Gabor Filter based Thresholding Level Method for Medical Image Enhancement

Patel Ankitkumar Arvindbhai[1] Kishor Bamniya[2]
[1]P.G. Student [2]Assistant Professor
[1, 2] KIT& RC, Kalol, India

Abstract---Digital image enhancement techniques provide a multitude of choices for improving the visual quality of images. A frequency domain smoothing-sharpening technique is proposed and its impact is assessed to beneficially enhance the lung cancer images. This technique aims to gain the advantages of enhance and sharpening process that aims to highlight sudden changes in the image intensity and identifying the level of image for diagnosis purpose. The already developed technique also eliminates the drawbacks of each of the two sharpening and smoothing techniques resulting from their individual application in image processing field. Significant improvement in contrast of masses along with the suppression of background information.The proposed technique is tested lung cancer images of average filter and thresholding of level. The simulated results show that the high potential to advantageously enhance the image contrast hence giving extra aid to radiologists to detect it damage portion in lung.

Keywords: Lung cancer, Gabor filter, Image enhancement, Thresholding.

I. INTRODUCTION

Lung cancer is considered to be as the main cause of cancer death worldwide, and it is difficult to detect in its early stages because symptoms appear only at advanced stages causing the mortality rate to be the highest among all other types of cancer. More people die because of lung cancer than any other types of cancer such as: breast, colon, and prostate cancers. There is significant evidence indicating that the early detection of lung cancer will decrease the mortality rate. The most recent estimates according to the latest statistics provided by world health organization indicates that around 7.6 million deaths worldwide each year because of this type of cancer.

Furthermore, mortality from cancer are expected to continue rising, to become around 17 million worldwide in 2030 [1]. There are many techniques to diagnosis lung cancer, such as Chest Radiograph (x-ray), Computed Tomography (CT), Magnetic Resonance Imaging (MRI scan) and Sputum Cytology [2]. However, most of these techniques are expensive and time consuming. In other words, most of these techniques are detecting the lung cancer in its advanced stages, where the patient's chance of survival is very low. Therefore, there is a great need for a new technology to diagnose the lung cancer in its early stages. Image processing techniques provide a good quality tool for improving the manual analysis. A numbers of medical researchers utilized the analysis of sputum cells for early detection of lung cancer [3]. For this reason we attempt to use automatic diagnostic system for detecting lung cancer in its early stages based on the analysis of the sputum color images [4]. In order to formulate a rule we have developed a technique for unsupervised segmentation of the sputum color image to divide the images into several meaningful sub regions.

Image segmentation has been used as the first step in image classification and clustering. There are many algorithms which have been proposed in other articles for medical image segmentation, such as histogram analysis, regional growth, edge detection and Adaptive Thresholding [5]. Review image of segmentation techniques can be found in [6]. Other authors have considered the use of color information as the key discriminating factor for cell segmentation for lung cancer diagnosis [7]. Figure 1 shows the beginning stages of cancer. In literature survey stage, we tried to get enough information related to our topic of research. Reading papers, collecting database, and making interviews with specialists, our tested database taken from IMBA Home (VIA-ELCAP Public Access) [5].

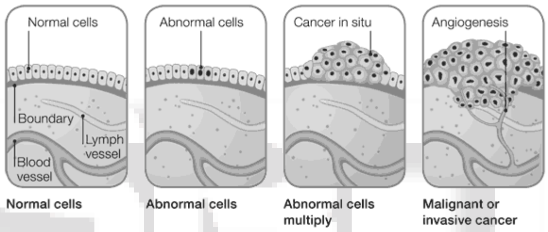

Fig. 1: The beginning of cancer

II. IMPORTANCE OF ENHANCEMENT

One of the most important stages in medical images detection and analysis is Image Enhancement techniques which improves the quality (clarity) of images for human viewing, removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations.

The original image might have areas of very high and very low intensity, which mask details. An enhancement technique reveals these details and adjust their operation based on the image information (pixels) being processed.

In this case the mean intensity, contrast, and sharpness (amount of blur removal) could be adjusted based on the pixel intensity statistics in various areas of the image. We can define image enhancement as away to improve the quality of image, so that the resultant image is better than the original one, the process of improving the quality of a digitally stored image by manipulating the image with MATLAB software. It is quite easy, for example, to make an image lighter or darker, or to increase or decrease contrast. MATLAB also supports many filters for altering images in various ways. The enhancement technique differs from one field to another according to its objective.

Image enhancement techniques can be divided into two broad categories:

(1). Spatial domain techniques, which operate directly on pixels, and
(2). Frequency domain techniques, which operate on the Fourier transform of an image.

As we work on medical images, we tried out three types of enhancement techniques: Gabor filter, Fast Fourier transform, and Auto enhancement. To talk about the better method we should use a theory to determine this unfortunately, there is no general theory for determining what `good' image enhancement is when it comes to human perception.

A. Spatial domain method

The value of a pixel with coordinates (x; y) in the enhanced image ^ F is the result of performing some operation on the pixels in the neighborhood of (x; y) in the input image, F. Neighborhoods can be any shape, but usually they are rectangular [8].

B. Frequency domain method

Image enhancement in the frequency domain is straightforward. We simply compute the Fourier transform of the image to be enhanced, multiply the result by a filter (rather than convolve in the spatial domain), and take the inverse transform to produce the enhanced image [8].

III. GABOR FILTER ALGORITHM

A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), 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.

Gabor filters are directly related to Gabor wavelets, since they can be designed for number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of biorthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. The Gabor space is very useful in e.g., image processing applications such as iris recognition and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

The Gabor Filters have received considerable attention because the characteristics of certain cells in the visual cortex of some mammals can be approximated by these filters.

In addition these filters have been shown to posses optimal localization properties in both spatial and frequency domain and thus are well suited for texture segmentation problems.

Gabor filters have been used in many applications, such as texture segmentation, target detection, fractal dimension management, document analysis, edge detection, retina identification, image coding and image representation. A Gabor filter can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope.

$h(x, y) = s(x, y)g(x, y)$, $s(x, y)$: Complex sinusoid

$g(x, y)$: 2-D Gaussian shaped function, known as envelope

$$S(x, y) = e^{-j2\pi(u_0x+y_0y)} \quad (1)$$

$$g(x, y) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{1}{2}(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2})} \quad (2)$$

The fundamental enhancement needed in mammography is an increase in contrast. Contrast between malignant tissue and normal dense tissue may be present on a mammogram, but below the threshold of human perception. Our emphasis at this stage is to provide the radiologist with a superior image. In the past, several image contrast enhancement methods have been proposed. Many image enhancement approaches in the area of adaptive histogram equalization were proposed. There was a problem in reducing mean brightness change. Adaptive unsharp masking technique as also applied for image contrast enhancement. It also lacks to detect low contrast edges present in the input image. The research works have been one on mammograms for its contrast enhancement and for identification of image features associated with breast cancer. These methods introduced enhancement on mammogram features using adaptive neighborhood method which are also not immune to noise. Rangayyan et al worked in mammography image contrast enhancement in which the contrast has been improved to a very good extend while compromising the naturalness of the original image.

From the literature survey on mammogram image enhancement and detection of micro calcification, still it is a problem in obtaining contrast enhancement without losing any relevant information in the original mammogram image. If it is tried to reduce any loss of information, then artifacts would be the next challenge or issue in contrast enhancement of mammogram images. The approach taken in this paper is to propose an optimal contrast enhancement for mammogram images to get both artifacts free and naturalness in the enhanced image. Hence there is a chance to give sufficient quality in the mammogram images to allow the radiologist to make his diagnosis with more confidence. The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application.

IV. IMPLEMENTATION WORK APPROACH

In the image Pre-processing stage we started with image enhancement; the aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques [12].

Image enhancement techniques can be divided into two broad categories: Spatial domain methods and frequency domain methods. Unfortunately, there is no general theory for determining what “good” image enhancement is when it comes to human perception. If it looks good, it is good! However, when image enhancement techniques are used as pre-processing tools for other image processing techniques, then quantitative measures can determine which techniques are most appropriate [12]. In our image enhancement stage we used three techniques: Gobor filter, auto-enhancement and Fast Fourier transform techniques.

Image segmentation is an essential process for most image analysis subsequent tasks. In particular, many of the existing techniques for image description and recognition depend highly on the segmentation results [13]. We used Thresholding and marker controlled watershed segmentation techniques.

Thresholding is one of the most powerful tools for image segmentation. The segmented image obtained from Thresholding has the advantages of smaller storage space, fast processing speed and ease in manipulation, compared with gray level image which usually contains 256 levels. Therefore, thresholding techniques have drawn a lot of attention during the past 20 years [14].

V. MATLAB BASED SIMULATION RESULTS

2,3 and Table 1 shows the simulated result using the Gabor algorithm and compare with various average and unsharpfilter methods, thresholding of images.

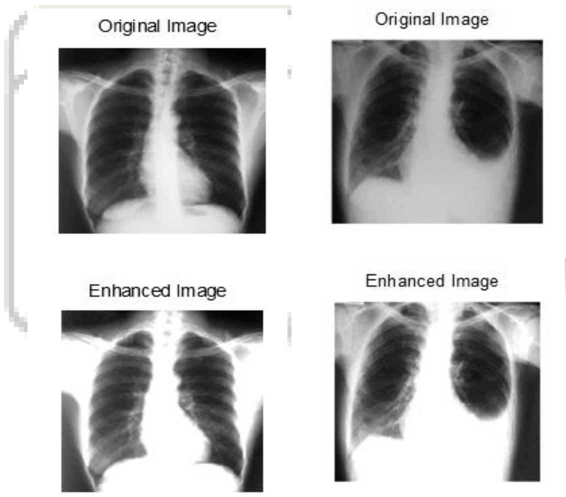

Fig. 2: Enhanced images

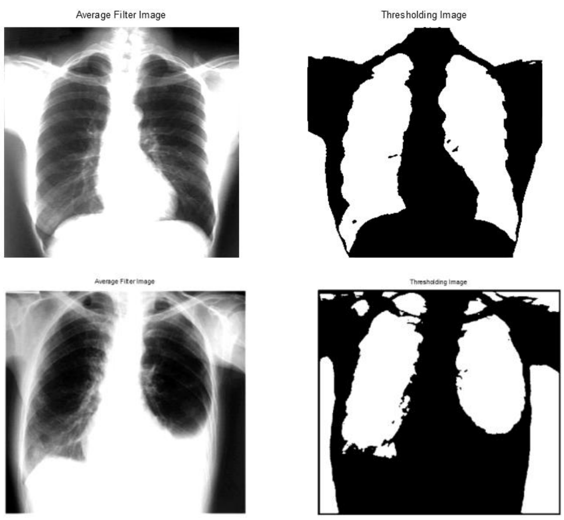

Fig. 3: Simulation result of various lung cancer images

Name of Image	Peak Signal to Noise Ratio (dB)		Thresholding level
	Average	Unsharp	
Image 1	43.8899	46.8574	0.61961
Image 2	20.4397	17.6197	0.60784
Image 3	23.7022	21.6141	0.55294

Table.1:The simulation compare of different images

VI. CONCLUSION

our observation of the gabor filter method and thresholding approach are giving a good image enhancement of the medical applications. The result images turned up new areas which might be of diagnostic interest.Combining Gabor algorithm with fast Fourier transform and thresholdingshowed to be a very effective method of eliminating the noise and enhancing edges, thus improving the signal-to-noise ratio. Superimposition of images processed using different techniques into single image within showed to advantageously enhance the visibility and ease the identification of valuable information to the human eye compare to various other methods of filtering.

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