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A Way to Improve Pectoral Muscle Isolation in Digital Mammograms

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Abstract: In most mammography images taken from the side view, there is a muscle above, which its gray surface is almost like tumors and some denser breast tissues. It is worth noting that the tumors wouldn't exist within the muscles, but may be very close to it. So it is better to separate the muscle before processing the whole image. In this project we have separated the muscle from the outskirt tissue by assimilating statistical methods and techniques to increase the zone of dealt. This new method was accomplished on 60 images of Mini MIAS database. To evaluate the accuracy of separation, first the range of muscles is marked by a physician or radiologist and is considered as a gold standard. The percent of overlapping between identifying by the computer and golden standard indicates the system accuracy. The results report accuracy of 90%. The benefits of this method are simplicity of implementation and its high speed.

Keywords: Mammography, pectoral muscles, breast cancer, statistical methods, region growing methods

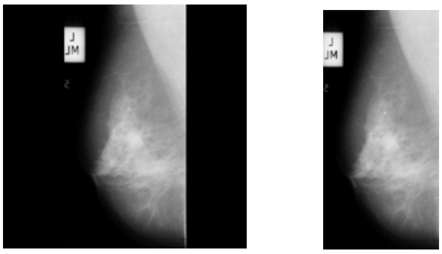
I. INTRODUCTION

In most mammography images taken from the side view, there is a muscle above with gray surface almost the same as the tumors and some denser breast tissue. Histogram is related to denser breast tissue and glands and upper muscles of the chest which is known in most cases they overlap with each other; this overlap causes errors in tumors diagnosis. It is worth noting that tumors wouldn't exist within the muscles, but may be very close to it. So it is better to separate the muscle before processing the whole image**.** Only a few works have been presented in the literature to address this problem. [1] used the Hough transform and a set of threshold values applied to the accumulator cells in order to detect the pectoral muscle. [2] used their gradient magnitude ridge traversal algorithm at small scale, and then solved the resulting multiple edges via a voting scheme in order to segment the pectoral muscle region. However, the hypothesis of a straight line for the representation of the pectoral muscle is not always correct, and may impose limitations on subsequent stages of image analysis. [3] used the polynomial modeling to isolate the upper chest muscles and [4] estimated the edge of muscle by a straight line, then they emended this line by using the position and direction of the muscles and using Iterative Cliff Detection method, and the reported result is 83.9%. The work we did in this paper to isolate pectoral muscle is in this way and we have used the sobel Differentiating from the logarithm of image energy, the zone increasing method, edge detection methods.

The paper is organized as follows: Section II presents our Method. The characteristics of the database used in this paper are presented in Section III. followed by the results and discussion in Section IV. Conclusions are presented in Section V.

II .OUR METHOD

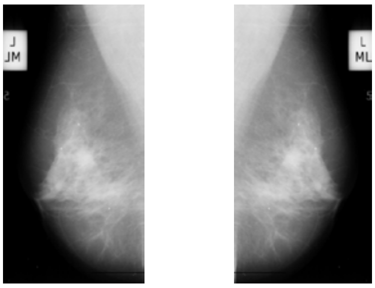
The first phase) our method in this article is the following, first we omit additional parts of the field not including the range of the chest and located on the left and right side of the image. Since the dark areas and their gray surfaces is near zero and these gray surfaces do not differ much, we can use light points to detect the amount of these parts. Figure 1(a) indicates this fact. What we have done in this paper to eliminate additional parts of the image, is that we have changed the place of all the files from left to right and right to left side, and we will go on until the amount of vertical light of the image grow more than a specific threshold or subtraction of the amount of vertical light of pixels be smaller, less than specified threshold and greater or more than specified threshold. If the vertical pixel brightness difference value smaller than a certain threshold, lower threshold and larger, is more or vertical image brightness value threshold is more marked, still within the field have, then subtracting the amount of vertical pixels the next light we calculated. This practice will continue to place the gray level variations smaller than a certain threshold, more or larger threshold, is less. Experimental threshold values to come. The additional episodes and should be removed from the image. An example in the form of a reduced size- viewing.



a b

Figure 1. a) original image size 1024 × 1024 b) remove extra background image size to 1024 × 510 is dropped

Second phase) after removal of additional parts of the picture, all the images should be unidirectional at this stage. Because the MIAS database images, used in this paper, belongs to both left and right breasts. In other words, in some images, breast image is on the right side and in some others on the left side of mammography image. For easier processing, the whole breast image is placed in the left side of the picture. To do this, first the breast direction should be understood. To do this, first we divided the image into two parts from the center point on a scale of vertical axis, then we were able to estimate the threshold of the gray surface in both half of the image. Definitely, the background threshold which the chest is located in will be higher than the backgrounds which are the setting. After finding the breast direction, we made it left the side. This practice is performed by hundred and eighty centigrade rotation of images to the right vertical axis. An example of the shift is given in figure 2.



a b

Figure 2. a) original chest image was right side. b) image for easier process has been left

Third stage) at this stage, we try to isolate pectoral muscles from mammogram. Since, in previous stages the images grew unidirectional (in all the images the chest is located on the left side), so the muscles, if there is any, is located above and on the left side of the image. Therefore, its range should be found and separated from the image. What we have done in this study to find the boundaries is that, we calculate the image energy first and add it to a certain threshold, then we took the natural logarithm of it and made the obtained image steady. After that the image was transferred to unmarked area of uint8. It is noteworthy that the degree of uniformity of the image depends on the number of the same gray levels. In fact, a series of pointed operations was used. With this simple and quick act, the image classification is acceptable. Since logarithm is a nonlinear operator, the range of gray levels will be split into several numbers. In fact, the areas with similar gray levels are allocated a number. for better resolution of the obtained image, we uniform the histogram. A sample of classified files and the related histogram can be observed in figure 3 and 4.

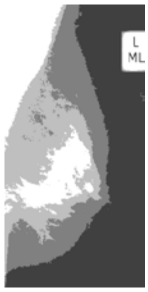
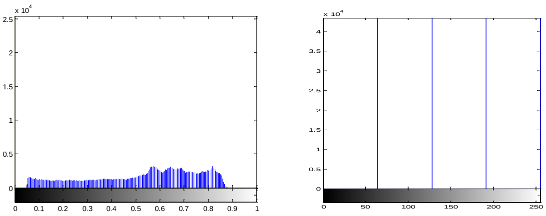


Figure 3 - image fragmented by proposed algorithm



a b

Figure 4. a) histogram related to the original image b) histogram related to the fragmented image

Then, we should find the main edges by using edge detection techniques. Since there may be some vessels determined as edges in the muscle. So we should find the original edges. To find these edges, it's better to reinforce and clear the strong edges. Specifying muscle edge depends on the same number of gray levels according to that the image will be uniformed. In the case that if the gray levels difference of pixels within the muscle is greater than the surrounding tissue, despite the muscle edge is determined better, the image will be consistent with a less degree. [5] used the two filters DWCE FWG to find the main edges. In this study, we have used FWG, a weighted frequency Gaussian filter, which will be reached by using (1) relation.

$$F(x,y)=F_F(x,y)+F_{sub^+}(x,y)+F_{sub^-}(x,y) \tag{1}$$

In relation (1), $F_F(x , y)$ is smoothed image of $F(x , y)$ by the Gaussian filter. $F_{sub}{}^{+}$ and $F_{sub}{}^{-}$ are defined as follows.

$$F_{sub^+}(x,y)=\begin{cases} F(x,y)-F_F(x,y) & F(x,y)>F_F(x,y) \\ \circ & otherwise \end{cases}$$

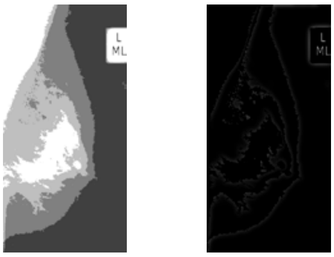
$$F_{sub^-}(x,y)=\begin{cases} F_F(x,y)-F(x,y) & F_F(x,y)>F(x,y) \\ \circ & otherwise \end{cases} \tag{2}$$

The filter is made based on two filters:

A) Denser image $F_F(x , y)$ which is a smoothed copy of the mammogram image. This image is reached by applying

Gaussian filter with zero mean and standard deviation of ten on the original image.

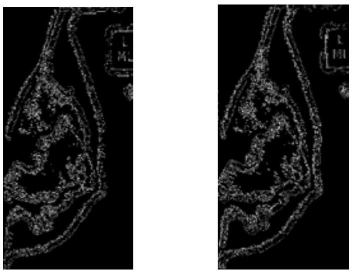
B) The lighter image $F(x , y)$ which is reached by reducing the original image from smoothed image. An example of the original image which the main edges is marked by FWG filter is visible in Figure 5.



a b

Figure 5. a) an example of segmented image, b) an example of the image in which its original edges are specified by using FWG filter.

Then we eradicate additional points of the image that would act as currant by applying the average filters and then take the derivative. After that by using Sobel edge detection methods and considering the vertical and horizontal edges threshold, we can see the image. An example of horizontal and vertical edges obtained of the image is visible in Figure 6.



a b

Figure 6. a) Horizontal image edges by sobel method b) Vertical edge image by sobel method

Then, by using horizontal and vertical borders of the image obtained in previous stage, we will estimate the muscle area. Whereas we are looking for strong edges and perhaps weak edges cause errors in diagnosis muscle size, so that the Canny method which finds too weak edges has not been used. Now, by using region growing techniques we expand the range until we reach the specific edge of muscle. Area growing algorithms act in the way that first they would consider one or more points as initial points. Then they add neighboring points to the original parts according to one or more stage to stage similarity criteria. In this case the area will grow and spread. Similarity criteria can be the variance between the points or the characteristic differences between a point (the characteristics mean of a point is lower than a specific threshold) and the other statistical criteria. Process of increasing the area continues until criteria violating. This means that the spot belongs to another area and growth has been suspended in this direction. When no neighbors is similar to desired area, increasing the area is completed [5].

According to the above description, firs we consider a point within the muscles known as seed as the primary point. Whereas the muscle is in the upside and the left side of image, so we set the first point of the image as the initial point. The intended Similarity criteria are to derive to ***x*** and derive to ***y*** from the image on which the mean filter applied and also the vertical and horizontal edges of files pre found. We consider lateral neighbor of the initial point, if the derivative to ***x*** was lower than a certain threshold and also we hadn't reached the marked edge for the muscle in the previous level, the point is added to the range area. Otherwise, we go to the next row. We repeat this action once again in a column-shaped manner and with regard to derivative to ***y***. At the end of this stage, muscle area is reached and then we separate it from the image.

A sample of the results is shown in Figure 7.

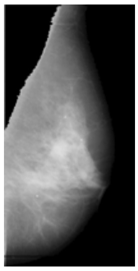


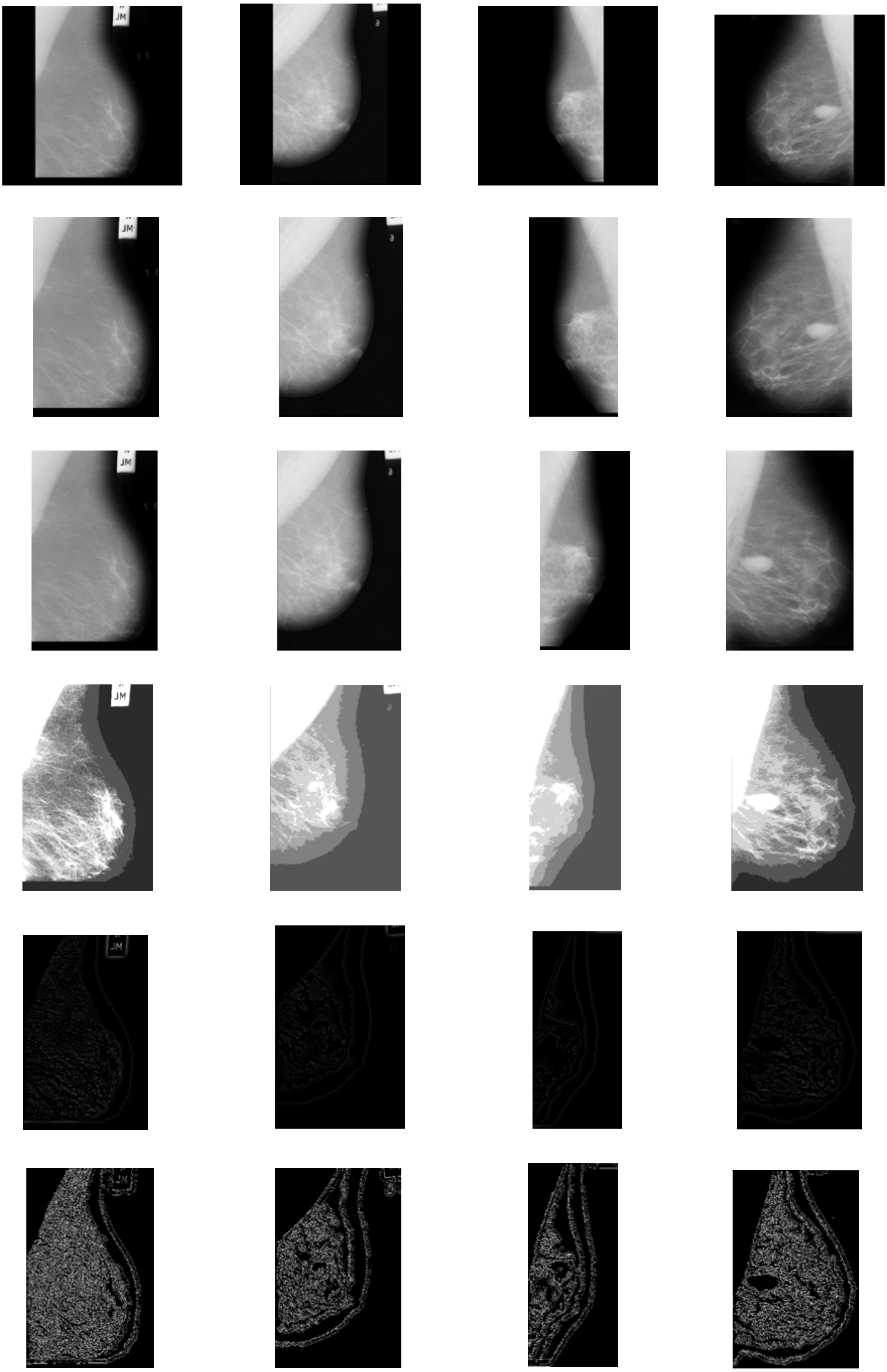
Figure 7. upper chest muscle is separated

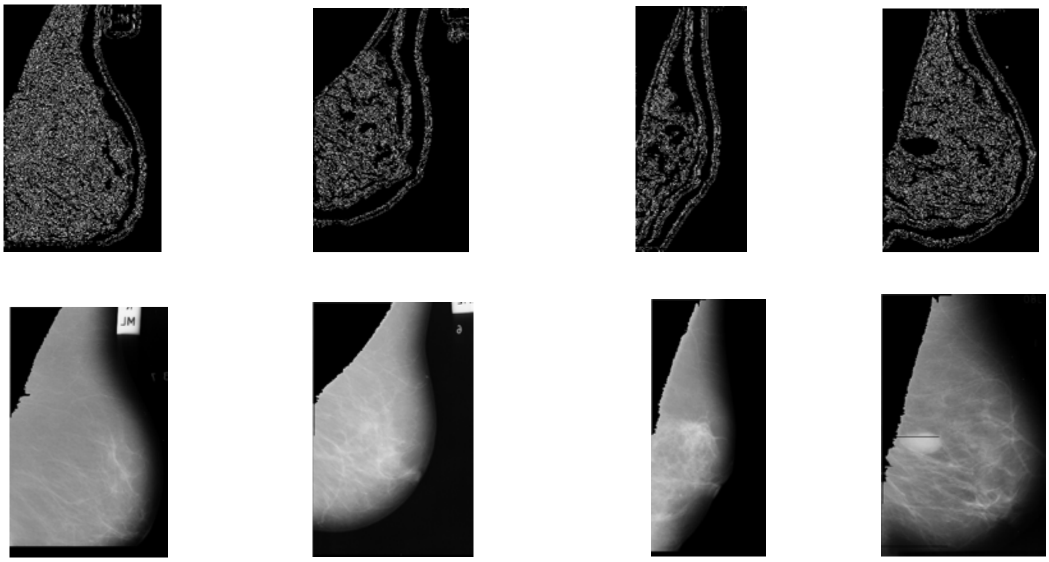
III. DATA BASE

A total of 60 images, randomly chosen from the Mammographic Image Analysis Society, London, U.K. (Mini MIAS) [6], were used in this paper. All images are MLO views with 200- m sampling interval and 8-bit gray-level quantization.

IV.RESULTS AND DISCUSSION

Histogram related to denser breast tissue and glands, and upper muscles of the chest known as Pectoral muscle overlap with each other in most cases. This overlap causes errors in the diagnosis of tumors, therefore it's better to remove Pectoral muscle before the study of tumors in the image. To do this, we have used the logarithm of the image energy, area increasing method, sobel edge detection methods, and differentiating. To evaluate the accuracy of separation, first the area of the muscle is identified by a radiologist or physician and is considered as a golden standard. The percent of overlapping between identifying by the computer and golden standard indicates the system accuracy. An example of Mammograms in which pectoral muscle have been removed in order to the method presented in this article is visible in figure 8. The results report accuracy of 90%. The benefits of this method are simplicity of implementation and its high speed.





(a) (b) (c) (d)

Figure 8. An example of mammograms in which the pectoral muscles is removed in order to our method.

V. CONCLUSION

In this paper, we have provided a method to improve pectoral muscle removed. In this method for easier processing according to the direction of the chest, first all of the images became left sided and then we were able to determine muscle range from the surrounding tissue and then we removed it from the mammogram by using logarithm of the image energy, area increasing method, sobel edge detection methods, and differentiating. Because of the difference and the light between muscle tissue and lateral tissues in the form of a phase in some cases ahead of or behind the muscle range is given to us, so we try to improve this method, because we think we can resolve this problem by determining the exact degree of uniformity of the image.

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