Automatic method for Cancer Detection and Segmentation in Digital Mammogram images by double threshold technique.

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Abstract:
Background: Breast cancer occurs with high frequency among the world's population and its one of the main reasons of death, but in middle-aged women since it is very difficult to early identify. Mammography is the most effective method for detection of breast diseases and specialized medical imaging for scanning the breasts. Moreover helps in the early detection and diagnosis of breast tumors.
Materials and Methods: In this paper, the work is initiated with basic pre-processing steps using removing objects outside the breast and reducing noise in the mammogram image . In the next stage we applied double thresholding technique based approach for Mammograms image segmentation. also, we added the borders to the final segmented image as a contour on the original image to helping to easily detect the breast cancer in different Mammogram images.
Results: Proposed algorithm is validated on MIAS database and processed using MatLab2013softwere.Removal of tape artifacts and labels are done in first stage of proposed algorithm(pre-processing stage), applied the double threshold technique and find the abnormal tumors in the image, and make a contour round the cancer mass on the original image.
Conclusion: In this work we have develop an algorithm for automatic tumors detection in mammograms, and enhanced double thresholding segmentation applied has enhanced wise effect for breast cancer qualitative detection in mammogram scan images, helping for better diagnosis. Moreover, this thresholding method has the advantage of not only reducing processing time but also the processing storage space.
Key Word: Digital mammogram, Breast region extraction ,Thresholding segmentation , Breast cancer.

I. Introduction

Breast cancer is the second common cancer worldwide after the lung cancer, the fifth common cause of cancer death, and the major cause of cancer death in women [1]. Breast cancer continues to be a significant public health problem in the world. Approximately, 182,000 new cases of breast cancer are diagnosed and 46,000 women die of breast cancer each year in US. Even more disturbing is the fact that one out of eight women in US and 10 women in Europe will develop breast cancer at some point during her lifetime[2].Beginning in the 1980s, screening mammography led to sweeping improvements in early detection of breast cancer [3].

Mammography is one of the most reliable methods for early detection of breast cancerous. However, it is difficult for radiologists to provide both accurate and uniform evaluation for the enormous number of mammogram generated in widespread screening. There are some limitations of human observers such as some anomalies may be missed due to human error as a result of fatigue With the advances of digital image processing, pattern recognition and artificial intelligence, radiologists have an opportunity to improve their diagnosis with the aid of computer aided detection (CAD) system [4].

Mammography is a specialized medical imaging that uses a low-dose x-ray system for scanning the breasts. A mammography exam, called mammogram, helps in the early detection and diagnosis of the breast diseases in women [5]. Usually, the breast cancer computer aided detection system starts with the pre-processing, which includes digitization of the mammogram with different sampling and quantization rates. Then, the regions of interests selected from the digitized mammogram are enhanced. The segmentation process is designed to find suspicious areas, and to separate the suspicious areas from the background that will be used for extracting features of suspicious regions. In the feature selection process, the features of suspicious areas will be extracted and selected, and suspicious regions will be classified into cancer and non-cancer [6,4]. Image segmentation is an

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effective way for detecting the breast cancer regions in mammograms, hence, better diagnosis. Segmentation refers to the operation of partitioning an image into component parts, or into separate objects, and there is more than one approach for image segmentation [7].Double thresholding segmentation approach is a simple and basic way for dealing with cancer cells image segmentation [8].

In this paper the same technique of double thresholding segmentation applied in [9] and [10] for Mammograms' image segmentation was implemented. An enhancement has been done to the segmentation approach by applying some operations after double thresholding. As a post-processing the borders of the final segmented image as a contour was added to the original mammogram image helping physicians to better diagnose the breast cancer in mammograms. The proposed approach has been applied on more than one mammogram scans taken from [11].The result is an enhanced detection and a better visualization of the breast cancer in different mammograms. Finally, it is concluded that enhanced double thresholding segmentation applied has improved wise effect onto the breast cancer detection into mammograms, helping physicians for better diagnosis.

II. Material And Methods

In this paper, the methodology proposed to detect breast massesin digital mammogram images, This methodology basis on several stages: Acquisition, pre-processing, segmentation and extracting of regions of interest.Acquisition is the first stage of any CAD tool.The following stage is pre-processing , this stage eases the processing to be performed by the subsequent stages by removing unwanted objects .The segmentation of (ROI) uses to identify areas in the image that are suspect of containing masses, so that the following stages only work with relevant regions.

1. Acquisition.

In this proposal we used mammogram digital images from Mammographic Image Analysis Society (MIAS) database .MIAS is a public database is an organization of UK research groups interested in the understanding of mammograms and has generated a database of digital mammograms. Films taken from the UK National Breast Screening Program.The   MIAS database contains 322 digitized films (as digital images with Dimensions 1024x1024.). also, It includes radiologist's "truth"-markings on the regions of any abnormalities that may be present.Using in this work more than 100 digital images from MIAS database. These images were randomly selected and processing using MATLAB (MATrixLABoratory) program .

2. Pre-processing.

The digital images in the MIAS present noise and typical elements of the mammographic exam which can interfere with this methodology. The elements that are not in the region of interest such as   patient identification and exam type marks, the background and occasionally noise produced by imperfections in the image generation. The objective of this pre-processing stage is to remove these unwanted elements and noise from the image in order to improve the discrimination of internal structures of the breast.

The pre-processing stage consists, using Matlab converting the mammogram image into a huge array of data , its data contents are about 1048576 pixels (1024 * 1024), make a method for detect the orientation of the breast in mammogram image and make the direction of the image always to the left direction. And apply processing method to remove noise and unwanted elements from the image and prominent the breast body in the image to help the physicians to diagnosis.
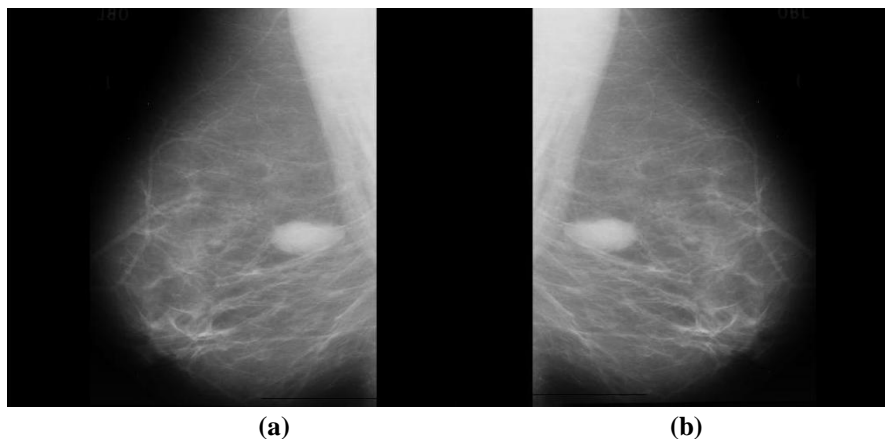

(a)   **(b)**
Figure1:preprocessing method to make the image orientation always left ,
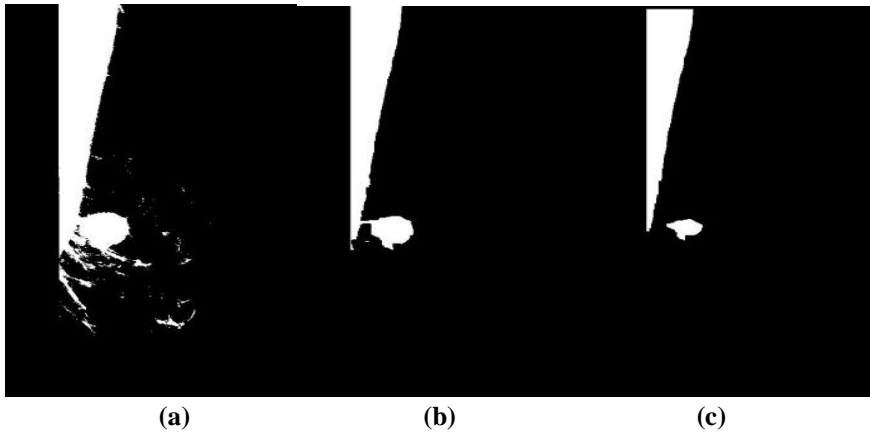**(a):** Original image , **(b):** Make a left direction.

| (a) | (b) | (c) |

Figure2: Thresholding Technique, **(a):** Binary image, **(b):** Vertical scan image, **(c):** horizontal scan image.

3. Segmentation

After pre-processing, the region of interest (region where mass is expected) is to be segmented. The segmentation of digital image is the process of partitioning a digital image into set of region that covers, also the goal of segmentation is to decompose the image into parts for further analysis, it is used to extract the part that need to be analyzed further.

Image segmentation is typically used to locate objects and boundaries (lines, border and curves) in images. Breast segmentation is essential to exclude the background information in analyzing mammogram image. In this study, a threshold technique is proposed to separate the RIO (breast body) and background (any thigs in background) regions in mammogram image. This technique is an easy and convenient way of performing the breast segmentation.

The technique used in segmentations involves several levels: segmenting the original digital image by double thresholding producing the second row , make a mask and multiplying the previous level by the mask , Contouring the abnormalities region onto the original digital image by the boundaries of the resulted binary image from previous level. The important step in this technique is to determine intensity value of the image to be able to find pixels that create the breast body .

The first objective in segmentation process is to determine the breast orientation, if that information is not possible to obtain from header of the image. Orientation is found by scanning the center horizontal line of the image from the left and right side until pixel values are higher than the background and determining which of these two distances is shorter.

Suppose that the original mammogram image is m(x,y). The thresholding technique is employed to form a binary image by segmenting the mammogram image into two regions, namely foreground (white region) and background (black region).

Producing the final enhanced segmented mammogram with contour shown in the last row of Figure(3 and 6).

The thresholded image u (x,y) is :

$$u(x,y) = \begin{cases} 0, & if \ m(x,y) \leq Q \\ 1, & if \ m(x,y) \geq Q \end{cases} \qquad (1)$$

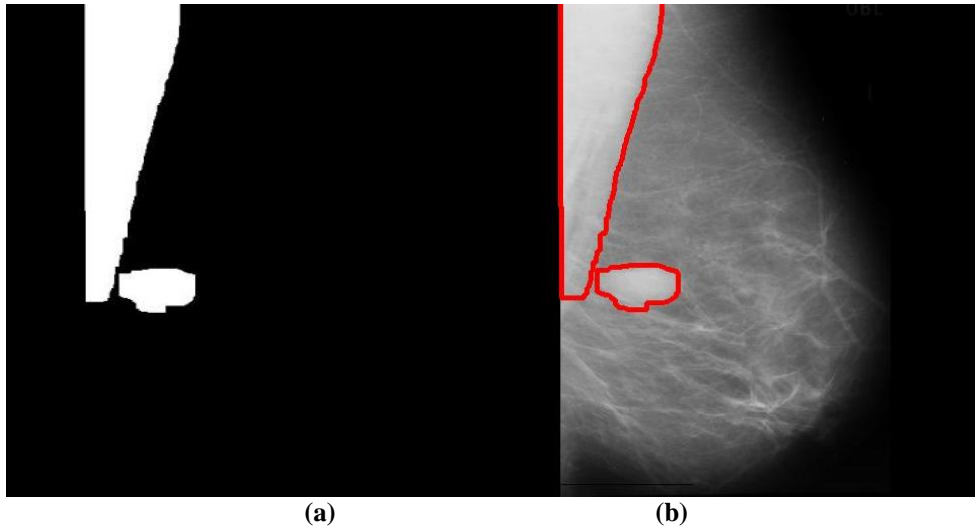Where Q is the threshold value that separates the foreground and background regions, which is manually set by user.

(a) **(b)**

Figure3: The contour on the image, **(a):** Double scan image.
(b): Original image with contour.

III. Result and Dissection

Proposed algorithm is validated on publicly available Mammographic Image Analysis Society (MIAS) data set containing 322 mammogram images available in this data set. All sample images are using nearest neighbor interpolation method. Removal of tape artifacts and labels are done in first stage of proposed algorithm (pre-processing stage). Experiments use MatLab2013 to write the method proposed in this paper. Figure(2 and 5) shows the intermediate results of breast region segmentation. Figure(1 and 4) (a)and (b) show the original mammogram, Figure(2 and 5) (a), (b) and (c) binarized image after performing thresholding operation.

 It is clear from Figure(2 and 5) that background information is successfully removed from the mammographic image.

        The sample segmented mammogram images after applying the algorithm with thresholding technique are shown in Figure(2 and 5) (b) and (c). Connected component labeling algorithm is applied to extract the segmented suspicious mass, Moreover added borders to the final segmented image as a contour to the original image as shown in Figure(3 and 6) to helping to easily detect the breast cancer. advantage of this method in this paper is low algorithm complexity and therefore short processing time.
        Results of cancer detection and segmentation are divided in three groups and shown in Table 1. Total percentage for "Good", "Acceptable" and "Unacceptable" results are shown at the end of each column.

Table no 1: Cancer detection and segmentation results.

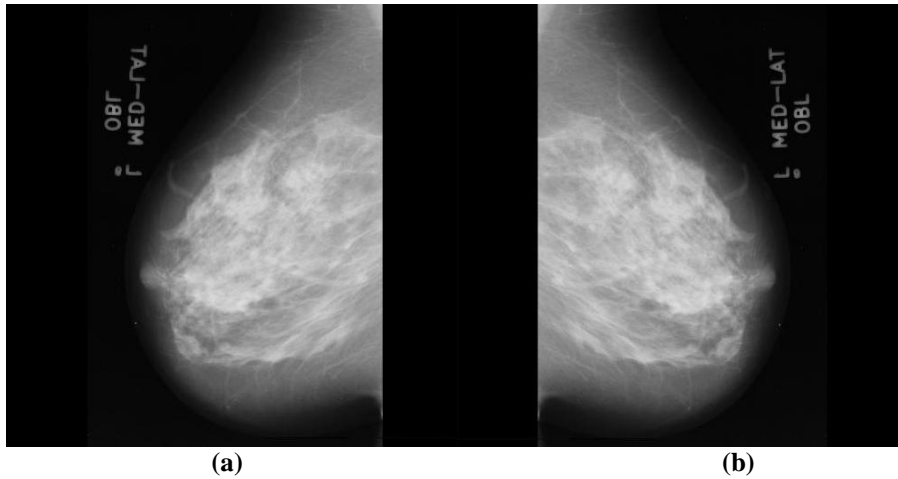| Result	Good	Acceptable	Unacceptable
Total cases 100 image	77	12	11
Percentage	77 %	12 %	11 %
	89%		**11 %**

(a)   **(b)**

Figure4:preprocessing method to make the image orientation always left ,
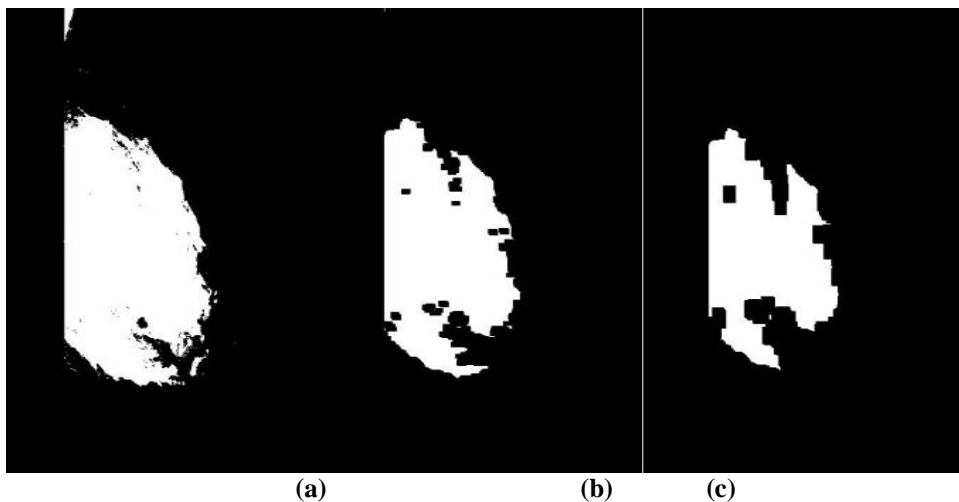**(a):** Original image , **(b):** Make a left direction.

(a)   **(b)**   **(c)**

Figure5: Thresholding Technique , **(a):** Binary image. **(b):** Vertical scan image.
(c): horizontal scan image.
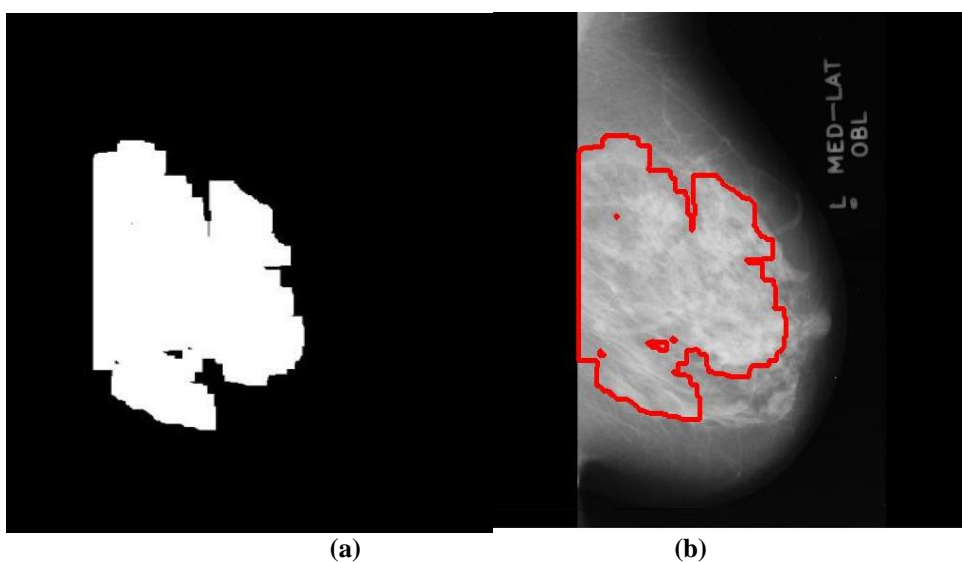

(a)   **(b)**

Figure6: The contour on the image, **(a):** Double scan image.
(b): Original image with contour.

IV. Conclusion

The mammogram image segmentations is an important task, since it limits the search area for suspicious region in the mammogram image and may bias in diagnosis procedures, in this paper we have develop an algorithm for automatic tumors detection in mammogram digital images and we proved that enhanced double thresholding segmentation applied has enhanced wise effect for breast cancer qualitative detection into mammogram scan images, helping for better diagnosis. Moreover, this thresholding method has the advantage of not only reducing processing time but also the processing storage space.

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