International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Available at http://inpressco.com/category/ijcet

Research Article

Detection of Ground Glass Nodules in Human Lungs Using Lungs CT Scans Images

Pareesha Aggarwal[a*] and Rishi Kumar[a]

[a]Amity School of Engineering and Technology, Amity University, Noida, India

Accepted 25 April 2013, Available online 1June 2013, **Vol.3, No.2 (June 2013)**

Abstract

In designing the computer aided detection systems, the segmentation of image, one of the image processing techniques plays a vital role and if the computer tomography (CT) images are used as input for such systems the results achieved are positive. This paper presents a proof of such statements that the Computer aided detection system based on segmentation techniques applied on CT images gives better results. In this paper we have provided the results of a Pulmonary Nodule Detection System which is based on segmentation of CT images of lungs to further detect the location of the nodule. In this paper we have briefly discussed the steps involved in designing the proposed pulmonary Nodule detection system and the results obtained after applying these steps have also been discussed.

Keywords: *CT, GGN, pulmonary nodule, Segmentation, Thresholding, False Positive Reduction*

1. Introduction

Lung cancer is the primary cause of cancer-related death in India as well as all over the world. Pulmonary nodules are the potential cause of the lung cancer (Pareesha Aggarwal et al,2013). If pulmonary nodules are detected at early stage then survival rate can be increased up to a higher limit.

The pulmonary nodule is a lesion in the lungs of a patient in the form of a round opacity, at least moderately well margin and not greater than 3 cm in the maximum diameter.

The selection of the pulmonary nodule is a challenging task because it is difficult to distinguish between real pulmonary nodule and the structure looking like a pulmonary nodule. The process of doing this task is known as False Positive Reduction.

Lungs nodules can be divided into various categories based on two main parameters. According to location and connection with surrounding, lungs nodules can be divided into four main classes and According to intensity, lungs nodules can be divided into two classes.

Segmentation of images plays an important role in developing various computer aided system in medical world. Large number of such systems has been proposed by researchers that can assist the doctors and physicians to diagnose their patients more efficiently. This paper introduces a Pulmonary Nodule Detection System which is based on the sequence of image processing technologies. The figure 1 gives a flow of the image processing technologies used and various other steps involved in the whole development of the proposed detection system.

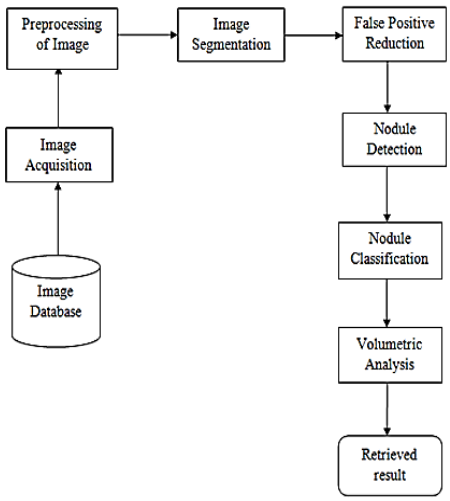

Fig1. Flow chart of the pulmonary nodule detection system (Pareesha Aggarwal et al,2013)

This paper includes the brief discussion of the each step and technology used as well as the results of the preprocessing of the image and segmentation of the image has been described.

The rest of the paper is structured as follows. The second section describes general image processing technologies used. The third section describes the other steps involved in the proposed method. Section four shows

*Pareesha Aggarwal is pursuing M.Tech in CSE

the results. Finally the future work and a conclusion of the discussion are provided in last section.

2. Image Processing Techniques Used

A. Image Acquisition

For training and testing of the system, a series of 201 slices of CT scan of a lung cancer patient is used. Each slice of the series shows the lung part of the patient consisting of the lesion. CT scan images have their own benefits in the medical field they are used because they enable visualization of low contrast or small volume nodules by decreasing slice thickness and slice spacing between the consecutive slices (Ashis Kumar et al,2012).

A good CT scan machine should consider the slice thickness greater than slice spacing otherwise when the image will be reconstructed, it will be erroneous because of lack of required information in the inter slice region.

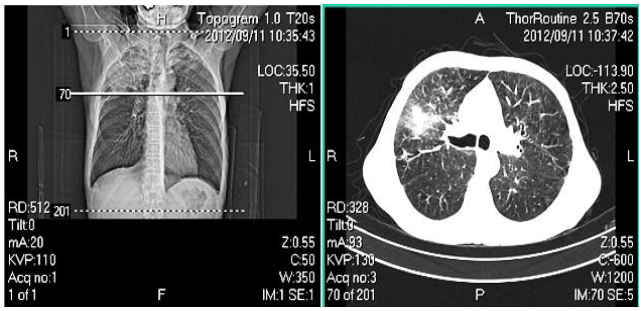

Fig 2. CT scan image of Lung

figure 2 shows the real dataset collected from the hospital which will be used to test the system and one of the selected slices of the CT scan of an another patient is used to train the system.

B. Preprocessing Of Image

Image pre-processing is the name given to the task performed on images at the lowest level of image processing. The aim is to improve the image data that suppress undesired distortions or enhances some image features important for further processing. It does not increase image information content. Image preprocessing is done to enhance the image and increase the accuracy of segmentation. The preprocessing of image is the first step which is applied on images in the image processing. The image processing involves noise reduction and image enhancement.

a) Image enhancement and Resizing: the process of enhancing the image and adjusting the size of image for the application.
b) Noise Reduction: the noise in the images is removed by choosing one of the various available filtering techniques (median filter, mean filter).

Here in our system in detection the pulmonary nodules the preprocessing is meant to remove the unwanted parts and to enhance the visibility of extracted nodule and segmentation of the preprocessed image to detect pulmonary nodule. In our case the results obtained after preprocessing has been shown in the third section. The figure 3 shows the CT scan image of the lung which is used for the learning and training phase of the proposed system.

Fig 3. CT scan image of Lung (input to the system)

The figure3 show the CT scan image of lung which is used as the input to the proposed system, in this image inside the boundary region of the lung that is black part is the back ground and the white spots can be the pulmonary nodule. The aim of our proposed system is to identify the right nodule by distinguishing it from nodule like structure that is false positive reduction. This can be achieved by the proper segmentation of the image. Thus, in the next part of this section we have discussed the segmentation of the image.

C. Image Segmentation

After the pre-processing, the image is ready for segmentation. Image Segmentation is the process which is applied on images to identify the regions of interest in the image. Segmentation subdivides an image into its constituent regions and objects. The level to which segmentation should be carried out depends on the problem to be solved. That is segmentation should stop when the object of interest in an application has been extracted. Methods and Algorithms of image segmentation are based on one of two basic properties of intensity values

a) **Discontinuity:** in this category approach is to partition an image based on abrupt changes in intensity.
b) **Similarity:** in this category approach is based on partitioning an image into regions that are similar according to a set of predefined criteria.

There are many different of segmentation approaches like Thresholding, region based segmentation, Graph cut, Fuzzy C-Mean, Mean Shift Filtering, hybrid Segmentation available with us according to the need of the application. These techniques are divided into three generation of the segmentation techniques that we can use in developing

any system or can apply for the segmentation of the images (Pareesha Aggarwal et al,2013).

For the proposed system **Thresholding** approach of image segmentation has been used and this approach is based on second criteria i.e. **Similarity**.

According to (Pareesha Aggarwal et al,2013), the Thresholding technique has its own different approaches available to be used by developers. These are local Thresholding, global Thresholding, Multiple Thresholding and Optimal Thresholding.

In Thresholding the image is segmented into two different regions one object and second background of the image in such a way that object and background pixels have intensity levels grouped into two dominant modes (Pareesha Aggarwal et al,2013). This division of image into two different regions is done by selecting an intensity value from the histogram of the image. This selected intensity value is known as threshold. The selection of intensity value is done using histogram equalization.

3. Proposed Method Techniques

A. False Positive Reduction

False positive reduction is the process of eliminating the nodule like anatomical structure present in the segmented part of lung CT image and this is done during the process of nodule detection. The meaning of false positive means the structure that look like lungs pulmonary nodule but they are not the real pulmonary nodules in the lungs. In this task such structure are eliminated and detection of such structure is done during the process of nodule Detection which is explained in the next part of this section.

Various methods like rule-based classifier, neural network classifier, ANN and fuzzy based can be used for false positive reduction in lung nodule. The output obtained after applying segmentation on image includes the view of false positives therefore in the result section we have included those results with the help of which reader can understand the exact meaning of the false positive reduction.

B. Nodule Detection

Nodule detection in lungs is the process of determining location of lung nodules within the lungs. In this process only the location of nodule is detected, the nodule detected can be of any class of nodules described above. Different methods can be used to detect different types of lungs nodules.

The efficiency of nodule detection process depends on the correctness of lung field segmented means on the process of lung segmentation and the method used for false positive reduction. Because if the false positives are identified correctly then the chances to detect and recognize the right pulmonary nodule in the CT Scan Image increases.

C. Nodule Classification

In this process on the basis of location detected and structure of nodule the class of nodule is determined.
On the basis of opacity structure, the pulmonary lung nodule can be divided into two classes' benign nodule and malignant nodule.

The proposed system is designed to detect the Ground Glass Nodule and the Ground Glass Nodules are the type of Malignant Nodules. These nodules have diameter greater than 10 mm and are solid nodules.

D. Volumetric Analysis

The process of analyzing the growth rate of the nodule is known as volumetric Analysis. This is the additional process which is done after detecting and classification of the nodule. This is done to detect the growth rate of the nodule means the speed with which the nodule is growing. This is done to analyze the level of cancer in the patient.

4. Results

In the above sections we have discussed the image processing techniques and other methodologies used in the proposed system to detect the pulmonary nodule in the lungs CT scan images.

In this section we have included the results obtained after applying these methods on the image used to train the system. The results of image preprocessing and image segmentation have been discussed and explained in brief in the next two sub sections of this section.

a) Image Preprocessing

In this sub section we have discussed the results of the preprocessing operation applied on the image. The figure4 shows the output obtained after applying preprocessing steps on the image. In our system we have converted the original image into grayscale image and than the median filter are used to remove the noise from the image. There are different types of filters that can be used to make the image noise free but the results of median filter is much better than the other filters therefore we have used Median filter in our system.

Further we have analyzed the histogram of the image to select the threshold value for applying the next operation on the image which is segmentation of the image. The figure5 below shows the histogram of the image.

b) Image Segmentation

In this sub section we have discussed the results of the Image Segmentation operation of image processing applied on the image. The figure6 shows the result of the Threshold Segmentation techniques used in our system.
The intensity value which is known as threshold (Pareesha Aggarwal et al,2013) is

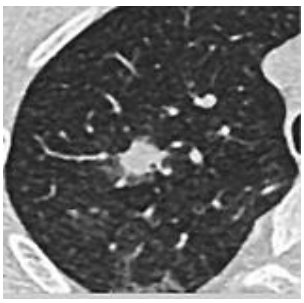

Fig 4. Preprocessed Image

Fig6. Segmented Image

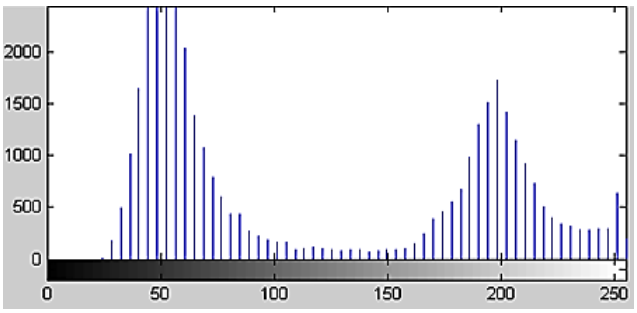

Fig 5. Histogram of Image

selected using the histogram shown in the figure5. The figure 6 shows the background and the object area separated from each other. The black spots inside the layer of lung show the nodule and nodule like structure. Any one of the black spot can be a pulmonary nodule. Therefore it is necessary to distinguish them from each other by further analyzing the structure of each black spot.

Further the figure 7 shows the further enhanced image in which the background of the image has been cleared further from the noise.

Fig 7. Segmented Image

This was the result of the Image Preprocessing and the Image Segmentation process. For the detailed study of segmentation you can refer to the (Pareesha Aggarwal et al,2013).

Conclusion and Future Work

In this paper we have discussed about the proposed system for detecting the Pulmonary Nodule in the Lungs using the Lungs CT scan Images. Further we have explained in brief each step used in designing the system as well as the results of some of the methodologies have been included and discussed for better understanding.

Further research will be focused on the implementation of the next remaining discussed steps to come up with the better and successful complete output of the proposed system which is the detection of the nodule and False Positive Reduction.

References

Pareesha Aggarwal, Abhishek Bhardwaj and Rishi Kumar (2013) Various Techniques Used for Segmentation of CT Image of Lungs at *IJCET*

Ashis Kumar Dhara, Sudipta Mukhopadhyay and Niranjan khandelwal (2012)Computer- aided detection and analysis of pulmonary nodule from CT images at *IETE technical review*.

Akinobu Shimizu, Keita Nakagomi, Takuya Narihira, Hidefumi Kobatake, Shigeru Nawano, Kenji Shinozaki, Koich Ishizu, Kaori Togashi (2011)Automated Segmentation of 3D CT Images Based on Statistical Atlas and Graph Cuts

M.Gomathi, and Dr. P.Thangaraj (March 2010), A New Approach to Lung Image Segmentation using Fuzzy Possibilistic C-Means Algorithm at *IJCSIS*, Vol. 7, No. 3.

E.M. Rikxoort, B.D. Hoop, M.A. Viergever, M. Prokop, and B.V. Ginneken (2009), Automatic Lungs Segmentation from thoracic computed tomography scans using a hybrid approach with error detection at *Medicla Physics*, vol. 36, no. 7, pp.2934-47.

Asem M. Ali and Aly A. Farag (2008), Automatic Lung Segmentation of Volumetric Low-Dose CT Scans Using Graph Cuts at *ISVC*.

D.J. Withey and J.H. koles (2007), Medical image segmentation: Methods and software at *NFSI and ICFBI* .

I. Sluimer, M. Prokop, and B.V. Ginneken (Aug 2005), Towards automated segmentation of the pathological lung in CT *IEEE Trans. At medical imaging*, vol. 24, no. 5, pp. 1025-38.

S. Hu, E.A. Hoffman, and J.M. Reinhardt (Jan 2001), Automatic lung segmentation for accurate quantization of volumetric X-ray CT images *IEEE Trans. Medical Imaging*, vol. 20, pp. 490-8.

S.G. Armato, M.L.Giger, C.J. Moran, J.T. Blackburn, K. Doi and H. MacMahon (1999), computerized detection of pulmonary nodules on CT scans at *RadioGraphics*, vol. 19, pp. 1303-11.

K. Kanazawa, Y. Kawata, N. Niki, H Satosh, H Ohmatsu and R. Kakinuma (1998), computer aided diagnosis for pulmonary nodules based on helical CT images at *Computerized Medical Imaging and Graphics*, vol. 22, pp. 157-67.

Yu- Hsiang Wang (2009),tutorial on image segmentation