Survey on Computerized Lung Segmentation and Detection

[1]Naveena Karunakaran,[2]Nishy Reshmi S.
[1]M.Tech Student,[2]Assistant Professor
[1]Department of Computer Science and Engineering,
[1]LBSITW, Poojappura, Trivandrum, Kerala, India

***Abstract*— Lung cancer is a disease of abnormal cells multiplying and growing into a tumor. Recently, image processing techniques are widely used in several medical areas for image improvement in earlier detection and treatment stages, where the time factor is very important to discover the abnormality issues in target images, especially in various cancer tumors such as lung cancer. The main aim is to detect nodules that overlap with ribs and/or clavicles and to reduce the frequent false positives (FPs) caused by ribs. Thus image quality and accuracy are also the core factors of this research. In CXRs the ribs and clavicles are suppressed with massive-training artificial neural networks (MTANNs). To reduce rib-induced FPs and detect nodules overlapping with ribs, we incorporated the VDE technology. The VDE technology suppressed rib and clavicle opacities in CXRs while maintaining soft-tissue opacity by use of the MTANN technique that had been trained with real dual-energy imaging. Our scheme detected nodule candidates on VDE images by use of a morphologic filtering technique. Therefore, by use of VDE technology, the sensitivity and specificity for detection of nodules, especially subtle nodules, in CXRs were improved substantially.**

***Index Terms*— Cancer detection, CADe scheme, suppressing ribs, MTANN**

I. INTRODUCTION

Lung cancer is the primary cause of tumor deaths for both men and women in most countries. Cancer cells can be carried away from the lungs in blood, or lymph fluid that surrounds lung tissue. Lymph flows through lymphatic vessels, which drain into lymph nodes located in the lungs and in the centre of the chest. Lung cancer often spreads toward the centre of the chest. Metastasis occurs when a cancer cell leaves the site where it began and moves into a lymph node or to another part of the body through the blood stream. Cancer that starts in the lung is the primary lung cancer. There are several different types of lung cancer and these are divided into two main groups: Small cell lung cancer and Non-small cell lung cancer which has three subtypes: Carcinoma, Adenocarcinoma and Squamous cell carcinomas. The overall five-year survival rate for lung cancer patients is only 14% [1].

Early diagnosis has an important prognostic value and has a huge impact on treatment planning. The most common sign of lung cancer are nodules and the nodule detection in chest images is a main diagnostic problem. Early detection and treatment of lung cancers can improve the survival rate by 50% if the tumor is detected early at Stage 1. Projection radiography is a simple, cheap, and widely used clinical test. Unfortunately, its capability to detect lung cancer in its early stages is limited by several factors. The availability of efficient and effective computer-aided diagnosis (CAD) systems is highly desirable.

In the last decade, several CAD systems for chest radiography have been proposed and tested on private image sets. Many different approaches, based on image processing techniques, conventional pattern recognition methods, and artificial neural networks (ANNs) are documented. It proposes a two-stage system that is the first one locates possible nodular patterns while the second, is implemented by discriminating nodules from nonnodules. Feedforward neural network are used in the system and suspicious regions are first detected in a low-resolution image, and subsequently local image curvature is analyzed to locate nodules.

The lung cancer detection system contains four basic stages. The first stage starts with taking a collection of CT images (normal and abnormal) from the available database JSRT. The second stage applies several techniques of image enhancement to get a best quality of image. The third stage applies image segmentation algorithms and finally the fourth stage obtains the general features from enhanced segmented image which gives indicators of normality or abnormality of images. Figure1 represents the lung cancer image processing stages.

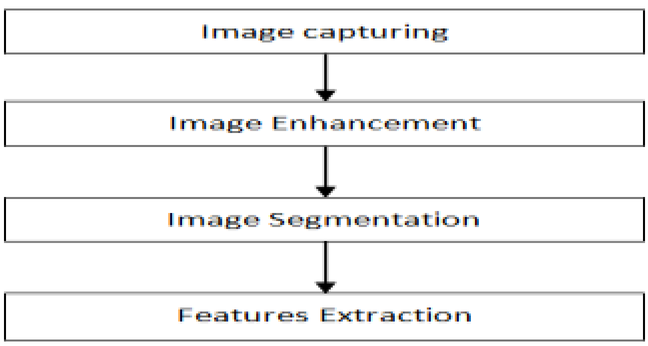

Figure1. *Lung cancer image processing stages*

II. Generic architecture of CADe systems

As years passed by the amount of data grew, this results in. CADe systems for detecting pulmonary nodules are usually composed of five subsystems: acquisition, preprocessing, segmentation, nodule detection and elimination of false positives [2]

- **Acquisition**

The acquisition subsystem is responsible for obtaining medical images. Public databases can be used to develop, train and validate CADe systems.

- **Preprocessing**

Preprocessing is the treatment performed on the image that aims to improve the quality of it to increase the precision and accuracy of processing algorithms that take place after this stage. This stage removes defects caused by the image acquisition process. The main techniques for preprocessing are: Median Filtering, Enhancement Filter, Contrast Limited Adaptive Histogram Equalization, Auto-enhancement, Wiener filter, Fast Fourier Transform, Wavelet Transform, Antigeometric Diffusion, Erosion Filter, Smoothing filters and Noise Correction.

- **Segmentation of pulmonary images**

This subsystem has the function to separate the study region from other organs and tissues in radiographic images in order to reduce the computational cost of the next stages [4]. The two main approaches for segmentation of lung images are: segmentation based on thresholding and segmentation by deformable models. In the segmentation approach based on thresholding, a threshold of intensity to perform the separation is utilized. This approach is possible since in the CT scans, lung tissues are present in darker shades when compared to other organs, such as heart, liver, and bone tissue. The main problem of this segmentation is that its accuracy is affected by the type of equipment that makes the acquisition and the location of nodules.

- **Nodule detection**

The stage for nodule detection aims at determining the presence of pulmonary nodules in the image. The main sources of errors in the detection are small nodules, ground-glass opacity nodules, nodules attached to vessels and nodules attached to parenchymal wall and diaphragm. Small nodules are difficult to segment due to spatial discretization used for the CT imaging where a voxel may represent more than one tissue type, resulting in averaging of their intensity values. Accurate segmentation of juxtavascular and justapleural nodules is a challenge because CT values for nodules and these non-target structures are often very similar. Ground glass nodules are difficult to detect because they are of low attenuation and have poorly defined borders.

- **Elimination of false positive**

This stage aims to remove the identification of false nodules through the features of the nodules found. Initially, the possible nodules detected are segmented and their features are extracted. The main extracted features are:

Intensity values of pixels[3]. They are extracted from the image histogram;

•Morphology: It contains information about the size and shape of the nodule. The size is determined based on the radius, area and perimeter. On the other hand the shape is determined by the compactness, roundness, smoothness, symmetry and concavity;

•Texture: It provides information on the variation in the intensity of the surface by analyzing characteristics, such as smoothness, roughness and regularity;

•Fractal: It provides information about the regularity and complexity of nodules by means of their level of self similarity.

The CADe system tries to eliminate false positives (FP). In order to eliminate FP, classifiers are used. In general, a classification system has two phases: the classifier training to learn the parameters of the system, and the testing phase, to evaluate the success of the classifier.

The main classifiers are: linear discriminant analysis, clustering, Markov random field], artificial neural networks, support vector machines (SVM), massive-training neural network (MTANNs)[5].

III. Discussion

The use of CADe systems improves the performance of radiologists in the detection process of pulmonary nodules. However, to be used routinely in the radiology department these systems must meet the following requirements: improve the performance of radiologists providing high sensitivity in the diagnosis, a low number of false positives, have high processing speed, present high level of automation, low cost (of implementation, training, support and maintenance), the ability to detect different types and shapes of nodules, and software security assurance.Based on literature research, it was observed that many, if not all, systems described in this survey have the potential to be important in clinical practice. However, no significant improvement was observed in sensitivity, number of false positives, level of automation and ability to detect different types and shapes of nodules in the studied period.

IV. Challenges

Further research is needed to improve existing systems and propose new solutions. For this, we believe that collaborative efforts through the creation of software communities are necessary to develop a CADe system with all the requirements mentioned and with a short development cycle. Thus, challenges for new CADe systems for detecting pulmonary nodules are:

•Development of new techniques, or improve existing ones, of segmentation of lung images to allow higher level of automation, including cases of severe pathologies, small nodules ($\leq 3mm$)

•Develop a system that identifies the nodules, determines their characteristics (malignancy, volume, presence of calcifications and their pattern, contours, edges and internal structures) and evaluates the evolution of the oncological therapy.
•Larger databases for efficient validation of proposed systems should be provided.
•The sensitivities of CADe systems are relatively high, but the number of FPs is high-compared to radiologists' performance. Therefore, further improvement in specificity is necessary in future research.

V. Conclusion

This paper presents a review on Computer Aided Detection systems for lung cancer in CT scans. An image improvement technique is developing for earlier disease detection and treatment stages; the time factor was taken in account to discover the abnormality issues in target images. Image quality and accuracy is the core factors of this research, image quality assessment as well as enhancement stage where were adopted on low preprocessing techniques. The main detected features for accurate images comparison are pixels percentage and mask labellig with high accuracy.

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References

[1] American Cancer Society, *American Cancer Society Complete Guide to Complementary & Alternative Cancer Therapies*, 2nd ed. Atlanta, GA.:American Cancer Society, 2009

[2] B. van Ginneken, B. M. ter Haar Romeny, and M. A. Viergever, "Computer-aided diagnosis in chest radiography: A survey", IEEE Trans.Med.Imag.,vol.20, no.12, pp.1228 -1241,.Dec 2011.

[3] K. Suzuki, J. Shiraishi,H.Abe,H.MacMahon, andK.Doi,"False positive reduction in computer aided diagnostic scheme for detecting nodules in chest radiograph by means of massive training artificial neural network", *Acad. Radiol.*, vol. 12, pp. 191–201, Feb. 2005.

[4] S. Kido, H. Nakamura, W. Ito, K. Shimura, and H. Kato,, "Computerized detection of pulmonary nodules by single exposure dual energy computed radiography of the chest", *Eur. J. Radiol.*, vol. 44, pp. 198–204,.

[5] K. Suzuki, H. Abe, H. MacMahon, and K. Doi"Image processing technique for suppressing ribs in chest radiographs by means of MTANN", *IEEE Trans. Med. Imag.*,2007, vol. 25, no. 4, pp. 406–416, Apr. 2006.