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Lung Cancer Detection from CT Image using Image Processing Techniques

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Abstract: Now a day lung cancer is the leading cancer among both men and women. Earlier detection of cancer is the only method to improve the survival rate. Presence of lung cancer can be diagnosed with the help of a CT image of lung. Doctor analyses the CT image and predicts the presence of cancer nodule. This manual detection may have the chances for false detection. So a computerized method for cancer detection is needed. Image processing technique can be used for this purpose. Lung cancer detection system can be developed by using these image processing techniques. Lung cancer detection system has three steps to detect the presence of cancer nodule in lung. Pre-processing stage, feature extraction stage and lung cancer cell identification are the steps. Pre-processing step includes image enhancement and image segmentation. Enhanced CT image of lung is then passed through segmentation phase. From the segmented output features are extracted to predict the presence of abnormality of lung. By using these extracted features classify the lung as normal lung or abnormal lung.

Keywords: image enhancement; log Gabor filter; thresholding; weibull segmentation.

I. INTRODUCTION

Cancer is now the biggest cause of death in the world. Lung cancer is one of the most common cancers in present days. Due to the lifestyle of people there is a gradual increase in cancer patient. Pain, breathlessness, cough, weight loss and fatigue are the common symptoms of cancer. Survival from the disease is difficult if it is not detected at the early stage. Only 15% of lung cancer is detected at the early stage. So it is necessary to detect the cancer in the early stage[1]. Normally cancer can be divided into two groups. They are non-small cell lung cancer and small cell lung cancer.

Lung cancer is diagnosed from the CT image of lung. Normally a doctor analyses the CT image of lung and detect the presence of cancer in lung. In this manual diagnose method may have the chance of false detection. False detection is due to the presence of air in bronchi, presence of ribs and blood vessels etc [2]. So it is essential to develop a method of computerized detection of cancer. Image processing techniques are the best tool for developing such a computerized method for lung cancer detection. CT image of lung is processed and finds whether the presence of cancer nodule is present or not. For this purpose there are many image processing tools [3][4]. This paper focused to build an efficient and accurate computerized method for lung cancer detection.

The remainder of this paper is organized as follows. In section II, describes the proposed lung cancer detection system. The experimental results and discussions are presented in section III. Finally, section IV concludes the paper.

II. METHODOLOGY

The method used is the image processing. Detection of cancer nodule is done in three steps. CT images are used as the input to detect the presence of cancer nodule. Images are collected from a private hospital. Images are stored in 512 x 512 pixels in size

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and in JPEG format. Processes performed throughout the project are done in MATLAB. Image pre-processing, feature extraction and cancer cell identification are the three steps. The flow of the project can be viewed in figure 1.

First step in the cancer detection process is the capture of input image. Input image is the CT image of lung. Second step is pre-processing. Pre-processing composed of two processes. They are image enhancement and image segmentation. Image enhancement is used to improve the interpretability of information in the image to the human viewers. There are many enhancement algorithms are there. Gabor filter, fast fourier transform, log gabor filter and auto enhancement are some of them. Image segmentation is second part in pre-processing stage. The purpose of image segmentation is to partition the image into meaningful region and to identify the object or relevant information from the digital image. Then the output from the segmentation process is goes to feature extraction stage. Features such as area, perimeter and irregularity are found out in feature extraction. On the basis of the extracted features the abnormality in lung are found out by the cancer cell identification module. The architecture of proposed lung cancer detection system is shown in Fig 1.

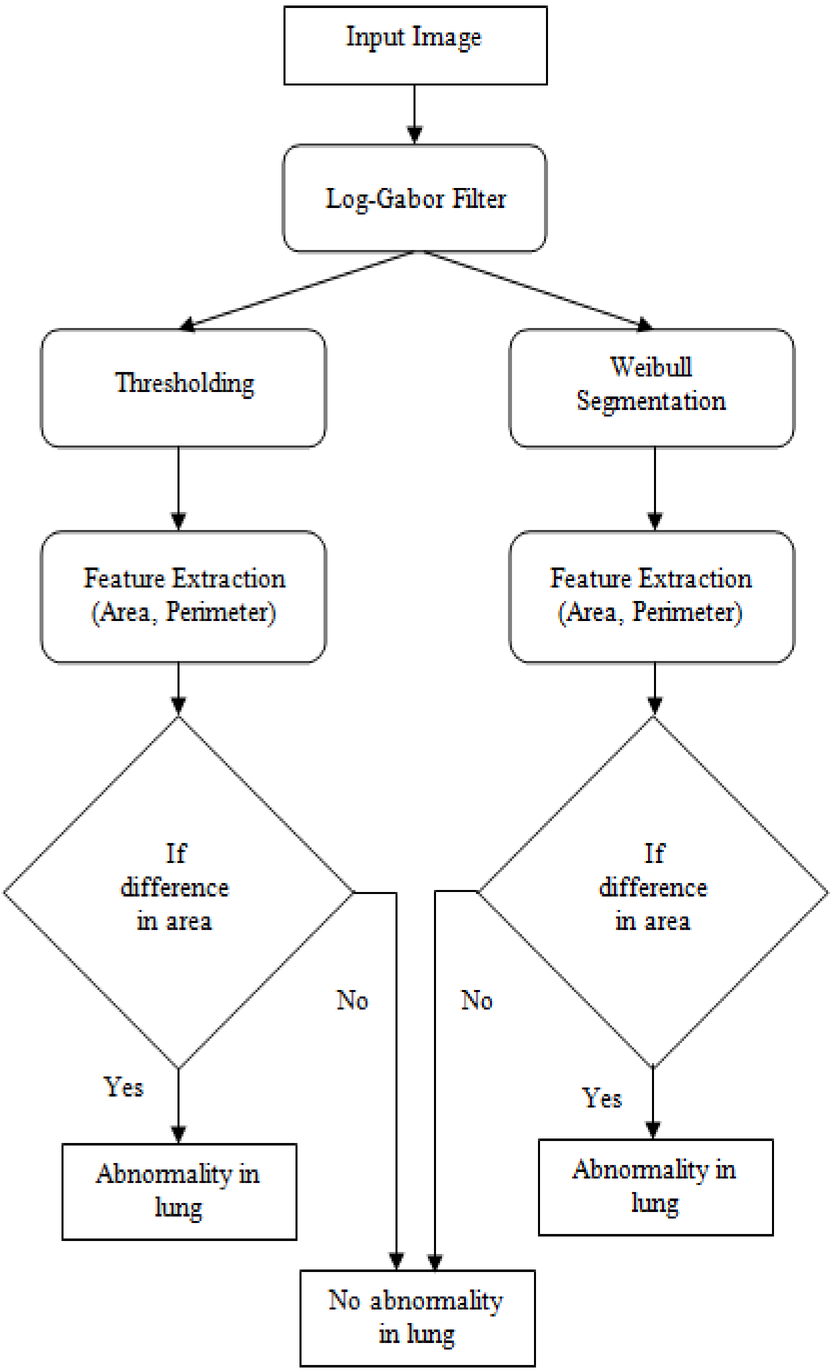
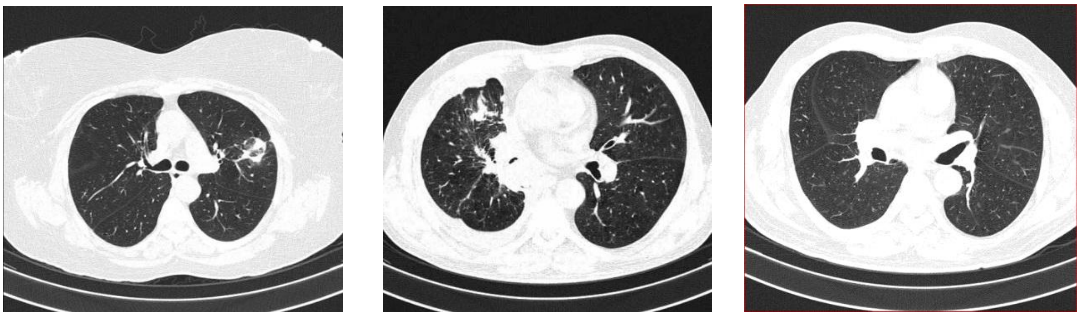


Fig. 1 Lung cancer detection system.

A. Image capture

Imaging plays an important role in diagnose of lung cancer. Different imaging techniques are X-ray, CT, PET, magnetic resonance imaging (MRI) etc. in this work we are using CT image of lung as input. CT image is chosen because CT images are more sensitive in finding the tumor size and the lymph nodes of lung. Input image is inflated lungs of 512 x 512 in pixel size and must be in JPEG format. Some of the input images are shown in figure 2.



(a) (b) (c)

B. Image pre-processing

It is the second module in lung cancer detection system. The purpose of pre-processing stage is to improve the image data by reducing the unwanted distortion. It is done by enhancing or separating the data which are needed for further processing. Image enhancement and image segmentation are the process performed in pre-processing stage.

i) *Image enhancement:* Image enhancement is used to improve the interpretability of information in the image to the human viewers. Image enhancement is of two types, spatial domain methods and frequency domain methods. Spatial domain method deals with the image pixel. Enhancement is achieved by changing the pixel values. That means, alternating the grey level value and change the contrast of the image. In frequency domain enhancement is achieved by changing the orthogonal transform of image. That means, based on the frequency domain the processing are performed. There are different methods for image enhancement. Gabor filter[5][6], fast Fourier transform, log gabor filter are the some of them.

   a. *Gabor filter:* Gabor filter was introduced by Dennis Gabor. This method is mainly applied over 2D images. Gabor filter is a liner filter which has an impulse response. Impulse response is defined by multiplying a harmonic function with a Gaussian function.

   b. *Fast Fourier transform:* Fast Fourier transform is the faster version of Discrete Fourier transform. This method operates on the Fourier transform of the image. Fourier theory tells that an operation called convolution is performed in the frequency domain to enhance the image. A convolution in the frequency domain is a simple multiplication of an image mask with the complex frequency domain image.

   c. *Log Gabor filter:* Log gabor filter was proposed by Field in 1987. Log gabor filter is the advanced version of gabor filter. Some alternatives are made on the gabor function is the log gabor function. Log gabor filter has two characteristics, one is it has no DC components and the second one is the transfer function of log gabor function has an extended tail at the high frequency end.

ii) *Image segmentation:* Image segmentation algorithms are based on discontinuity and similarity. These two are the properties of intensity values. The purpose of image segmentation is to partition the image into meaningful region and to identify the object or relevant information from the digital image. Image segmentation highlights the information which we are needed for further processing from the image and thus make it easy to analyze. There are

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many types of segmentation algorithms. Thresholding[7], watershed segmentation[8], weibull segmentation[9] are some of them.

a. *Thresholding:* Thresholding is the most powerful tool for image segmentation. Thresholding operation first converts the grey scale image into binary image. Thresholding operation selects a threshold value T and it assigns two levels to the images that is one is above and the other is below the threshold value. By using the threshold value T, it can separate the object from the background. Then any point (x,y) for which f(x,y) > T is called an object point, otherwise the point is called a background point.

b. *Weibull segmentation:* Weibull segmentation is one of the segmentation method used in medical images. Distribution parameters of weibull distribution describe the texture contrast, scale, shape, and generate a six-stimulus basis for texture perception. So it can be treated as a good model. Variation in the weibull parameters produces verity of distribution, which includes exponential and Gaussian and Raleigh. In this technique the image is assumed to have a weibull distribution. A complex image is represented by Cm,n. If the amplitude of the pixel |Cm,n| is a weibull distributed random variable with form parameter γm,n and scale parameter βm,n. Its probability density function is given by equation(1). Mean value, standard deviation and weibull parameters γi,j and βi,j are calculated. Then the central pixel is replaced by βi,j and finds the minimum and maximum value of βi,j. Then the βi,j value is mapped to 0 to 255 using the equation(2).

$$p(|C_{m,n}|) = [\gamma_{m,n} / \beta_{m,n}][|C_{m,n}| / \beta_{m,n}]^{\gamma_{m,n}-1} \exp[-|C_{m,n}| / \beta_{m,n}]^{\gamma_{m,n}-1} . (1)$$

$$output_{i,j} = [I_{dif} / m_{dif}][\beta_{i,j} - \beta_{min}] + I_{min} . \qquad (2)$$

Histogram of the resulted image is plotted and the minimum grey level value and maximum grey level value are selected from the histogram. Then according to the number of classes entered from the input the image is segmented into regions.

C. Feature extraction and Cancer cell identification

Feature extraction is the important stage in this work. It uses different methods and algorithms to extract the features from the segmented image. Based on the extracted features normality and abnormality of the lung are decided. The features which we are extracted are area, perimeter and average intensity. Segmented images have only two values 1 and 0. Nodule part will be represented with value 1. Then area of the nodule can be calculated by finding number of pixel with value 1. Perimeter of the nodule means the number of pixels in the boundary region of the nodule.

Average intensity is another feature which is used for the purpose of cancer detection. Select two threshold values for mean intensity values, and then calculate the average intensity value for the candidate region. If the average intensity value is between the threshold values then this part is assumed to be cancerous otherwise not. Based on area of the nodules the cancer caused nodules are identified. If the nodule size is greater than 25mm then it is assumed as abnormal image. If the nodule size is less than 25mm then it can be assumed as a normal image.

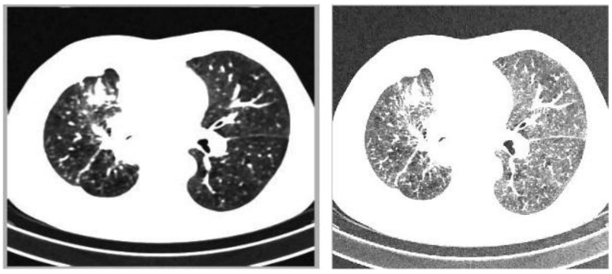
III. Results and Discussion

The experiments are conducted on the lung cancer detection system (LCDS) with the inputs are CT images of lung. CT image is successfully processed by each step in lung cancer detection system and the resulted was obtained.

CT image of lung is given to various image enhancement techniques and the output is obtained. Various image enhancement techniques are Gabor filter, Fast Fourier transform and log-gabor filter. The resultant enhanced images of Fig 2(b) is shown in Fig 3.

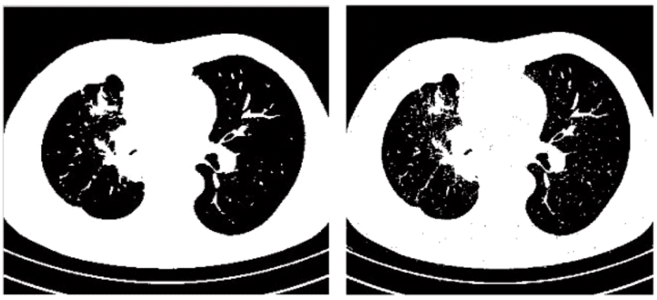
Output from image enhancement technique is used as the input to the image segmentation module. In this work output from log gabor filter is used as input. For image segmentation two techniques are used, that is thresholding and weibull segmentation. Resultant output from both the method are generated and evaluated. Obtained results are shown in Fig 4. Entropy values of the resultant images from both the methods are calculated. Best segmented image is finding out on the bases of the entropy value. Image with higher entropy value is the best image which gives more information. Such images are good for further processing. Resultant output from weibull segmentation gives higher entropy value when compared with the output from thresholding.

Outputs from both the segmentation techniques are processed separately under the feature extraction and cancer cell identification module. Cancer cell identification module identifies the cancer caused part in lung and marked with red colour. Results are shown in Fig 5.



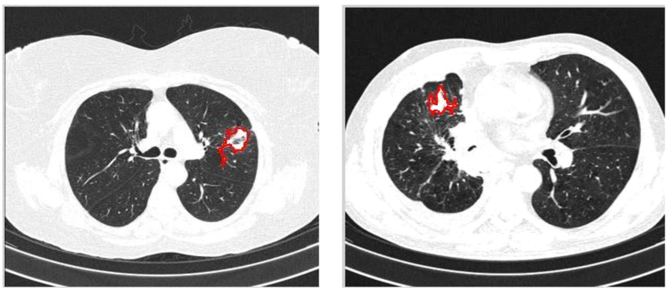
(a) Log-gabor (b) FFT

Fig. 3 Enhanced images



(a) Weibull segmentation (b) Thresholding

Fig. 4 Segmented images



(a) (b)

Fig. 5 Cancer caused part is detected and marked with red colour

IV. Conclusion

Cancer is now the biggest cause of death, among them death due to lung cancer is increasing gradually. This paper focused on detection of lung cancer from CT image of lung by using image processing. Also aims to find a better segmentation algorithm which produces a good result. The experiment is conducted and evaluates the output produced. Based on entropy values of segmented image it is clear that weibull segmentation technique produces good image. So it can conclude that weibull segmentation is better than thresholding.

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