Online available since 2011/Mar/28 at www.scientific.net

doi:10.4028/www.scientific.net/AMM.52-54.2128

Feature Extraction on Medical Image using 2D Gabor Filter

Muhammad Noorazlan Shah Zainudin [1,a], Muzalifah Mohd Said [2,b] and Mohd Muzafar Ismail [3,c]

Faculty of Electronic Engineering and Computer Engineering
Universiti Teknikal Malaysia Melaka
Melaka, Malaysia
noorazlan@utem.edu.my[a], muzalifah@utem.edu.my[b], muzafar@utem.edu.my[c]

Keywords : Mammogram, Gaussian filter, Gabor filter

Abstract. Mammography is a specific type of imaging that produces an X-ray picture of the human breast. Detection of tumors at an early stage is important step in diagnosis of the abnormalities in mammograms. In many of the cases, preprocessing process of the raw image involving of enhancement, filtering and determination of textural features have been necessary for successful implementation of this study. Raw image is applied histogram equalization method in order to enhance the image intensity. Thus, the noise of that image is eliminated using Gaussian filtering method. Gabor wavelet based algorithm such Gabor filter is used to extract the feature of that images.

Introduction

The highest factor diseases that contribute to the number of death rates among women in the world are caused by the breast cancer. Although, there are available various treatment procedures, most reliable and highly better performance on those procedures still become an issue till now. One of the approaches that have been used in various hospitals or medical centre is by using diagnostic of mammogram X-ray image. Recently, most of the diagnosis is based on the computer learning and the technique are widely used is classification. This research focuses on sample of mammogram image and concentrated in a small area of the mammogram while the rest being normal.

Due to that problem, the goal of this research is to study the technique of multi-scale filtering methods for feature extraction of image using the Gabor filter method. The preprocessing process of the sample image such as image enhancement, image filtering has been performed before the process feature extraction will be applied. Finally, the extracted data will be classified using the neural network supervised learning classifier techniques for the further analysis.

Digital Screening Mammogram

Mammograms are used for diagnosis breast cancer those who have no signs or symptoms of the disease at an early stage. Mammography is specific type of imaging that produce x-ray image of breast and used to detect the tumor and cysts [1] and also can differentiate between cancerous and noncancerous tissues. In order to confirm either a lump detected of the in screening is cancer or not, further testing is necessary to performed. The process of capturing the images known as screening mammogram usually involves two x-rays of each breast. Even though the early detection can increase treatments and highly accurate, but like most medical test it is not perfect (American Cancer Society). According to these articles, mammography method can be detected average 80% - 90% of breast cancers of woman without symptoms. Diagnostic mammogram is different from screening mammogram because they involve more x-rays in order to obtain views of the breast from several angles and take longer time to process. Then, all suspicious abnormalities that have been

detected should be biopsied for a definitive diagnosis. There are specific hints and factor in order to determine the category of the mammogram between normal, malignant and benign [2]. Suspicious area that can be determined from the detailed picture that has been produced will be used of radiologist for further analysis.

Preprocessing of Medical Images

Medical images is use to detect the tumors and cysts in order to help differentiate between non-cancerous and cancerous disease [2]. Basically, these images are different from the typically photographic image because they internal anatomy is reveal as opposed of the surface on this images [3]. The preprocessing of image refers to the initial processing of raw image to correct geometric distortions, calibrate the data radiometrically and eliminate the noise and clouds that present in the data. The process for identifying abnormal region on the digital images can be divided into two parts as the segmentations of elements and their subsequence classification. Unfortunately, ultrasound systems are inherently very noisy, rendering it difficult to interpret the images and to successfully detect the features of that image. In the segmentation stages, process of noise reduction of the sample images should be performed to make sure the analysis of data more accurate and give better result. Several techniques that can be used to remove the noise of the sample image are the Bayesian Wavelet Coring, Gabor Wavelet and Wavelet Packets.

Enhancement Process using Histogram Equalization

Histogram is a graph indicating the number of times each gray occurs in the image. Normally in the preprocessing process, the first step that should be done is enhancement process to the raw image to expand the range of gray levels (contrast enhancement). Since the contrast is expanded for most of the image pixels, the transformations improve the detectability of may image features. Histogram equalization is applied because this method did not require user input gamma value. The probability density function of pixel intensity level r_k is given by:

$$p_r(r_k) = \frac{n_k}{n} \tag{1}$$

where $0 \le r_k \le 1, k = 0,1,...,255$

n_k is number of pixel at intensity level r_k

n is total number of pixels

The histogram is derived by plotting $p_r(r_k)$ against r_k. A new intensity s_k of level k is defined as:

$$S_k = \sum_{j=0}^{k} \frac{n_j}{n} = \sum_{j=0}^{k} p_r(r_j) \tag{2}$$

Noise Filtering using Gaussian Filter

Image noise can be described as unwanted, usually unwanted variation in brightness and color information in an image. Most of the medical images, such mammogram, MR and CT contain large area of background noise, which are useless in medical diagnosis [6]. The pre-processing stage deals with problems related to variable shape sizes, color, background noise and variable placement angles of the shapes. The background noise outside the diagnostic region should be removed first before perform conversation of the image to the data value. There are several methods image

filtering that can be applied on the image such rough set theory [5], median filter [4], Weiner filtering and etc. There are two components in the filter which are high-frequency components such as edges and noise. Low-frequency components include backgrounds and skin textures. Gaussian filter is group of low-pass filter which is it passes over low-frequency components and reduces high-frequency components.

2D Gabor Filter

Gabor filters is linear filter whose impulse response is defined by harmonic function multiplied by Gaussian function. Because of the multiplication-convolution property, the Fourier transform of the Gabor filters impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. Two-dimensional Gabor functions are use to model the spatial summation properties of simple cells in the visual cortex. The Gabor is defined as :

$$\lambda,\theta,\varphi,\sigma,\gamma(x,y) = \exp\left(\frac{-x^2+\gamma^2y^2}{2\sigma^2}\right)\cos\left(2x\frac{x'}{\lambda}+\varphi\right) \tag{3}$$

$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$

where arguments x and y specify the position of a light impulse in the visual fields. The Gabor function specified the values of parameters wavelength, orientation, phase offset, aspect ratio and bandwidth will be calculated and displayed as an intensity map image in the output window. The image in the output window has the same size as the input image. The data that has been produced will used for further classification process.

Experimental Result

Almost all raw images contain noise or unwanted information. Thus, the preprocessing should be applied to make the images that are used for an input data is clear in order to guarantee the optimum rate of the classification.

Preprocessing of Raw Images

The sample image of the mammogram for the normal and cancer diseases shows in the Fig 1 below.

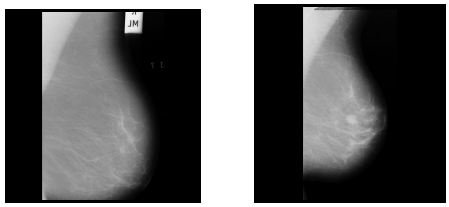

Fig 1 (left) mammogram of normal breast, (right) mammogram of abnormal breast

Histogram equalization is a better approach compared to the histogram stretching because they didn't need user to define the gamma value. The results of image enhancement that are applied histogram equalization are shown in Fig 2 below.

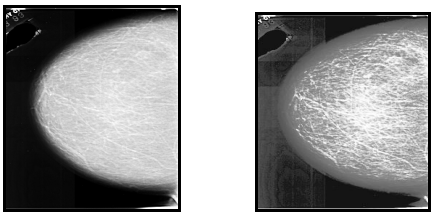

Fig 2 (left) original image (right) image after enhancement using histogram equalization

The frequency of an image is a measure of the amount by which gray level values change with distance. The characterized by large change in gray values over small distances is called as high-frequency components such edges and noise. Gaussian filter is one of the classes of low-pass filtering and the result shows that the noise is smoothed out and the signal also distorted at the same. The image below show the result after applying the Gaussian filter with filter size 5 x 5, standard deviation is 0.5 and gamma value 250. The result of the image that is applied Gaussian filter and median filter shows on the Fig 3 below.

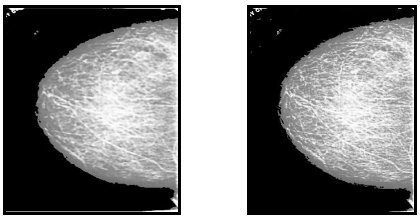

Fig 3 (left) effect of median filter (right) effect of Gaussian filter

The interest areas in mammograms consisted of high-density regions, represent by light shades of gray and white. To determined the abnormalities from the image, high-pass filtering are use to attenuate the effects of lesser dense regions in mammograms. . In this case, the pixel size of cropped image is choosing 30 x 30 resolutions. The interest areas in mammograms consisted of high-density regions; represented by light shades of gray and white are shown in the Fig 4 below.

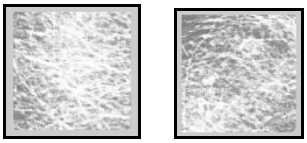

Fig 4 The ROI of the image with mask 30 x 30 pixel

Feature Extraction

The Gabor wavelet-based algorithm is use to extracted the spatial-frequency texture features of the mammogram images.

2D Gabor Filter

2D Gabor filters are a traditional choice for obtaining localized frequency information and offer the best simultaneous localization of spatial and frequency information. The Gabor function for the specified values of the parameters “wavelength”, “orientation”, “phase offset”, “aspect ratio” and “bandwidth” will be calculated and displayed as an intensity map image in the output window. This function is tested with several different parameters on the same image. The output of filtered images is calculated based on the filter output value that have been produced. The experiment result of the output filtered image was applied 2D Gabor filter are shows in the Fig 5 below. The description of the parameter that has been used is shown in the Table I below.

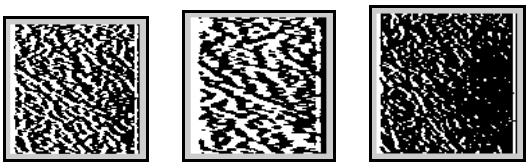

Fig 5 Effect of 2D Gabor filter with different input parameter

TABLE I
DESCRIPTION OF PARAMETER THAT HAS BEEN USED

Parameter / Image	γ	λ	b	θ	φ	s
Left	0.1	8	1	0	0.7	1
Middle	0.1	15	1	0	1	1
Right	0.1	6	1	0	0.5	1

The experiment shows that when the input wavelength is large, the output image get more blurred and less localized in the image. If wavelength chosen too large (low frequency are extracted), the bandwidth of filter decrease (high selectivity in the frequency domain) and the spread in spatial domain are increase. In this experiment, analysis show that the first image (left) is better compared to the other two images.

Summary

Several suggestions for the future work is to perform classification experiment from the extracted data that has been obtained in order to determine either the images are normal or abnormal. The performance from those classifiers will evaluate in term of classification accuracy rate.

References

[1] Christoyianni, I., Dermatas, E. and Kokkinakis, G. (2001). Automatic Detection of Abnormal Tissue in Mammogram. *IEEE*, 877-880.

[2] Oktem, V. and Jouny, I. (2004). Automatic Detection of Malignant Tumors in Mammograms. *26th Annual International Conference of the IEEE/EMBS, 2004. IEEE*, 1770-1773.

[3] Sheela, L.J. and Shanthi, V. (2007). Image Mining Techniques for Classification and Segmentation of Brain MRI Data. *Journal of Theoretical and Applied Information Technology*, 2005-2007. 115-121.

[4] Vasicek, Z. and Sekanina, L. (2007). An Area-Efficient Alternative to Adaptive Median Filtering in FPGAS. *IEEE*, 216-221.

[5] Xie, Y. (2008). On Medical Image Filtering Based on Rough Set Theory. Fifth *International Conference on Fuzzy Systems and Knowledge Discovery, 2008. IEEE*, 276-280.

[6] Yinfeng, L. and Jian, Z. (2004). An Effective Lossless Compression Algorithm For Medical Image Set Based on Denoise Improved MMP Method. *IEEE*, 729-732.

Advances in Mechanical Engineering
doi:10.4028/www.scientific.net/AMM.52-54

Feature Extraction on Medical Image Using 2D Gabor Filter
doi:10.4028/www.scientific.net/AMM.52-54.2128