Abnormal Tissue Detection of Breast Ultrasound Image using Combination of Morphological Technique

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Abstract— Breast cancer is the most common killer in women worldwide, which is originating from breast tissue. Early detection of breast cancer plays an important role in its therapy. Existing breast cancer detection method like ultrasound imaging can not be used at all ages, also quality of obtained images affected by speckle noise. Thus, it is essential to introduce new method to overcome these problems.This paper proposes an approach of detecting abnormal tissue in ultrasound breast image. The objective is to detect the abnormal tissue such as cyst or tumor inside breast tissues using image segmentation and combination of morphological technique. Image was processed using threshold segmentation method followed by dilation and erosion. The region of abnormalities tissue were found and has been differentiating from other tissue through several step of method applied. Besides, the same method was applied to the other different type of breast abnormalities tissue and the necessary result was obtained. The finding results show that this method can be used for early detection of breast cancer since it can detect several types of abnormalities in breast tissues.

Keywords—Breast Cancer, Tumor, Image Segmentation, Thresholding, Ultrasound Breast, Morphological

1 Introduction

Breast cancer occurs to over 8% women during their lifetime, and is the most common cancer affecting women. It is predicted that one out of nine women has chance developing breast cancer [1]. Since the main mechanism of this disease is still unidentified, early detection and diagnosis can be beneficial for effective therapy. More emphases are given on early detection of breast cancer. At present, breast ultrasound (BUS) imaging is the most common technique in early detection and classification of breast cyst [2].

Ultrasound imaging method is used to diagnose patient and it plays a vital role in early detection of cancers. Therefore, it is crucial to obtain an accurate detection of interest region. Different types of tissue will cause different acoustic impedance, thus the result obtained from ultrasound wave will differ due to the reflection, refraction and deflection process. It is important for sonographer to analyse the image as it is always difficult to identify its interest region due to low contrast and fuzzy boundary between region and the background. Original image obtained from ultrasound machine consist of speckle noise and weak edges.

Thus, to overcome this problem, several methods such as thresholding segmentation and morphological technique are necessary to remove the noise and obtained the abnormal tissue from the image.

Ultrasound imaging method is very common in analyzing medical images. It is very significant to segment out different kind of tissues and organs in the ultrasound image for accurate diagnosis. The objective of this journal is to briefly explain about thresholding segmentation with the combination of morphological technique in processing the ultrasound image. Computer-assisted and automated segmentation is developed because of the need of high efficiency and reproducibility in image processing. Various kinds of image segmentation techniques are applied to segment out different areas in medical images using these automated procedures. Thus segmentation has a great role in detecting this cancer disease.

Segmentation is very important in medical image processing. It has become one of the major chores in the process of medical images. The precision of segmentation technique has great effect on other post processing tasks, such as image analysis and quality extraction. This method is a necessary step in medical

image processing in order to identify the objects location as well as the volume, area and the dynamic behavior analysis of anatomical structure.

There are lots of medical imaging techniques that can be applied to detect the abnormalities of the breast tissue and to diagnose the disease. But most of the technique was unsuitable to apply at all ages. Thus, a method for early detection is needed. Besides, the speckle noise will affect the quality of image obtained. There is an idea to use ultrasound machine to take image of breast tissue as it is a non-invasive device and easy to use. Then, Image processing technique is needed to apply on the image to enhance the accuracy of interpretation. Next, Image segmentation can be used to partition an image into region of interest (abnormal tissue) and allocating the tumor. In addition, the thresholding and morphological process were done repeatedly to distinguish the abnormal tissue.

The objective of this project is to take the image of normal breast using Ultrasound machine and to compare it with abnormal tissue obtained via internet. Then, carry on the process of enhancement, morphological and thresholding segmentation of the image.
This method needs to initialize manually close to the region of interest, in other word, to crop the interest region for applying imaging process technique. Besides, it is difficult to obtain the size of each breast layer since there are just look alike. And the histogram of the image is not much differing.

In the following section 2, we describe the material and methods used in this work. The results of present method are shown in Section 3, and finally we draw some conclusion in Section 4.

2 Materials and Methods

Since MAP Pearlman Gaussian filter has been proved to perform well only for prostate cancer, it is not suitable to be used for detecting abnormal tissue inside the breast ultrasound image. Therefore, instead of filtered the image, we proposed the method of segmentation with the combination of morphological technique to distinguished the abnormal tissues.

2.1 Image Collection

Ultrasound can image several different types of breast conditions, including both malignant (cancerous) and benign (non-cancerous) lesions. It is used frequently to

evaluate breast abnormalities that are found during clinical breast exams or with screening mammogram.

Usually, ultrasound is useful in detecting abnormalities in patient dense breast especially for teenage since younger women, have denser breast. Density is used in term to describe breast tissue that has many glands close together. Commonly, dense breasts make breast masses difficult to detect on mammogram film. It is reasons why, teenage girl are not recommend using mammogram.
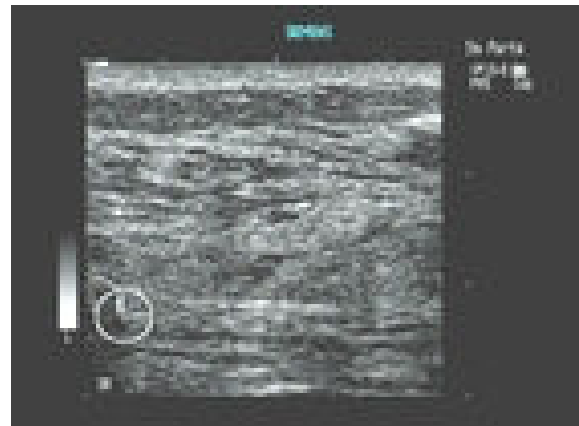

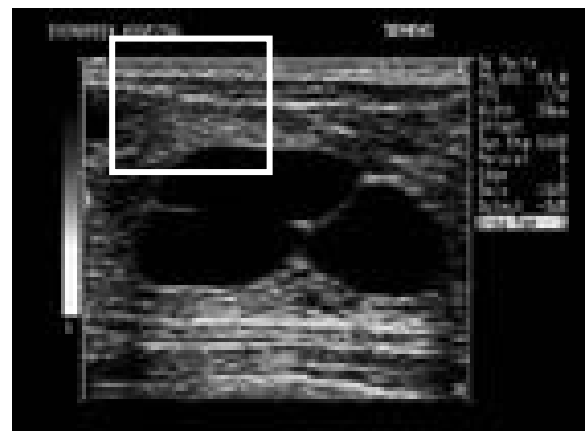Figure 1: The subtle differentiate of glandular tissue in normal breast

Figure 2: Sharp cyst inside breast tissue

Figure 2 shows an image of sharp cysts. For women between ages 30 to 50, breast cysts are the most common benign breast lumps occurs to them. It is a tiny accumulation of fluid. It can be categorized into two types, simple and complex cysts. Simple cysts are typically round or oval and have smooth edges while complex cysts can be filled with debris and sometimes required aspiration to confirm that they are indeed benign cysts. There are unknown reasons what causes cysts. But cysts tend to change with hormonal variations

either during normal menstrual cycles or from post-menopausal hormone replacement therapy.

Cysts aspiration is a technique used to remove cysts. It may be drain out with a small needle using ultrasound guidance. Cyst do not become cancer or increase the risk of cancer.

Figure 3: Carcinoma detected in breast

Figure 3 reveals a hypoechoic, poorly defined, irregular mass in the breast. An evidence of acoustic shadowing posteriorly exists.It's suggested to have malignant mass of the breast.

Figure 4: Fibroadenoma inside breast

From the figure 4, we can see a palpable, non-tender and freely mobile small mass on the right breast. The mass appeared in oval shaped and measured 10 x 5 mm. The lesion seemed extremely mobile on probe pressure and non-calcify structure

2.2 Image processing

An approach to overcome the problem is a series of image transforms which are determine by trial and error.

This approach involves Pre-processing, thresholding and post-processing. A simple filter was used as the first stage to smooth out the high frequency components of the image and making some of the noisier areas more uniform, so that it would be easier to be segmented.
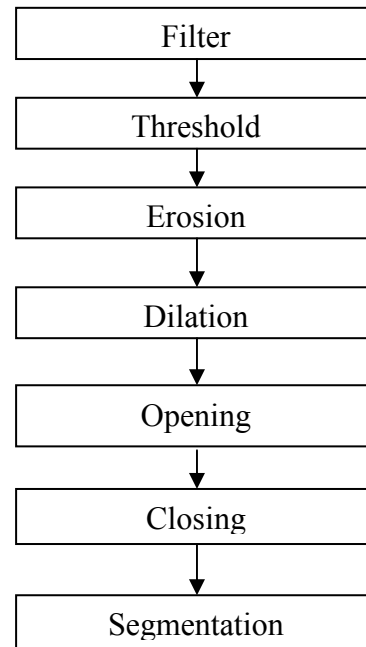

Figure 5: Methodology Approach

After being filtered, an Otsu's threshold technique was applied [10]. The process would convert the image into the binary image. After that, erosion was applied to the image so that it can split the joined object. It is followed by dilation process and then the opening of the image. To make sure the segmentation of the cyst would applicable to detect cyst on the other image, a process of dilation and erosion was repeated.

Thresholding can be analyzed as follow:

$$T = T[x, y, p(x, y), f(x, y)] \qquad (1)$$

Where $f(x, y)$ is gray-level at (x, y) and $p(x, y)$ denotes some local property, for example average gray level in neighborhood.

A threshold image $g(x, y)$ is defined as:

$$g(x, y) = 1, f(x, y) > T \qquad (2)$$
$$0, f(x, y) < T \qquad (3)$$

Where 1 is object and 0 is background

When T = T [f(x, y)], threshold is global
When T = T [p(x, y), f(x, y)], threshold is local
When T = T[x, y, p(x, y), f(x, y)], threshold is dynamic

After that, a tumor is being identified and other unnecessary region was removed so that the image of the cyst would be isolated. The final image was then applied to the original image to see the compatible of the segmentation and the cyst.

Morphological Image processing involved in this processing as it is used to removed and expand the image until it reach its suitable size. Theoretically, morphological operations are used to remove imperfections introduced during segmentation and also typically operate on bi-level image.

Mathematically erosion operation is written as

$$A - B = \{z|(B)_z \quad A\} \qquad (4)$$

Since erosion is the dual of dilation, it express as

$$(A \quad B)^c = A^c \quad B \qquad (5)$$

As before B is the structuring elements. Different shape of B will lead to different result. Thus, erosion shrinks the size of the set A.

While, the mathematical operation for dilation is written as

$$A \quad B = \{z|(B)_z \quad A = \quad \} \qquad (6)$$

This process is same as the convolution process. Simply says that the result will obtained when any of the element in B overlaps with element in A. Thus, B is called as the structuring element and its size is much smaller than the size of A. Due to this, dilation is used to expand the size of the image.

3 Results and Analysis

Figure 6 is the original image shows the cyst appeared inside women's breast. This image will be processed through several steps as being discussed previously.
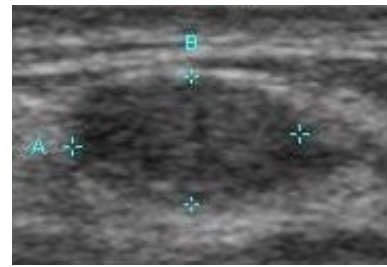

Figure 6 : Original Image for Cyst

To detect the cyst which is categorized as an abnormal breast tissue, this image was filtered and enhance to make the abnormal tissue clearer. After that, an Otsu's threshold method was applied to the image.
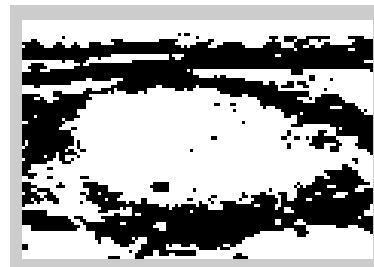

Figure 7 : Thresholding Segmentation

The original image was converted to the binary image as shown in figure 7 for the image to being threshold segmented. The white area inside figure 7 was suspected as the tumor/cyst area. Thus, we do next processes by focusing on it.

Figure8: An erosion Process

After doing the threshold segmentation, to reduce the noise and other unnecessary white region, an erosion process was applied. As shown in Figure 8, the white region can be reducing to the interest region of the cyst or tumors.

Figure 9 : A dilation Process

Compared to Figure 8, Figure 9 shows an approximately the same interest region as the original image in Figure 7. To obtain this area of interest region, a dilation process was applied back after the erosion has done. By controlling its weighting factors, the size of dilation can be control until the region we want.
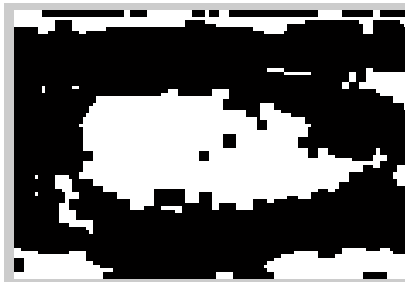

Figure 10 : An Opening Image

Figure 10 shows image after being through a morphological of opening image process. This image may look similar as figure 8, but the quantity of noise has been reduced. And the size of interest region had been separated from other region.

Figure 11: Closing Image

Figure 11 shows the image of the interest region after being process using morphological technique of closing method. Closing and opening is the combination of dilation and erosion. The different between using each method alone and combined was shown in figure 10 and figure 11. The process is done on the previous image.

Repeated step might need to make sure the regions of interest of the abnormalities tissue were obtained.

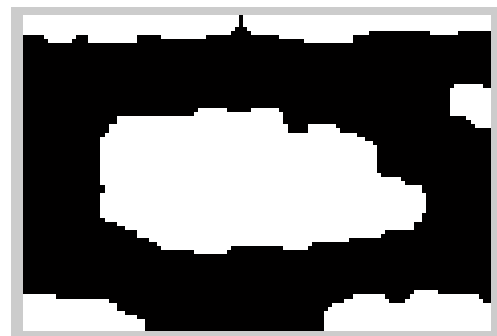Figure 12: Erosion Process on image obtained from closing Image

Figure 13: Final Image

The final image shown in figure 13 was then being implemented into the original image and it seems that the cyst has been detected. The result of this finding will be separated into few part of different disease occurred by the abnormalities of the breast tissue. Same method is used but for different disease analysis.

The transformed MAP algorithm recommended by Medeiros et al. was used in this study. The MAP estimator is applied, where a degree of homogeneity in the surrounded area of the noisy pixel controls the current adaptive window. The samples in the margin of this window are then used to determine the size of the next window.

Before process of filtering start, the colour image will be converted to gray scale image to ease the processing techniques by varying the value of the variances along the x and y-axis and also the centre frequencies of the filter, the degree of the smoothing can be adjusted to get a better image with minimum noise.

Since there are differences in the gray intensity in the image, thresholding segmentation is used to partition the abnormal breast tissue from the normal surrounding tissues based on the intensity. Segmentation is used to

isolate the abnormalities as it is hard for the naked eye to clearly identify the border of the tumour. The intensity range is different for each image due to the different modalities used. After verifying the proposed techniques with five images of different disease diagnosed, it can prove the validity of the techniques. Most of the segmented images can clearly isolate the abnormal tissue from the surrounding tissues. However, there are some images which cannot really partition the other abnormal tissue due to the low differences in the gray intensity between the tumor tissue and the surrounding tissues. Hence, this process still can help to easy diagnose of abnormal tissue at the early stage.

Easy detection of abnormalities in breast tissue is the main advantage of our proposed method. This method also has some disadvantages. From the analysis in 5 different images of different diseases that taken through ultrasound, it shown that region that has low contrast will cause the misdetection of the contour. The resolution of the image is low due to similarity between those tissue layers inside the breast.

Recommendation for the improvement is taking the image of breast tissue using more advance ultrasound devices with the high intensity to differentiate layer by layer. This can solve the problem of similar intensity between tissues.

4 Conclusion

We have proposed a new combination method and it is found to be applicable to all type of abnormal tissue exist in breast tissue.

The methods applied in this paper are threshold segmentation followed by erosion, dilation, opening and closing technique until the region of abnormal tissue were obtained. In this paper, an original medical image segmentation algorithm using MATLAB has been tested successfully using ultrasound breast image

It can be concluded that, this combination method has been successfully used in detecting and analysing the abnormal tissue from the breast tissue.

By using this method, abnormal tissue inside breast tissue can be detect and classified as a tumor or cyst based on its physiological term. Therefore this method can be used for early detection of the disease of breast especially breast cancer since it can detect many types of abnormal tissue exist in the breast tissue.

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