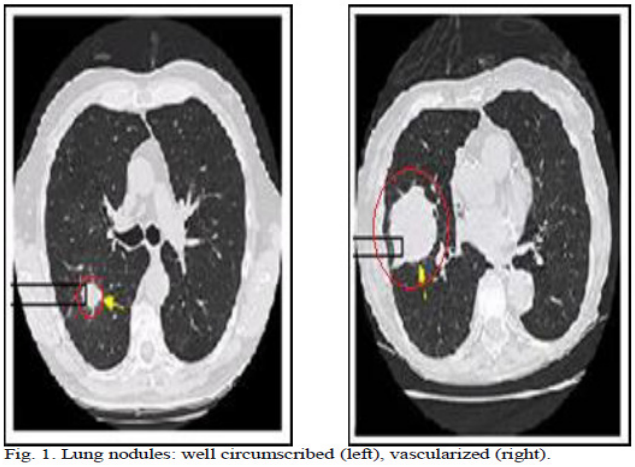

Fig. 1. Lung nodules: well circumscribed (left), vascularized (right).

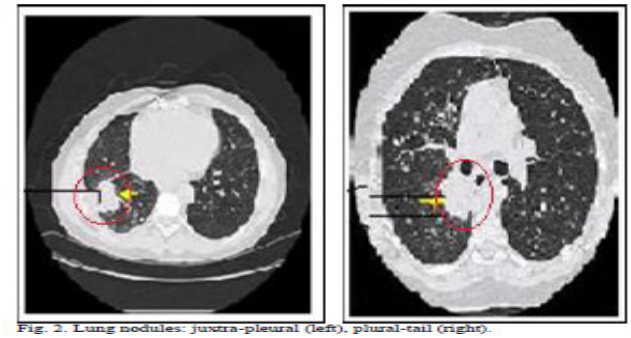

Fig. 2. Lung nodules: juxtra-pleural (left), plural-tail (right).

detect the lung nodules on the basis of features they extracted. Suzuki developed a pattern-recognition technique based on an artificial neural network (ANN) called as Massive Training Artificial Neural Network (MTANN) [3]. That addressed one of the limitation of CAD (large number of false-positive detection), it reduced of false positives (FPs). MTANN didn't require much training

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cases. It gets trained with only 10 positive and 10 negative cases. Mekada used maximum distance inside connected components (MDCC) for 3D X-ray CT images to discriminate between nodule regions and normal structures [4]. Its sensitivity is 71% and 7.4 false positive of average in each case study of 242 CT images. Paik proposed a method that used surface normal overlap (SNO) to detect the lung nodules and colon polyps [5]. 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.

III. NODULE DETECTION METHODS

A pulmonary nodule is almost spherical shaped opacity measuring less than 3 centimeter in diameter surrounded by lung parenchyma. Its shape can be deformed by the neighboring vessels or pleural surface. Four types of nodules identified by were: well-circumscribed, the nodule is at the core of the lung tissue without being connected to vasculature; vascularized, the nodule is at the center of the lung filed but is significantly connected to the surrounding lung vessels; pleural tail, the nodule is located near the pleural surface connected by a thin structure; juxtra-pleural, a substantial portion of the nodule is connected by a thin structure [1].

A. *Thresholding*

A combination of thresholding and rule based method was proposed to identify the location of nodules. Bounding box method, gray level thresholding and rolling ball algorithm for segmenting lung nodules were used followed by a dot enhancement filter applied on three directions. Thresholding and multi scale morphological filtering were implemented by to detect SPNs. Thresholding techniques followed by watershed algorithm and region growing technique were applied to attain more accurate segmentation of nodules.

B. *Morphological Approach*

Morphological based segmentation was used by to detect the pulmonary nodules. Pleural tail and Juxta pleural nodules were segmented from a huge set of CT scans using morphological operations which extracted both small and large nodules. The successive use of thresholding and morphological operations to extract SPNs were proposed.

C. *Template Matching*

Template matching methods to segment the SPNs were used that could detect the circular /semicircular nodules. Both circular and semicircular templates to detect nodules residing inside and on the boundaries of lung region were developed. This circular, spherical hypothesis is not enough to portray the actual geometry of nodules. Lesion's geometry can be irregular due to their attachment to the pleural surface or lung vessels. A variational level set segmentation was proposed where a signed distance function was used to represent a 2D contour followed by template matching algorithm to extract juxtra-pleural nodules. Nodule detection is a process of identifying the nodules and their location in the lung field. The success of this process heavily depends on the accuracy of the lung parenchyma segmentation and false positive reduction method. Well-circumscribed nodules detection is relatively easy as they are isolated in nature. But detecting the other three types is a challenging task as these types generate mostly false positive results. Numerous methods have been proposed for detecting the candidate lung nodules. Thresholding, morphological processing, template matching, watershed algorithm, clustering, connected component analysis and a combination of these methods lead to other methods of segmentation.

TABLE I. NODULE DETECTION METHODS

Study	Method	Dimension
Roozgard et al. [6]	Watershed Algorithm, Median Filter, Morphological Dilation and Erosion Filter	2D
Hiram Madero et al. [7]	Template Matching, Watershed Algorithm	2D
AmalFarag et al. [8]	Template Matching	2D
Hong Shao et al. [9]	Template Matching, Adaptive Threshold Technique	2D
Si Guang-lei et al. [10]	Thresholding, Morphological Processing	2D
Maria Evelina et al. [11]	3D Region Growing Method, Wavefront Algorithm, Morphological Operations	2D

IV. CONCLUSION

Designing an effective CAD system for detection of lung nodules has been gaining its momentum as early detection increases the survival rate. In this paper a review of various approaches towards an automated detection of lung nodules are summarized. It is evident from the survey that the necessity to move from 2D to 3D CT image processing is more demanding. The techniques described above are very popular and has been used in medical practices. 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 suited algorithms useful in lung nodule detection. Many studies for lung nodules have been going on. The present challenges and trends, in this field, suggested that the search of more effective and accurate CT for lung cancer detection will remain an active research area.

REFERENCES

[1] A. Farag, A. Ali, J. Graham, S. Elshazly, and R. Falk, "Evaluation of geometric feature descriptors for detection and classification of lung nodules in low dose CT scans of the chest", in Proc. ISBI,pp **169–172, 2011**.

[2] K. Kanazawa, Y. Kawata, N. Niki et al., (2012), "Computer-aided diagnosis for pulmonary nodules based on helical CT images", Computerized Medical Imaging and Graphics, vol-**22**, no-**2**, pp **157–167**, **1998**.

[3] K. Suzuki, S. G. Armato, F. Li, S. Sone, and K. Doi, "Massive training artificial neural network (MTANN) for reduction of false positives in computerized detection of lung nodules in low-dose computed tomography", Medical Physics, vol-**30**, no-**7**,pp **1602–1617**, **2003**.

[4] Y. Mekada, T. Kusanagi, Y. Hayase et al., "Detection of small nodules from 3D chest X-ray CT images based on shape features," In Proceedings of the Computer Assisted Radiology and Surgery (CARS), vol-1256, pp **971–976**, **2003**.

[5] D. S. Paik, C. F. Beaulieu, G. D. Rubin et al., "Surface normal overlap: a computer-aided detection algorithm with application to colonic polyps and lung nodules in helical CT", IEEE Transactions on Medical Imaging, vol-**23**, no-**6**, pp **661–675**, **2004**.

[6] A Roozgard et al., "Malignant Nodule Detection on Lung CT Scan Images with Kernel RX algorithm", proc. IEEE-EMBS International Conference on Biomedical and Health Informatics, pp **449-502**, **2012**.

[7] Hiram Madero Orozco et al., "Lung Nodule Classification in Frequency Domain Using Support Vector Machines", proc. IEEE 11th International Conference on Information Sciences, Signal Processing and their Applications: Main Tracks, pp **870-875**, **2012**.

[8] Amal Farag er.al, "An AAM Based Detection Approach of Lung Nodules from LDCT scans", IEEE, pp **1040-1043**, **2012**.

[9] Hong Shao et al., "A Detection Approach for Solitary Pulmonary Nodules Based on CT Images", proc. 2nd IEEE International Conference on Computer Science and Network Technsology, pp **1253- 1257**, **2012**.

[10] Si Guang-lei et al., "A Novel Method for Lung Nodule Segmentation Based on CT Images", proc. 2nd IEEE International Conference on Applied Robotics for the Power Industry, pp **826-830**, **2012**.

[11] Maria Evelina et al., "Algorithms for automatic detection of lung nodules in CT scans", IEEE International Workshop on Medical Measurement and Applications, MEMEA, **2011**.

[12] V.G Aswathy and Mrs.T.Johncy Rani," A Supervised Lung Nodule Classification method using patch based context analysis in LDCT image," International Journal of Engineering Research and General Science Volume 3, Issue 1, January-February, 2015 ISSN 2091-2730.

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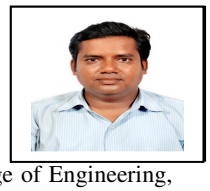

Devendra Ingale, has completed his B.E E&TC degree from GCOE, Amravati in year 2002 and M.E. Electronics degree from SRTM, University in year 2006. At present he is working as Assistant Professor at department of & Telecommunication, Jayawantrao Sawant College of Engineering, Hadapsar, Pune. He taught numerous subjects at undergraduate and postgraduate level mainly in signal processing and communication systems. His area of expertise covers topics from Image Processing and Pattern recognition domain.