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A Review on Lung Nodule Detection in CT image using Image Processing Techniques

R. Manickavasagam [1]
[1]Assistant Professor,
Department of ECE, Alpha College of Engineering,
Chennai- 124.

S. Selvan [2]
[2]Principal,
St.Peter's College of Engineering and Technology,
Avadi, Chennai-54

***Abstract* - Early detection of lung cancer is the promising way of patient's survival which can be detected by using Computed Tomography which is the technique in the detection of lung nodule compared to the other imaging techniques. This paper describes about the comparison of various image processing techniques such as pre-processing, segmentation, feature extraction and classification and gives a better result on the performance. The most preferred technique from the comparison of by using median filter for pre-processing, optimal thresholding for segmentation and BPN for classification which gives the accuracy, sensitivity, specificity of 98%,99%,98% and also other method using SVM classifier. Thus these methods are preferred for lung nodule detection.**

Keywords- Lung Nodule, CT images, pre-processing, enhancement technique, segmentation, feature extraction, classification, sensitivity, specificity, accuracy, precision.

I. INTRODUCTION

The lung cancer is the second most common cancer in both men and women in Europe and in the United States that represents a major economic issue for health care system. In the report of American Cancer Society published in 2003 13% [8] of all cancer diagnosis are lung cancer has been analyzed in 5 years. Sometimes rate increases upto 49% when disease is still localized and also recognized.

Lung cancer is caused by uncontrollable irregular growth of cells in lung tissue. These lung tissue abnormalities are often called lung nodules. They are small and roughly spherical mass of tissue about 1 mm to 30 mm in size [10]. In general, they can be categorized into 4 groups including juxta-vascular, well circumscribed pleural tail, and juxta-pleural. Pulmonary nodules are the characterization of the early stage of the lung cancer. And this can be detected using CT scan, MRI, SPECT and PET.

Computer tomography (CT) t is said to be the best imaging modality for detection of pulmonary nodules particularly, since the introduction of spiral (helical) technology. The CT sensitivity increases with a reduction of the slice thickness due to a decrease of partial volume effect, and overlapping images reconstruction improves the detection of small nodules located at the boundary of two contiguous non-overlapping images.

Initially there are various processing techniques which are applied to extract the affected region of lung from the CT images. Then with a clustering algorithm the segmentation process is performed. This paper aims at a comparison of different methods in lung nodule detection by using CT.

In this paper Chapter I describes about the importance of Computed Tomography in the detection of lung nodule. Chapter II describes about the steps followed in this paper for lung nodule detection using image processing techniques. Chapter III describes about the comparison of image processing techniques and its performance for the detection of Lung nodules.

II. MATERIALS AND METHODS

The detection of lung nodule consists of four steps: pre-processing of original image, lung region segmentation, feature extraction and classification. This section explains each step one by one. The technique starts with pre-processing of the image in order to enhance the contrast of image by removing noise. After pre-processing segmentation is done and feature extraction on ROI is carried out and then classified by using classifier for the detection of lung nodule.

Pre-processing & Enhancement technique:

The pre-processing and enhancement technique are done in order to improve the quality of image. Image enhancement can be defined as conversion of image quality to a better and more understandable level.

Image enhancement improves the quality (clarity) of image for human viewing. Removing blurring and noise, increasing the contrast and revealing details are the examples of enhancement operations. Some of the techniques are Gaussian filtering, median filtering, gabor filtering, linear filtering and histogram equalization. Gaussian filter is used for smoothing and hence to reduce the noise [1].Median filter [2,3] is preferred because the blurring of the edges in the image is less as compared to other filter[5,6]. Bilateral filter is used to enhance plate like structures whereas CED (Coherence enhancing diffusion) can preserve small spherical structures and enhance tubular structures [1]. Gabor filter is used especially for texture analysis due to its optimal localization properties in both spatial and frequency domain [9].Histogram equalization is an important application of grayscale transformation and is one method to enhance image [7].

Lung Region Segmentation:

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. We segment lung are for minimizing the search space of lung

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nodule detection. There is several segmentation methods like thersholding, region segmentation, wavelet transform etc. Wavelet transform can describe an image in a various scales and noise can be reduced with the help of low pass filter. Thersholding [1, 3, 6] is used to segment the image in two regions based upon the pixel value difference between the object of interest in the image and the background and it will generate a binary image. Region growing method [4, 7] causes back group elimination and other addition part such as bones to extract lung tissue and region of interest (ROI) in the lung image.

Feature extraction:

The feature extraction mainly extracted from region of interest (ROI). The method used where GLCM and binarisation masking approach [9]. The parameters include area, diameter, and circularity [1]. Area, perimeter [2]. Area, energy, contrast, entropy, correlation [3]. Normally the statistical texture analysis the texture features are computed from the statistical distribution of observed combinations of intensity points in each combination, statistics are classified as first order, second order etc. The gray level coocurrence matrix method is a way of extracting second order statistical features. A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels G in that image. According to GLCM the textural features are measured as entropy, correlation etc. The entropy is which shows the information of the image is needed for the image compression. Correlation measures the linearity of gray level in neighboring pixels. Next the binarisation approach which extracts the number of white pixels and check them with that of original image in order to find the abnormalities, when compared with binarisation GLCM has better role in feature extraction it takes the different combinations of pixel brightness values.

Classification:

There is number of classification technique used in final stage of nodule detection. The used methods are SVM, ANN (BPN), ANFIS, FIS, and LDA. The SVM method is uses the combination of two different features which gives better classification. The ANN (BPN) has good result on accuracy, sensitivity, specificity [3, 5]. The fuzzy interference system is a method of mapping an input space to an output with aided fuzzy logic; it is designed to enhance the performance of classification [4]. The LDA classifier used to classify the nodule and normal anatomical features.

III. PERFORMANCE EVALUATION

There are different metrics to measure the performance of the image processing techniques which are commonly and mainly used in medical diagnosis systems. These metrics are true positive (TP), true negative (TN), false positive (FP), false negative (FN). TP is number of correct predictions in which an instance is positive. FN is number of incorrect predictions in which an instance is negative. FP is number of incorrect predictions in which an instance is positive. FN is number of incorrect predictions in which an instance is negative. According to these metrics, we could calculate the measures below to evaluate the performance of the system.

1) *Accuracy(Acc) is* the ratio of number of correctly identified examples to the total number of test examples as:

$$Acc = \frac{TP + TN}{TP + TN + FP + FN}$$

2) Sensitivity (Sn) gives the proportion of actually classified positives.

$$Sn = \frac{TP}{TP + FN}$$

3) Specificity (Sp) gives the proportion of correctly identified negatives.

$$Sp = \frac{TN}{TN + FP}$$

4) Precision (prc) measure shows the amount of predicted nodules that are actually related to the cancer.

$$Prc = \frac{TP}{TP + FP}$$

Table 1. Comparison of preprocessing, enhancement technique & segmentation

Author	Preprocessing& enhancement technique	Segmentation	Sensitivity	Specificity
Wook-jin choi et al.(2013)[1]	Gaussian filter, median, bilateral & CED	Optimal thresholding	91.02%	96.92%
Khin mya et al.(2014)[2]	Median filter	Ostu'sthresholding	-	-
Jaspinder kaur et al.(2014)[3]	Median filter	Optimal thresholding	99%	98%
Prashantnaresh et al.(2014)[5]	Median filter	Wavelet	-	-
Taruna aggarwal et al.(2015)[6]	Median filter	Optimal thresholding	97.14%	53.33%
Abbas et al.(2015)[7]	Median filter & histogram equalization	Region growing &thresholding	73.55% 81.96% 73.44%	94.68% 93.59% 94.94%

Table 2. Comparison of feature extraction & segmentation

Author	Feature extraction	Classification	Accuracy	Precision
Wook-jin choi et al.(2013)[1]	GLCM	SVM	93.97%	91.61%
Khin mya et al.(2014)[2]	GLCM	ANN	90%	-
Jaspinder kaur et al.(2014)[3]	GLCM	BPN	98%	-
Hamid bagherieh et al.(2014)[4]	GLCM	FIS	95%	-
Prashantnaresh et al.(201)[5]	GLCM	ANFIS	95%	-
Taruna aggarwal et al.(2015)[6]	GLCM	LDA	84%	-
Abbas et al.(2015)[7]	GLCM	MLP KNN SVM	90.41% 91.20% 90.60%	77.76% 76.33% 78.59%

Comparisons:

Image processing has shown improvement in medical industry in terms of prediction and decision making of lung nodule. Hence the lung nodule detection techniques which have been proposed and reviewed by various authors

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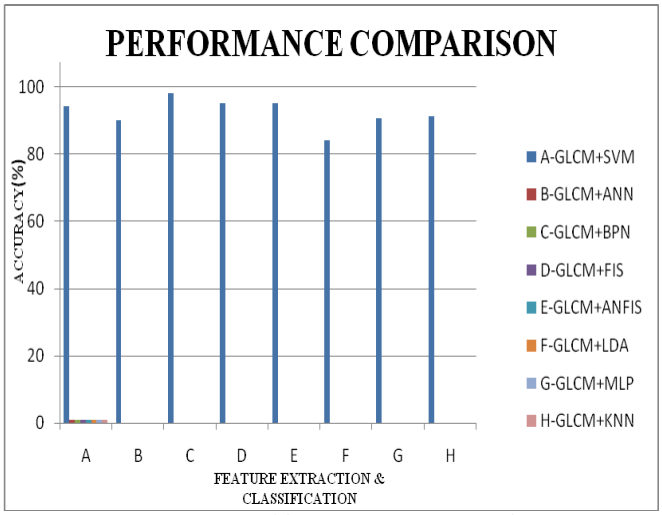
are being compared. Wook-Jin choi and Tae-sun choi proposed a method using Gaussian filter, median filter, bilateral and CED for enhancement technique [1]. In this segmentation is done on the basis of optimal thresholding, feature extraction utilizes GLCM method whereas classification utilizes SVM classifier. This approach has provided 91.02% of sensitivity, 96.92% of specificity, 93.97% of accuracy and 91.61% of precision. Khinmyamyatun and Aungsoekhaing proposed a method for lung nodule detection [2]. Here the enhancement of image is done by median filter, segmentation byostu's thresholding method and feature extraction by GLCM method. But the classifier used in this approach is ANN which provided 90% of accuracy.



Graph1. Accuracy of feature extraction & classification

In Jaspinderkaur, Nidhigarg and Daljeetkaur proposal median filter is used for enhancing the image, optimal thresholding for segmentation and GLCM method for feature extraction [3]. But the classifier used here is BPN which provides 99% of sensitivity, 98% of specificity and 98% of accuracy. In Hamid bagheri, Atiyeh hashemi and Abdol hamid pilevar proposed a method which uses linear filtering which is used for enhancement of the input and region growing method which eliminates the back group noise and extract the region of the interest(ROI) and GLCM for feature extraction and Fuzzy interference system as classifier [4]. This gives the accuracy of 95%.Prashantnaresh and Dr. Rajashreeshettar has made a survey on lung nodule detection in which he found that by using the median filter for pre-processing method, wavelet threshold for segmentation, feature extraction uses GLCM for feature extraction and ANFIS for classification have produced 95% accuracy [5]. Tarunaaggarwal, Asnafurqan and kunalkalra have proposed a method in which median filter, optimal thresholding method, GLCM and LDA classifier have been used which produces 97.14% sensitivity, 53.33% specificity and 84% accuracy [6]. In Farzad vashaghani farahani, Abbas, Ahmadi and M. H. Fazelzarandi proposal median filter, histogram equalization, region growth thresholding, GLCM and with three different classifiers are used. With MLP classifier it produced 73.55% sensitivity, 94.68% specificity, 90.41% accuracy and 77.76% precision. With KNN classifier it produced 81.96% sensitivity, 93.59% specificity, 91.20% accuracy and 76.33% precision. With SVM classifier it produced 73.44% sensitivity, 94.94% specificity, 90.60% accuracy and 78.59% precision [7].

IV.CONCLUSION

In this paper a comparative analysis of lung nodule detection in CT images is performed. Among that the CAD system which uses median filter, optimal thresholding, GLCM and BPN has provided 99% sensitivity, 98% specificity and 98% accuracy and the CAD system which uses Gaussian, median, bilateral, CED filter, optimal thresholding, GLCM and SVM has provided 91.02% sensitivity, 96.92% specificity, 93.97% accuracy and 91.61% precision. Future work and deep learning can be done on this paper to reach better performance in which BPN classifier can be used in image processing techniques because from the clinical point of view this method is found to be one of the best methods.

REFERENCES

[1] Khin mya mya tun et al "Feature extraction and classification of lung cancer nodule detection using image processing technique" ,International Journal of Engineering and Technology(IJERT)" , Vol.3 Issue3, March-2014.

[2] Jaspinder kaur et al "An automatic CAD system for early detection of lung tumor using back propogation network" ,International conference on medical imaging,m-health and emerging communication system(Medcom)" pp.257-261,2014.

[3] Hamid bhagerish et al "Mass detection in lung CT images using region growing sementation and decision making based on fuzzy systems", I.J Imag, .graphic and signal processing, vol.6, 16-24, 2013

[4] Prashant naresh et al "Image processing and classification techniques for early detection of lung cancer for preventive health care:A survey",International journal of recent trends in Engineering & Technology",Vol.11 pp.595-601,June 2014.

[5] Taruna aggarwal et al "Feature extraction and LDA based classification of lung nodules in chest CT scan images" International conference on advances in computing,communication and informatics (ICACCI), pp.1189-1193,2015.

[6] Farzad vasheghani farahani et al "Lung nodule diagnosis from CT images based on Ensemble learning" International conference on Computational intelligence in Bioinformatics and computational biology (CIBCB), pp.1-7,12-15 Aug.2015.

[7] Rithika aggarwal et al "Detection of lung cancer using content based medical iamge retrieval", Fifth International conference on Advanced computing & communication technologies,pp.48-52,2015.

[8] Bhagyashri G.Patil et al "Cancer cells detection using digital image processing methods" International journal of latest trends in engineering & technology(IJLTET),vol.3 isssue 4, pp.45-49 4th March 2014.

[9] H.mahersia et al "Lung cancer detection on CT scan images:A review on the analysis technique"International journal of advanced research in artificial intelligence,vol.4no.4,pp-36-46,2015.

[10] P.Delogu et al "Pre-processing methods for nodule detection in lung CT", Computer Assisted Radiology and Surgery, Proceedings of the 19th International Congress and Exhibition (Berlin, Germany), International Congress Series, vol. 1281, pp. 1099-1103, 2005.

[11] Vaibhav K. Lithitkar et al "Automated detection on cancerous lung nodule from the computed tomography images" IOSR journal of computer engineering(IOSR-JCE),volume16,Issue1,ver VIII,pp5-11, 2014.

[12] Amjed S. Al-fahoum et al " Automated detection of lung cancer using statistical and morphological image processing technique" Journal of biomedical graphics and computing,vol.4 no.2,pp.33-42,2014.