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A Novel Approach for the Detection of Small Cell Lung Cancer Based on Entropy and PSNR Value

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Abstract— **Lung cancer is one of the serious diseases affecting mankind. Locating lung cancer is a tedious task as it shows only few symptoms and also its evaluation is difficult. But image processing techniques seems to be an efficient method for the early detection of lung cancer. The quality and accuracy of the image are the two factors in detecting lung cancer which in turn depends on image enhancement and segmentation stage. Early detection of lung cancer can reduce the mortality rate. So in this work, a comparison is made among the different techniques in both the stages to determine the efficient method. Simulations are done using MATLAB.**

Keywords— **Enhancement, Gabor filter, Segmentation**

I. INTRODUCTION

Cancer is one of the serious health problems affecting the world among which lung cancer is an important one. The mortality rate due to lung cancer is very high. But the early detection of lung cancer can reduce the mortality rate. Studies show that 85% of the lung cancer in males and 75% of the lung cancer in females is due to cigarette smoking [1].

Lung cancer is a malignant tumor in the tissue of one or both of the lungs. Some people have primary cancer that started in the lungs. Others have cancer that started somewhere else in the body and spread to the lungs (secondary cancer). Lung cancer is the deadliest type of cancer for both men and women. Each year, more people die of lung cancer than of breast, colon, and prostate cancers combined.

There are different types of lung cancers like small cell lung cancer and non-small cell lung cancer. Small cell lung cancer is the starting stage and as the name indicates the size of the affected part will be small. It is a fast growing type cancer and affects other cells also. It is further divided into small cell carcinoma (oat cell cancer) and combined small cell carcinoma. Small cell lung cancer usually starts in the breathing tubes at the center of the chest. It is the most aggressive type of cancer because it spreads to other part of the lungs fastly and can cause death. Non-small cell lung cancer is the next phase of lung cancer as it affects more number of cells. It is further divided into Adenocarcinoma, Squamous cell carcinoma and large cell carcinoma.

Studies show that in 2013 about 580,350 were died in America due to lung cancer. Lung cancer is found to be the second most cause of death in America accounting for 1 among 4 deaths. The overall survival rate is very low. Males are mostly affected and smoking is the main reason for the lung cancer [2].

Lung cancer is a serious health problem affecting mankind. Studies show that the early detection of lung cancer can decrease the mortality rate to a great extent [3]. At the present scenario, an efficient method for the lung cancer detection is absent. But image processing techniques can solve this problem [3]. It helps in the early detection if an efficient image processing technique is present. So in this work, a comparison is made among the different techniques at each stages of image processing to determine the best method for the early detection of lung cancer. The current work is organised as follows:

II. IMAGE ENHANCEMENT

Image enhancement is the fundamental image processing technique. It is done to improve the quality of the image for making it visually feasible. Depending on the features we want to enhance, there are different image processing techniques. Some images will be noisy and so we have to reduce the noise present in it for further processing. So removal of noise is a kind of image enhancement technique. In some other cases, the image captured by the image capturing device may be very dark. In such cases, image enhancement technique can be used to increase the contrast or intensity of the image. So the ultimate aim of an image enhancement technique is to process the image, so that it is suitable for further processing. Enhancement techniques are application dependent [2]. The type of enhancement technique depends on the type of application. Here for the enhancement stage, the techniques used are: Gabor filter, Median filter and Fast Fourier Transform.

A. Gabor Filter

Gabor filter is a linear filter named after Dennis Gabor used for edge detection. Its impulse response is defined by a sinusoidal wave multiplied by a Gaussian function. Because of the multiplication-convolution property, the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function [3]. The filter has real and imaginary components. These two components may be formed into a complex one or can be used individually. Gabor filter equations are defined as [3]:

a) For Complex:

$g(x, y; \lambda, \theta, \psi, \sigma, \gamma)=$

$$\exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\exp\left(i\left(2\prod\frac{x'}{\lambda}+\psi\right)\right) \quad (1)$$

b) For Real:

g(x, y; λ, θ, ψ, σ, γ)=

$$\exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\mathrm{Cos}\left(2\prod\frac{x'}{\lambda}+\psi\right) \quad (2)$$

c) For Imaginary:

g(x, y; λ, θ, ψ, σ, γ)=

$$\exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\mathrm{Sin}\left(2\prod\frac{x'}{\lambda}+\psi\right) \quad (3)$$

Where,

$$x' = x\mathrm{Cos}\theta + y\mathrm{Sin}\theta$$
$$y' = x\sin\theta + y\mathrm{Cos}\theta$$

The various parameters includes: the variance σ of the Gaussian function. The spatial aspect ratio γ specifies the ellipticity of the support of the Gabor function.

B. Median Filter

The median filter is a non-linear filter that can be used to remove noise. It is a kind of pre-processing technique, the result of which is used for further processing. It is also a spatial filter where it replaces the center value in the window with the median of all pixel values in the window. The kernel is usually square, but can be of any shape. It can also be used for preserving the edges. Edges are of critical importance in the appearance of an image. The median filter has got two advantages over mean filter:

- Median is more robust than mean and so a single very unrepresentative pixel in a neighborhood will not affect the median value significantly.
- Median value is actually one of the pixel values in the neighborhood and so it will not create unrealistic pixel values especially at the edges. Median filter is edge preserving than mean filter.
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C. Fast Fourier Transform

The Fourier Transform is an important image processing technique that can decompose the image into sine and cosine components. The input to the Fourier Transform will be spatial domain and its equivalent output transform will be in frequency domain. In the Fourier domain image, each point represents a particular frequency contained in the spatial domain image. The Fourier Transform is used in a wide range of applications, such as image analysis, image filtering, image reconstruction and image compression.

The Fourier Transform produces a complex number valued output image which can be displayed with two images, either with the real and imaginary part or with magnitude and phase [3]. In image processing, often the magnitude part is displayed as it contains most of the information about the image in spatial domain. However, if we want to re-transform the Fourier image into the correct spatial domain after some processing in the frequency domain, we must make sure to preserve both magnitude and phase of the Fourier image. The Fourier domain image has a much greater range than the image in the spatial domain. Hence, to be sufficiently accurate, its values are usually calculated and stored in float values [3].

III. IMAGE SEGMENTATION

It is the most challenging and critical problem in image processing and analysis. It is the process of partitioning the image domain into meaningful object regions. Its central position in image processing comes from the fact that the delineation of objects is usually the first step in other higher level processing tasks, like image interpretation, diagnosis, analysis, visualization, virtual object manipulation, and often even registration. Image segmentation may be thought of as consisting of two related processes [4]:

- Recognition: It is the high-level process of determining roughly the whereabouts of an object of interest in the image.
- Delineation: It is the low-level process of determining the precise spatial extent and point-by point composition of the object in the image.

An important goal of image processing is to change the representation of the image into a more meaningful and easier to analyse form. It is mainly used to locate objects and boundaries in the image. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics [4]. The resultant of image segmentation will be a collection of segments that will entirely cover the image. All pixels in a given region are similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic. Segmentation algorithms are based on one of two basic properties of intensity values: discontinuity and similarity. The first category is to partition the image based on abrupt changes in intensity, such as edges in an image. The second category is based on partitioning the image into regions that are similar according to a predefined criterion [3].

A. Otsu's Thresholding

Thresholding is an important process in image processing applications. Otsu's thresholding discovered by the scholar Otsu in 1979 is a kind of global thresholding that can be applied onto gray images. Thresholding is the process of selecting an optimal threshold value for separating objects of interest from the background based on their gray level distribution. The output will be a binary image which is easily interpretable by humans. And because of this, thresholding is a difficult task. The binary image of thresholding is obtained by turning all pixels below some threshold to zero and all pixels about that threshold to one. If g(x, y) is a threshold version of f(x, y) at some global threshold T, it can be defined as [5]:

$$g(x,y) = \begin{cases} 1; \text{ if } f(x,y) \geq T \\ 0; \text{ Otherwise} \end{cases} \quad (4)$$

In this work, Otsu's method that uses (gray thresh) function to compute global image threshold is used. Otsu's method is based on threshold selection by statistical criteria. Otsu suggested minimizing the weighted sum of within class variances of the object and background pixels to establish an optimum threshold. Minimization of within class variances is equivalent to maximization of between-class variance. This method gives satisfactory results for bimodal histogram images. Threshold values based on this method will be between 0 and 1, after achieving the threshold value; image will be segmented based on it [3].

B. *Marker Controlled Watershed Segmentation*

Marker controlled watershed segmentation is a tedious process in image processing which is used for separating touching objects in an image [6]. It is a robust and flexible method for segmentation of objects with closed contours, where the boundaries are expressed as ridges. The marker image used for watershed segmentation is a binary image consisting of either single marker points or larger marker regions, where each connected marker is placed inside an object of interest.

Each initial marker has a one-to-one relationship to a specific watershed region, thus the number of markers will be equal to the final number of watershed regions. After segmentation, the boundaries of the watershed regions are arranged on the desired ridges, thus separating each object from its neighbors. The markers can be manually or automatically selected, but high throughput experiments often employ automatically generated markers to save human time and resources [7].

The basic procedure of marker controlled watershed segmentation is as follows:

- Computation of the segmentation function.
- Compute foreground markers. These are connected blobs of pixels within each of the objects.
- Compute background markers which are the pixels that are not part of any image.
- Modify the segmentation function so that it has minima at the foreground and background marker locations.
- Compute the watershed transformation.

C. *Histogram Equalization*

Histogram equalization can be said to be an important and automatic point processing technique for contrast enhancing images. It is called an automatic procedure because it does not require any user control parameters for its application to an image i.e., there is one and only one histogram equalized result for a given image. It is a sophisticated technique that can be used to improve the dynamic range and contrast of an image by non-linearly reassigning pixel intensity values in the image such that the resulting image has a uniform distribution of the pixel intensity values across its entire range of values [6]. The whole idea behind histogram equalization is the belief that the pixel intensities should be evenly distributed across the entire possible intensity range for better dynamic range of the intensities and contrast for a better image. Thus, it can be said that the aim of histogram equalization is to obtain a modified image that has a flat histogram, without affecting the intensity information structure of the original image. Histogram equalization employs a non linear mapping that reassigns the intensity values so that we obtain an image with uniform intensity values.

IV. FEATURE EXTRACTION

Feature extraction is an important stage in which the required feature is extracted from the segmented image. Here in this work, the basic morphological operations are performed to extract the required feature.

A. Erosion

Morphology is an approach for image analysis which is based on the ideas developed by J. Serra and G. Matheron of the Ecole des Mines in Fontainebleau, France. It is based on set theory. . For morphology of binary images, the sets consist of pixels in an image. Mathematical morphology is a powerful tool for geometrical shape analysis and description. Erosion is one of two fundamental operations in morphological image processing from which all other morphological operations are derived. It was originally defined for binary images, later being extended to gray scale images, and subsequently to complete lattices. The basic idea in binary morphology is to probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image. This simple "probe" is called structuring element, and is itself a binary image.

The two principal morphological operations are dilation and erosion. Dilation allows objects to expand, thus potentially filling in small holes and connecting disjoint objects. Erosion shrinks objects by etching away (eroding) their boundaries. These operations can be customized for an application by the proper selection of the structuring element, which determines exactly how the objects will be dilated or eroded. The dilation process is performed by laying the structuring element B on the image A and sliding it across the image in a manner similar to convolution. It is best described in a sequence of steps:

- If the origin of the structuring element coincides with a 'white' pixel in the image, there is no change; move to the next pixel.
- If the origin of the structuring element coincides with a 'black' in the image, make black all pixels from the image covered by the structuring element.

$$A \,\theta\, B = z \,/\, (B_z) \subset A \qquad (5)$$

Let A and B be sets in Z^2, erosion of A by B, denoted by A θ B is defined as above:

V. PROPOSED METHODLOGY

A. Image Acquisition

It is the first stage in any image processing technique where the CT scan images is collected and stored. The image is converted into gray scale image and used for further processing. Pixel values of gray scale image are ranging from 0 to 255, where 0 represents black and 255 represents white.

B. Image Enhancement

The image that is obtained through image acquisition may not be of the required format. That means it may contain noise etc. So that image is undergone through image enhancement process through which the quality of the image can be improved. Thus the enhanced image can be used for further processing.

There are many image enhancement techniques available. But among them, only some gives required results. So here a comparison is made to determine the best enhancement technique that helps in the early detection of lung cancer. The comparison is made among Gabor filter, Median filter and FFT based on their entropy and PSNR value.

Entropy gives us the amount of information content present in an image. It is defined as:

$$\text{Entropy (p)} = -\sum_{k=0}^{L-1} p\left(X_k \log_2 p\left(X_k\right)\right) \quad (6)$$

Peak signal to noise ratio is defined as:

$$\text{PSNR} = 10 \log_{10} \frac{\left(L-1\right)^2}{MSE} \quad (7)$$

Where,

$$\text{MSE} = \sum_{i=1}^{M}\sum_{j=1}^{N} \frac{\left[X(i,j) - Y(i,j)\right]^2}{M * N} \quad (8)$$

Where X (i, j) is the input image, Y (i, j) is the output image and M, N are the number of pixels.

C. *Image Segmentation*

Image segmentation is used to change the representation of the image into a more meaningful form so that it can be easily interpreted by humans. Segmentation divides the image into different segments. In this work, a comparison is made among the different segmentation processes like Otsu's thresholding, Marker controlled watershed algorithm and Histogram equalization to determine the best segmentation process.

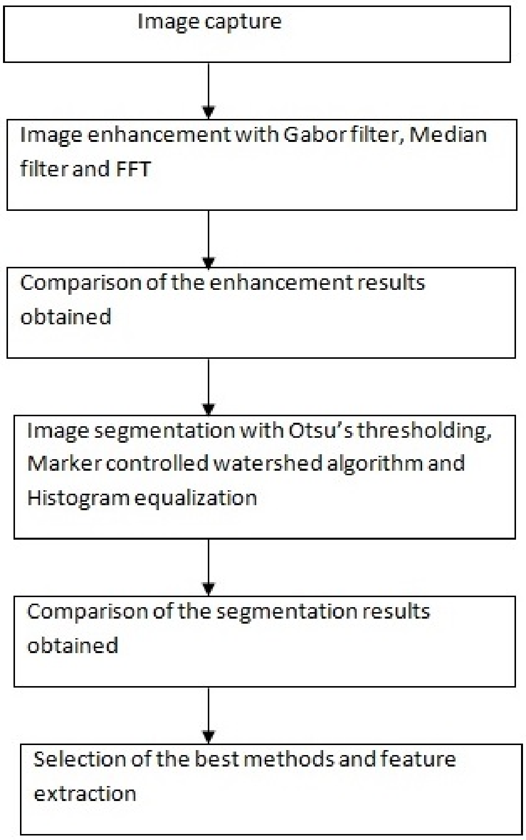

Fig. 1 Proposed methodology

D. Feature Extraction

The required feature from the segmented image is extracted in this process. In this work, the basic morphological operator erosion is used to extract the required feature.

VI. RESULTS AND DISCUSSIONS

The CT scan of the image is taken as the input image and is given by:

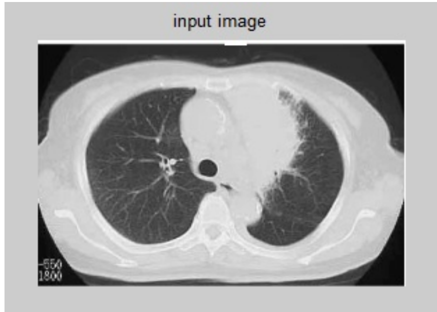

Fig -2: Input image

A. Image Enhancement

The outputs obtained with Gabor filter, median filter and FFT are given below:

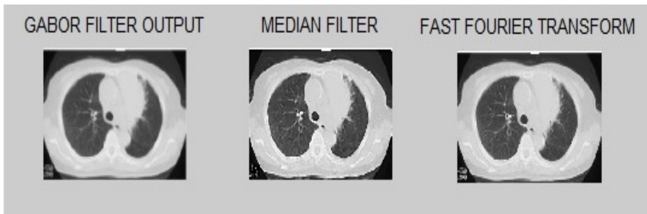

Fig -3: Enhanced images

Table -1: Entropy value with enhancement

Filter	Entropy
Gabor Filter	7.0300
Median Filter	6.9639
FFT	6.9216

Table-2: PSNR value with enhancement

Filter	PSNR
Gabor Filter	32.4060
Median Filter	21.3408
FFT	18.9170

B. Image Segmentation

The outputs with Otsu's thresholding, Marker Controlled watershed segmentation and Histogram equalization is given below:

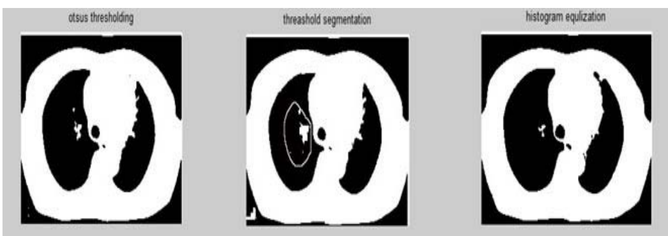

Fig -4: Segmentation results

C. Feature Extraction

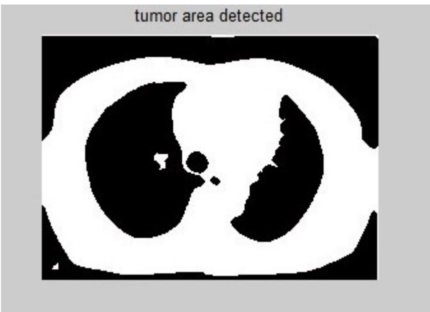

Fig -5: Tumor area detected

As we discussed, we know that lung cancer is a fatal disease and its detection is a very crucial process. The early detection of lung cancer can reduce the mortality rate. Present systems are not efficient in the early detection of lung cancer. So here comparison is made among the various image processing stages to determine the efficient method.

We know that entropy is the amount of information contained in an image. The more the entropy value, the better is the image for further processing. So it can be said that entropy is an important parameter in image processing. So here entropy is considered to determine the best enhancement technique. From the table, it is clear that Gabor filter gives large value of entropy compared with other filters. And also the PSNR value of Gabor filter is highest compared to other methods. So it can be said that the image enhanced with Gabor filter contains more information. So this output can be used for further processing. And also the mean value of Gabor filter seems to be the highest. From the segmentation stage, it is clear that marker controlled watershed segmentation gives better segmentation results. The time taken for the detection of tumor is also considered here. It is found that the output of Gabor filter followed by marker controlled watershed segmentation gives better tumor detection with less time. The feature is extracted using the morphological operator erosion.

VII. CONCLUSION

This proposed work addresses the image processing techniques for the detection of cancerous cell in lungs. Comparison is performed in different image processing stages. As we know that the early detection of lung cancer can reduce the mortality rate, an efficient method has to be found for the same. So from the comparisons made, for the image enhancement process, Gabor filter gives better enhancement with less noise. For the segmentation process, marker controlled watershed algorithm gives better segmentation. These two results can be used for the feature extraction process.

REFERENCES

[1] Bhagyashri G. Patil, "*Cancer Cells Detection Using Digital Image Processing Methods*," International Journal of Latest Trends in Engineering and Technology (IJLTET), Vol. 3 Issue 4 March 2014.

[2] Mokhled S. al-tarawneh, "*Lung Cancer Detection Using Image Processing Techniques*," Leonardo Electronic Journal of Practices and Technologies, Issue 20, January-June 2012 p. 147-158.

[3] Vijay A.Gajdhane, Prof. Deshpande L.M, "*Detection of Lung Cancer Stages on CT scan Images by Using Various Image Processing Techniques*," IOSR Journal of Computer Engineering (IOSR-JCE), Volume 16, Issue 5, Ver. III (Sep Oct. 2014), PP 28-35.

[4] Dasu Vaman Ravi Prasad, "*Lung Cancer Detection Using Image Processing Techniques*," International Journal of Latest Trends in Engineering and Technology (IJLTET), Vol. 3 Issue 1 September 2013.

[5] Nguyen, H. T.,et a, "*Energy-Driven Watershed Segmentation*," IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume 25, Number 3, pp.330-342, March 2003.

[6] Dr. H. B. Kekre, Ms. Saylee M. Gharge, "*Image Segmentation using Extended Edge Operator for Mammographic Images*," International Journal on Computer Science and Engineering, Volume 02, No. 04, 2010.