

BREAST TUMOR ANALYSIS BASED ON SHAPED

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ABSTRACT

Breast cancer is one of the deases that causes death in woman. Mammography image can be used to detect breast cancer. In this paper, algorithm for analysis breast tumor is presented. First step is localized the suspicious area to create the Region of Interest (ROI), edge detection, contour delimitation and analysis breast tumor.

Keywords: extraction, mammography, Region of Interest (ROI), edge detection, contour delimitation

1 INTRODUCTION

Image Processing has been applied in many fields including the medical field. The medical image analysis require very high accurate diagnose level especially in detecting a cancer. Breast cancer is the second reason that causes death in woman around the world after cervix. The early detection method of cancer can be done using mammography. An expert can recognize the abnormality of breast from the characteristics of the image visually. The characteristics here are (1) asymmetries images between left and right breast, (2) the occurrence of masses in the breast, (3) distortion of the normal breast tissue architecture and (4) the presence of microcalcifications in the breast.

Pawar[8] developed a method that can be used to detect the location of breast tumor. In his research, mammography image is digitalized while the suspicious area of tumor identified as a brighter area that surrounding the tissue. This image has the same density inside the area with the circular shape that has variety sizes and unclear edge. The steps used to detect the edge are (1) image enhancement is done by using Median Filtering to remove noise, (2) High Pass Filtering is used to improved the edge enhancement, (3) edge detection using Sobel algorithm. To detect the existence of a tumor, a template with 2 characteristics are made; approximately circular shape and the same brightness area. This template is used as an image reference. The image mammogram will be matched

with the template and then the level of similarity is measured to obtain the tumor location.

Based on the characteristics above, the problem is how to develop the algorithm to analysis the characteristics of breast tumor.

The rest of this paper is organized as follow: Section 2 describe the methodology that consists literature review of beast tumor and analysis methodology based on shape. Section 3 discusses about the result of experiment and the last section is conclusion and discusion.

2 METHODOLOGY

2.1. Breast Tumor

Tumor is abnormal bumpy due to the cells that growing cells continuously. There are 2 types of tumor; benign and malignant. Malignant tumor is known as cancer. The cancer cells can spread to the whole part of body. This cancer can caused fatality of life. Breast cancer is a cancer in interfere with duct, lobules and tissue. To reduce the risk factor, it is necessary to do an exam as early as possible. There are 3 steps to do the early tests; (1) Breast Self Exam (BSE), (2) to do medical examiner with the help of medical expert to confirm the result of breast self exam or if there is complain, (3) The following examine to complete the doctor observation using mammogram. Mammogram utilizes energy X-Ray to produce the image. To obtain the breast image, there are 2 viewpoints of the breast [3]; MLO (Medio-Lateral-Oblique) and CC (Cranio-Caudal). The direction of MLO viewpoint is from rear point of the breast; meanwhile in CC the viewpoint is from top to bottom of the breast. The capturing of breast images are taken from right and left side.

According to the image from the mammography check up, the normality and abnormality of a breast can be identified. Figure 2 shows the image result from normal mammogram where both of the breasts look symmetries with the normal tissue structure.

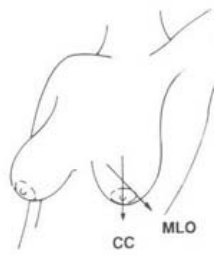
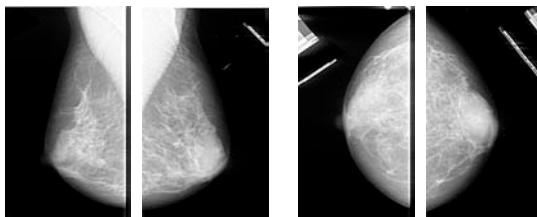


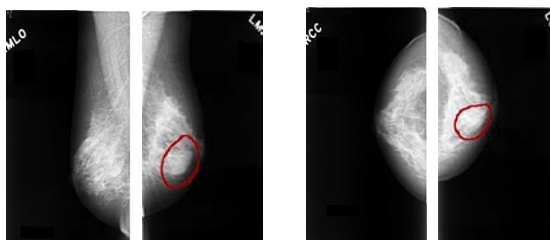
Figure 1. Viewpoint for capturing images



(a)Right MLO (b)Left MLO (c)Right CC (d)Left CC

Figure 2. Normal Breast Case

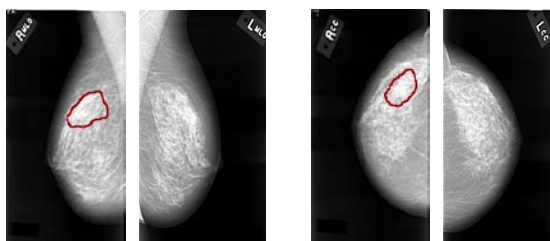
Figure 3 illustrates that the left breast (with the circle) identify a mass and according to the expert there is mass. The expert categorized the images as benign breast tumor case.



(a)Right MLO (b)Left MLO (c)Right CC (d)Left CC

Figure 3. The Benign Tumor Case

Figure 4 shows the small bright spots in the left breast that have the high intensity (with the circle). The expert categorized the image as malignant breast tumor case.



(a)Right MLO (b)Left MLO (c)Right CC (d)Left CC

Figure 4. The Maglinant Tumor Case

According to the visually characteristic mammogram images, the expert classifies the breast tumor according to the mass and margin in 2 groups; benign and malignant. Mass can be classified to 5 basic shapes and 5 margins [3]. The basic shapes are oval, round, lobulated, irregular and architectural distortion. The margins are (1) Circumscribed, which are well defined and sharply demarcated with an abrupt transition between the lesion and the surrounding tissue, (2) Obscured, which are hidden by superimposed or adjacent normal tissue, (3) Micro-lobulated, which have small undulating circles along the edge of the mass, (4) Ill-defined, which are poorly defined and scattered, (5) Spiculated, which are marked by radiating thin lines.

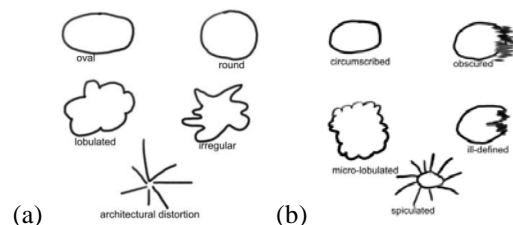


Figure 5. (a) Shape of mass (b) Margin of mass

According to the shape of mass and margin, breast tumor can be classified to benign and malignant. The oval or round mass identifies the benign, while the ill-defined and speculated have a big possibility as malignant. If the mass and the edge boundary is very thin, it is difficult to determine a tumor whether it is a benign or a malignant even though the test is done by the expert.

2.2. Shape Analysis Methodology

The major outline of analysis breast tumor consists of 4 (four) steps. The step can be seen in Figure 6. The first step is to localize the Region of Interest (ROI) or suspicious area of the tumor. The second step is edge detection using filtering. The third step is contour delimitation and the last step is analyzing shape.

We used mathematical morphology such as closing and opening operator at the first step to localized the used of the suspicious area. Compound of closing and opening operator can localized suspicious area of tumor, meanwhile the other area will be erased, and therefore the Region of Interest (ROI) can be created. The ROI still contains part of tumor or without tumor (if there is tumor). The boundary of these two parts sometimes are not clearly. Therefore, we add a process to sharpened

the edge using average of histogram in this section. All of the pixel with lower value will be decreased and the value above the average value will be increased. The formula that being used for this process is

$$Pixel(n, m) = Pixel(n, m) * \exp\left(\frac{255 - Pixel(n, m)}{255 + Pixel(n, m)}\right) \quad (1)$$

The result of process can be seen in Figure 8 and 9. The result of first process sometimes still contains noise or the edge of tumor not clearly due to the impact of the blur. Therefore we need LARIM filtering to detect the edge on the second process. This filter has noise and blur parameter. Filter $f(x)$ can be written as [9]

$$f(x) = \text{sgn}(-x)K_1 e^{-\alpha|x|} \left(1 - \cos(\alpha\beta|x|) + \frac{(1-\beta^2)}{2\beta} \sin(\alpha\beta|x|) \right) \quad (2)$$

Filtering is done by smooting filter that can be calculated as follows [9]

$$h(x) = \int f(x)dx = K_2 e^{-\alpha|x|} \left(1 - \frac{1}{2} \cos(\alpha\beta|x|) + \frac{1}{2\beta} \sin(\alpha\beta|x|) \right)$$

- (3)
 K_1, K_2 : normalization constant
 α : scale parameter related the noise
 β : blurring parameter

The smooting filter is done to reduce or remove the effect of noise.

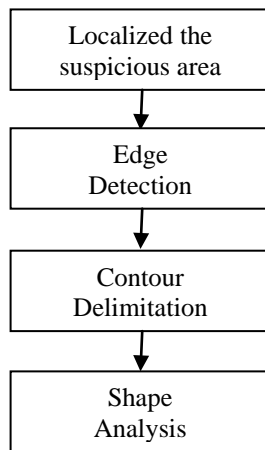


Figure 6. Shape Analysis Block Diagram

The next step is edge detection. The output of edge detection can be seen in Figure 9. The Figure shows that the edge or contour of object has thickness more than one pixel. Contour delimitation is needed for analyzing the shape more easily.

The aim of third step (contour delimitation) is to decimation contour to make the thickness to be one pixel thick. The process is simple; track and reserve external pixel of contour. The other pixel that not include inside the external part will be remove (make zero value). Tracking is done by verification around the neighborhood pixel. The pixel is mentioned as external part of contour if and if there is a neighborhood pixel that has lower value (zero) and this pixel will be reserve. On the other hand, the pixel is not consider as external part of contour if and only if there are no neighborhood pixel that has lower value (zero) then the pixel can be removed (can be given zero value). The result of contour delimitation is shown in Figure 10 where the shape of tumor can be seen clearly.

The last step is analyzing the shape. The aim of shape analysis is to compare between the shape of benign and maglinant tumor which is detected in mammogram image toward the shape of mass and/or margin template which is specified by the expert. The process is done by the shape of contour chain code in order to specify tumor detection whether it is a benign or maglinant, therefore detected tumor will match with chain code template of 5 kinds of mass and margin. Chain code was chosen since this algorithm can be used resize the tumor's images.

3 RESULT OF EXPERIMENT

The data of digital mammography in this research is in the format of bitmap (bmp) image with resolution 50 dpi. In this research, there are 86 images [7]. The example of the diagnosed image by the expert can be seen in Figure 7. The circular is signed by the expert which shows the area is a suspicious area of tumor because there is a mass inside the image.

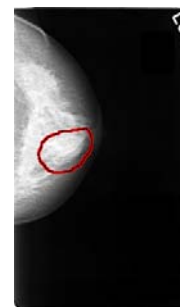


Figure 7. Digital Mammography

According to the expert, the image is observed by the shape of the mass and the margin (Figure 5 a and b), the mass is oval and the margin is ill-

defined. Therefore the expert categorizes the image of as benign case (the information in database declare in form text illustration following the image).

Figure 8 to 10 represents the result of every step in the schema of Figure 6 using image in Figure 7. Figure 8(a) is the result of mathematical morphology and cropping. The Figure represents the suspicious area of tumor (the part of area is signed with the circle by the expert). The region is called ROI and furthermore it will be processed to see the possibility if there is tumor in an area. According to tumor characteristics, the area of tumor always has higher intensity than the area without tumor, but the boundary between them often contain noise and blur. Therefore the process of edge enhancement is important as a first step to separate the region of higher and lower intensity. Using the equation 1, it is obtained the result in Figure 8(b). From the Figure, it can be seen that the higher intensity has the possibility of the occurrence of a tumor where the lower intensity without a tumor. This can be sharpened the differences, therefore the edge detection of tumor can be seen clearly. Therefore edge tumor can be seen clearly. However it is not significant the real edge, because there are some effect of noise and blur that influenced this process.

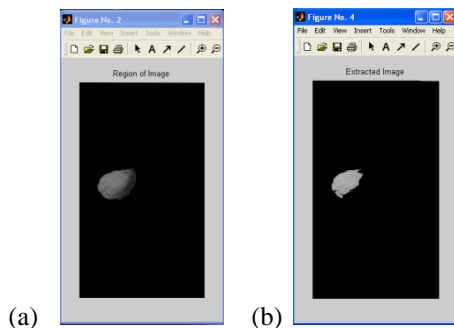


Figure 8. Result of ROI extraction, (a) without edge sharpening, (b) with edge sharpening

Figure 9 shows the result of edge detection using LARIM filter (equation 2 and 3). This filter has good ability to detect noise or/and blur edge object. In the result, edge/contour tumor obtains more than one thickness pixel. Contour delimitation is needed in this experiment to make the process easier. Figure 10 shows the result of contour delimitation, it can be seen clearly the contour tumor has only one pixel thick.

We can compare between the result of edge detection (Figure 9) and the shape of mass (Figure 5a). We can also compare between the result of

contour delimitation (Figure 10) and the margin of mass (Figure 5b). Visually, based on the Figure 5a and 5b, tumor shape has the mass of oval and the margin of ill-defined. Hence, tumor categorizes as benign tumor. To make comparing automatically, the next step is to code the contour shape into chain code. First coordinate of Figure 10 was detected (171, 30). The contour with the direction opposite from watch pointer was traced. The code is as follows

```
00212122221211111110101010010010101001000
00000010000006060546660006006066650550550
545055056666665054450.
```

This code will be matching with template.

There are 88% images can be processed in this experiment.



Figure 9. Result of Edge Detection

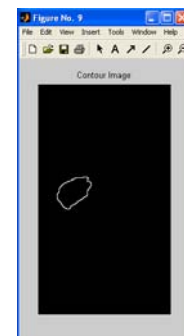


Figure 10. Result of Contour Delimitation

4 CONCLUSION AND DISCUSSION

Based on the experiment that has done, the algorithm from the first step to the last can detect the shape and the margin of breast tumor. The first step using mathematical morphology, the higher intensity of a suspicious tumor can be localized therefore Region Of Interest (ROI) is created.

The second step is edge detection. This step is done to remove or reduce noise before proceeding edge detection. In the following step, contour delimitation is done for decimation contour up to one pixel thickness. The last step, the shape of mass and margin can be coded using chain code.

The future work, we can compare the chain code with shape of mass and margin template to determine whether tumor is benign or maglinant. tumor level as the result of expert.

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