



Detection and Segmentation of Lung Cancer using Statistical Features of X-Ray Images

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Abstract— The early detection of lung cancer is a difficult task because it is one of the important problems due to the installation of complex cancer cells. It is difficult to diagnose quickly through the x-rays only, therefore enlisted this techniques such as digital technologies, becoming a process of early detection of cancer easier complicated. X-ray images contain the noise so as to contain the bones of the rib cage, as well as the bones of the sternum, which is a major obstacle to distinguish cancer, therefore, to improve the images using a filter (median) as well as the way of image segmentation, the thresholding and edge detection methods. Dividing the lung into two parts (upper and lower) comparing the parts with each other to identify which part carry the tumor .The statistical features has been calculated using first Order histogram. In this research three images of one patient has been used after several stages of treatment.

Keywords— Cancer, X-ray image, segmentation, statistical feature

1. INTRODUCTION

Lungs are located on the lateral sides of the thoracic cavity and separated from each other by the mediastinum. As the left lung is physically smaller than the right lung This is because the right and left lungs exhibit some obvious structural differences since the heart projects into the left side of the thoracic cavity, the right lung is subdivided into the superior, middle, and inferior lobes by two fissures. The left lung has a medial surface indentation, called the cardiac impression that is formed by the heart [1].

Lung disease refers to disorders that affect the lungs, the organs that allow us to breathe. Breathing problems which are caused by lung disease may prevent the body from getting enough oxygen [2].

Lung cancer is a highly aggressive and frequently fatal malignancy that originates in the epithelium of the respiratory system. Smoking causes about 85% of all lung cancers. Metastasis, the spread of cancerous cells to other tissues, occurs early in the course of the disease, making a surgical cure unlikely for most patients [1]. X-ray imaging is the fastest, most common, and least expensive diagnostic. Production of digital X-rays from pictorial radiographs is becoming a common practice to maximize information and reduce the number of

rejected X-rays [3]. X-rays are among the oldest sources of electromagnetic (EM) radiation used for imaging. The best known use of X-rays is medical diagnostics [4].

2. METHODOLOGY

Analysis of tissue is a process which is very successful in the diagnosis of medical images of abnormal lung tissue and for this reason we need the help of x-rays and digital image processing, which is the way of modern diagnosis defect. The steps to detect the cancer are:-

1. Cancelling the ribs which appear white on the lungs this can make mastics in detecting the cancer by subtracting the background of the lung image from the cancer.
2. Dividing the lung which carry the cancer into two parts (normal and abnormal). Comparing these with each other by the histogram plot and statistical features.
3. When we specify which part hold the cancer the image is processed by the following steps:-

A. Image segmentation

Image segmentation is the most difficult task in image processing. Segmentation refers to the grouping of image elements that exhibit “similar” characteristics, i.e. subdividing an image into its constituent regions or objects [5]. The thresholding process is the simplest way to segmented the x-ray image.

B. Median Filter

Median filtering is a nonlinear signal processing technique which is useful for noise reduction in images [6]. It is the best-known order-statistic filter, which replaces the value of a pixel by the median of the intensity levels in the neighborhood of that pixel.

C. Thresholding

Thresholding is one of the simplest segmentation methods. It can extract the object from the background by grouping the intensity according to the threshold value [7].

D. Edge detection

Edge detection is a type of image segmentation techniques which determines the presence of an edge or line in an image and outlines them in an appropriate way [8]. The main purpose of edge detection is to simplify the image data in order to minimize the amount of data to be processed [9].

E. Region of interest

A region of interest, is a selected subset of samples within a dataset identified for a particular purpose. The concept of an ROI is commonly used in many application areas. In medical imaging, the boundaries of a tumor may be defined on an image or in a volume, for the purpose of measuring its size [10]. And It’s property which are the statistical and Geometrical features.

3. FIRST-ORDER STATISTICS FEATURES

First-order statistics measure the likelihood of observing a gray value at a randomly-chosen location in the image. First-order statistics can be computed from the histogram of pixel intensities in the image. These depend only on individual pixel values and not on the interaction or co-occurrence of neighbouring pixel values [11].

Where, i is between (0, 255), $p(i)$ the probability density of occurrence of the intensity ,as determined from the histogram with total number of pixels in the image is given as[12].

$$P(i) = H(i)/NM \quad \dots\dots\dots (1)$$

Where

$i= 0,1,2,\dots\dots G-1$

G=gray level tone of an image.

N=number of cell in horizontal domine , M= number of cell in vertical domine. The features which obtained from the histogram.

- Energy

Provide the sum of squared elements. It is also known as uniformity or the angular second moment. Its range is from 0 to 1. Energy is E for a constant image [13].

$$E = \sum_{i=1}^{G-1} (p(i))^2 \quad \dots\dots\dots (2)$$

- *Entropy*

Measures the randomness of a gray-level distribution. The Entropy is expected to be high if the gray levels are distributed randomly throughout the image [13]. It is given by

$$H = -\sum_{i=1}^{G-1} p(i) \log_2[p(i)] \dots\dots\dots (3)$$

- *mean*

It provides the mean of the gray levels in the image. The Mean is expected to be large if the sum of the gray levels of the image is high [13]. It is given by

$$\mu = \sum_{i=1}^{G-1} i p(i) \dots\dots\dots (4)$$

- *Variance*

Variance tells us, how spread out the distribution of gray levels is. The Variance is expected to be large if the gray levels of the image are spread out greatly [13]. It is given by

$$\sigma^2 = \sum_{i=1}^{G-1} (i - \mu)^2 p(i) \dots\dots\dots (5)$$

- *Standard Deviation*

Standard Deviation shows much 'variation' or 'dispersion' exists from the average [13].

$$Std = \sqrt{\sigma^2} \dots\dots\dots (6)$$

- *Skewness*

Skewness of the histogram is also known as third moment. This measure is 0 for symmetric histograms, positive by histograms skewed to the right (about the mean) and negative for histograms skewed to the left. For smooth images this value comes to be negative. Following equation is used to calculate third moment[14].

$$\mu_3 = \sigma^{-3} \sum_{i=1}^{G-1} (i - \mu)^3 p(i) \dots\dots\dots (7)$$

- *kurtosis*

The kurtosis is the flatness of histogram [12]. Kurtosis is the degree of peskiness of a distribution, defined as a normalized form of the fourth central moment μ_4 of a distribution. There are several flavors of kurtosis commonly encountered, including the kurtosis proper [15,16] .

$$\mu_4 = \sigma^{-4} \sum_{i=1}^{G-1} (i - \mu)^4 p(i) \dots\dots\dots (8)$$

4. EXTRACTING THE LUNG DISEASE

In the sample images, the background illumination is clear in the center of the image than at the other regions. The morphological opening operation is used to estimate the background illumination. Morphological in erosion followed by a dilation, the opening operation has the effect of removing object that can not completely contain the structuring element. To create a more uniform background, subtract the background image, background, from the original image, after subtraction, the image has a uniform background but is now too dark. The thresholding has been applied with adding a pseudo –color image a matrix which is RGB to identify each object in the matrix image with a different color in the associated color map matrix.

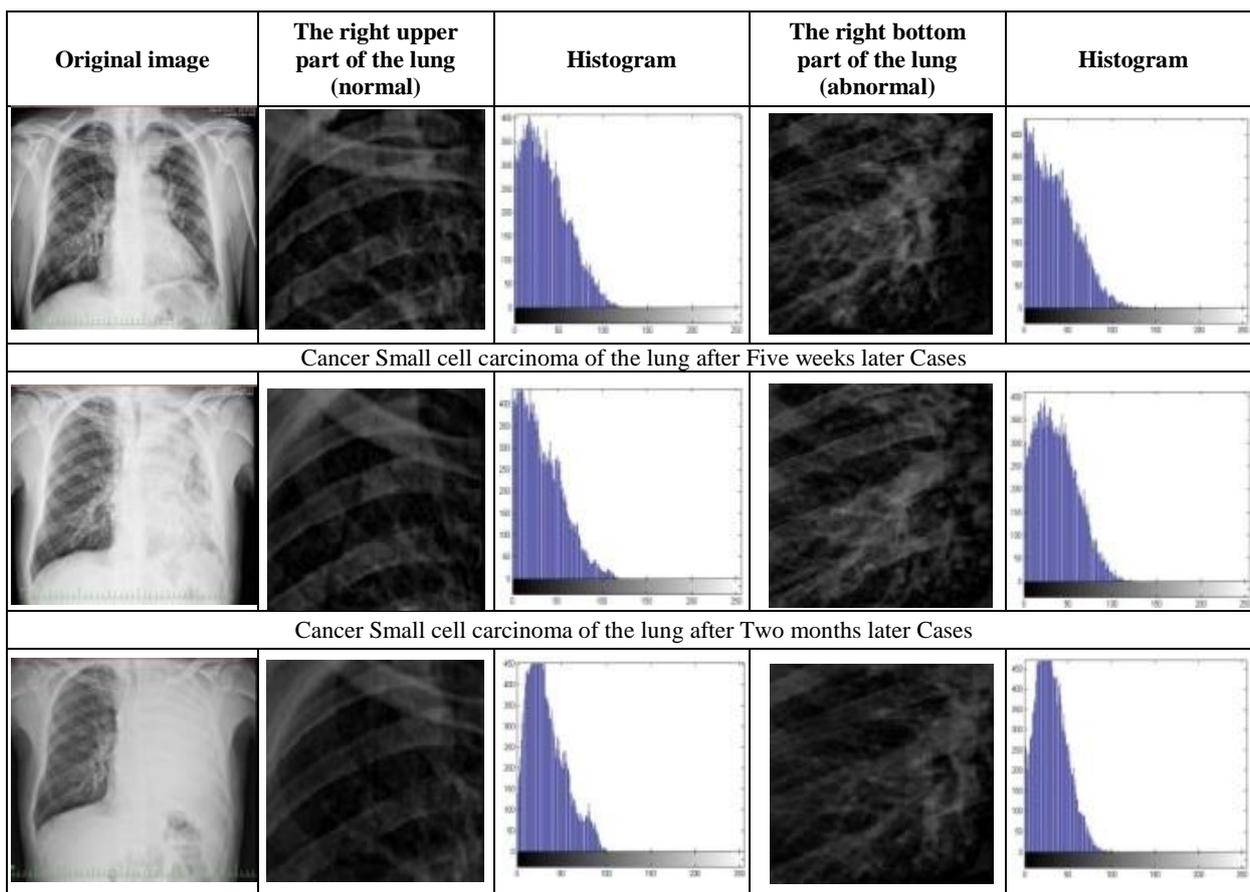


Fig 1 Shows the left and right part of the lung for the normal and abnormal images with histogram of three cases of at different time

TABLE 1
The statistical features for the special Cancer Case

Image No.1	mean	variance	energy	Skewness	kurtosis	entropy	Standard Deviation
upper right side	36.6054	833.4615	0.0126	5.6749e-005	6.8089e-008	0.1133	28.8697
Bottom right patient	39.973	845.8074	0.0140	5.7665e-005	6.8178e-008	0.1268	29.0827

TABLE2
The statistical features for the special Cancer Case after Five weeks

Image No.2	mean	variance	energy	Skewness	kurtosis	entropy	Standard Deviation
upper right side	33.3142	760.5291	0.0139	6.9343e-005	9.1178e-008	0.1185	27.5776
Bottom right patient	37.6092	807.7151	0.0125	5.6452e-005	6.9891e-008	0.0914	28.4203

TABLE 3
The statistical features for the special Cancer Case after Two months

Image No.3	mean	variance	energy	Skewness	kurtosis	entropy	Standard Deviation
upper right side	33.8003	642.8964	0.0150	8.2895e-005	1.2894e-007	-0.0294	25.3554
Bottom right patient	31.3018	497.3995	0.0163	1.1170e-004	2.2458e-007	0.0293	22.3024

Three samples for the same patient have been taken for different time after the patient has received a treatment we have take an image for the patient after five weeks, then after two months. The statistical features for the three images are shown in table (1,2,3) figure (2) shows the (ROI) for the cancer.

Image No.	RGB image	Threshold after ROI	Edge detection using prewitt
image number 1			
After Five weeks Image No.2			
After Two months Image No.3			

Fig 2 The color and ROI cancer region for three cases after (five week and two months)

4.1 Statistical features for the cancer

After the cancer detected and separated from the other lung texture. We calculate the statistical features.

TABLE 4
The Statistical Feature for the Image shows in figure (2) of Cancer Cases

Image No.	mean	variance	energy	Skewness	kurtosis	entropy	Standard Deviation
Image 1	8.8624	1.9143e+003	0.7213	6.7628e-005	3.5328e-008	0.1915	43.7527
After Five weeks No.2	14.1698	3.0648e+003	0.6212	2.5659e-005	8.3719e-009	0.2909	55.3606
After Two months No.3	7.8350	1.6763e+003	0.7102	8.8426e-005	5.2751e-008	0.2009	40.9426

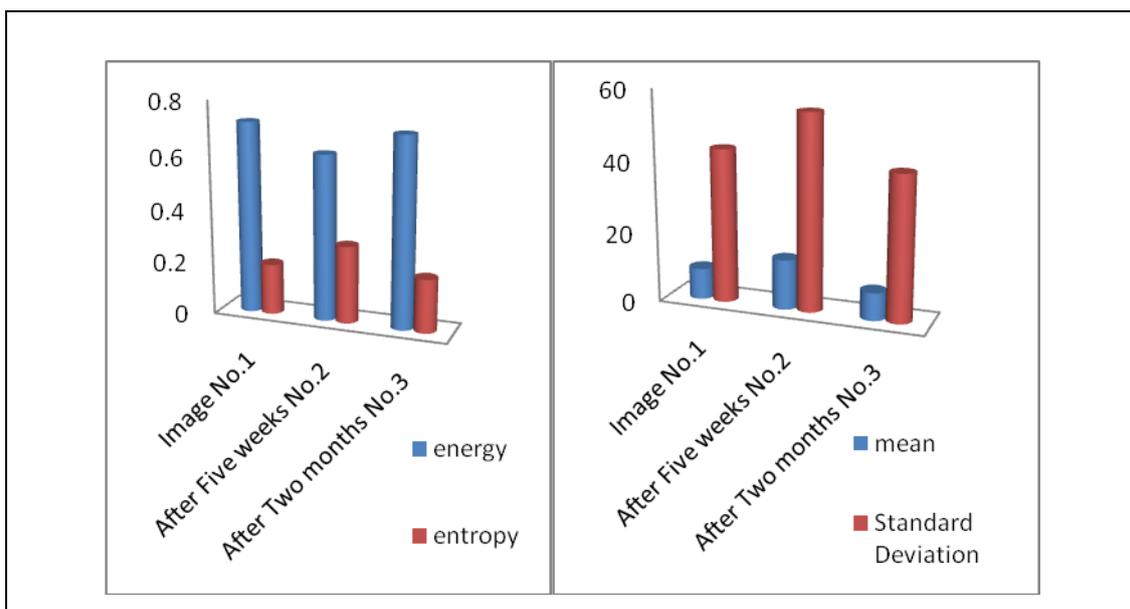


Fig 3 The Statistical Feature for the Image figure (2)

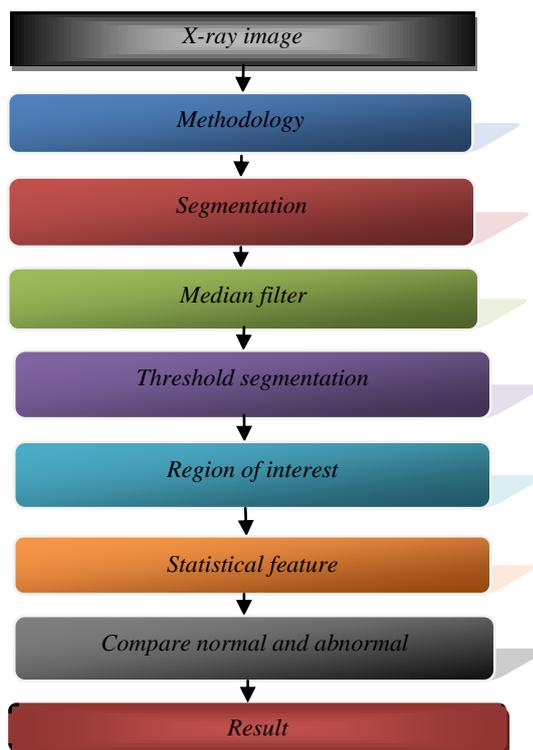


Fig 4 Shows the diagram for the assume system to detection the cancer

5. CONCLUSIONS

This search aim to extract the cancer from the lung by using the segmentation method and the enhancement filter (median) then the region of interest is used to get the cancer out from the rest lung. The comparison of the histogram between the upper and lower part of the lung gives indication about which part carry the cancer, with the help of the statistical feature which has been calculated for the three images after five weeks and after two months table (1,2,3) shows the statistical features for the three images and the comparison between the upper and lower part of the lung, table (4) shown the first-order statistical features for the cancer. The mean value after two month and after the patient has received treatment is lower than before treatment also the skwness is high this mean's that the texture of the lung become more symmetry than before, the energy increase and the entropy decrease this gives explanation about the number of gray level in the image (i.e) increase energy lower gray level number and the tissue of the lung become homogenous than before this also means that the lung tissue become smooth than before taken the treatment .

REFERENCES

- [1] M. Mckinley¹ and V. D. O'Loughlin², *Human Anatomy*, ¹Glendale community college, ²indiana university, ISBN 0_07_249585_5, Qm23.2.M38 pp: 773-784, 2006.
- [2] R. M. Castellan, M.D.¹, R. E. Manrow², T. Richards, M.D.³ and J. J. Smith, M.S.N, R.N., A.O.C.N.⁴, M. White, Sc.D.⁵, *Lung Disease*, M.P.H. Division of Respiratory Disease Studies National Institute for Occupational Safety and Health¹, Ph.D. Associate Director, Office of Cancer Content Management National Cancer Institute², Medical Officer Centers for Disease Control and Prevention³, Nurse Consultant National Cancer Institute⁴, Branch Chief, Epidemiology and Applied Research Division of Cancer Prevention and Control Centers for Disease Control and Prevention⁵, pp:1;November 29,2010.
- [3] Dr. K. I. Jassam¹, and professor, M. Carr², "REMOVAL OF RANDOM NOISE FROM CONVENTIONAL DIGITAL X-RAY IMAGES", Researcher, the Institute of Islamic Medicine for Education and Research Panama City, FL¹. , Department of Surveying Engineering University of Maine Orono, ME². USA Commission No: VII, PP: 113, 1992.
- [4] R. C. Gonzalez and R.E. Woods, *Digital Image Processing*, 3rd ed., © by Pearson Education, Inc. Pearson Prentice Hall, Pearson Education, Inc. Upper Saddle River, New Jersey 07458, 2008.

- [5] S. Beucher, "The Watershed Transform Applied to Image Segmentation", Proceedings of the Pfefferkorn Conference on Signal and Image Processing in Microscopy and Microanalysis, pp. 299–314, September 1991.
- [6] W. PRATT, *DIGITAL IMAGE PROCESSING*, Fourth Edition, Published by John Wiley & Sons, Inc., Hoboken, New Jersey. Published simultaneously in Canada, 2007.
- [7] S. Rujikietgumjorn. "SEGMENTATION METHODS FOR MULTIPLE BODY PARTS", PROJECT IN LIEU OF THESIS Presented for the, Master of Science Degree The University of Tennessee, Knoxville, pp: 8, July 31, 2008.
- [8] W. Frei and C. Chen, "Fast Boundary Detection: A Generalization and New Algorithm," *IEEE Trans. Computers*, vol. C-26, no. 10, pp. 988-998, Oct. 1977.
- [9] J. Canny, "A computational approach to edge detection," *IEEE Trans. Pattern Analysis and Machine Intelligence*, Vol. 8, No. 6, pp. 679-698, Nov. 1986.
- [10] A. Pathan and B.K.saptalkar," Detection and Classification of Lung Cancer Using Artificial Neural Network", *International Journal on Advanced Computer Engineering and Communication Technology* Vol-1 Issue:1 :ISSN 2278 – 5140. 2bairusaptalakar@gmail.co
- [11] B. Julesz, "Nonlinear and Cooperative Processes in Texture Perception," In *Theoretical Approaches in Neurobiology*, T.P. Werner, E. Reichardt, (Editors). MIT Press, Cambridge, MA, pp. 93-108, 1981.
- [12] A. Hussain, A.N. Mazher and A. Razak, "Classification of Breast Tissue for mammograms images using intensity histogram and statistical methods", *A Refereed Science Journal issued by the college of science university of Baghdad*, vol 53, No.4, December 2012.
- [13] N. S. Lingayat and M. R. Tarambale,"A computer based feature extraction of lung Nodule in chest x-ray image", *International journal of bioscience. Biochemistry and bioninformatics*, vol.3, No.6, November 2013.
- [14] S. A. Patil, "Texture analysis of TB X-ray images using image processing techniques", *Journal of Biomedical and Bioengineering*, vol 3, issue 1 pp.-53-56, 2012.
- [15] M. Abramowitz and I. A. Stegun, (Eds.). "Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables", 9th printing. New York: Dover, p. 928, 1972.
- [16] J. F Kenney and E. S. Keeping, *Mathematics of Statistics*, Pt. 2, 2nd ed. Princeton, NJ: Van No strand, 1951.