Breast Cancer Detection Based on Watershed Transformation

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Abstract

Image processing techniques is widely use in the medical image currently. Ultrasound and X-ray medical images are plays an important role in the detection of breast cancer. This paper is an attempt for breast cancer detection. Segmentation method based on morphological watershed transform to extraction watershed lines from a topographic representation of the input image. In this paper, a diagnostic approach of breast cancer is presented based on two types of medical images .The first was captured by ultrasound device, while the other was captured by X-ray mammography device. The diagnosis of breast cancer is achieved by image processing techniques .The proposed algorithm based on morphological operation and segmentation watershed transformation. The proposed approach obtained very similar diagnosis of breast tumor in the types of medical images. The proposed algorithm tested on digital medical image ultrasound ,x-ray obtained from Mosul Hospital. The results obtained are good**.**

Keywords: *Breast Cancer, Medical Image ,Watershed Transform Topography ,Mathematical Morphology Operation* .

1. Introduction

Cancer disease begins in the cells of the human body, which is generated by abnormal division of those cells**.** There are two types of cancer, benign tumors are not cancerous and malignant tumors are cancerous [1]. Breast cancer causes deaths among women in many parts of the world is the most frequently diagnosed cancer among women between 40 and 60 years of age .Breast cancer can be avoided and curable if early detection. In recent years, several techniques have been applied for tumor detection from various modalities, namely, X-ray mammography, CT-scan and magnetic resonance, ultrasound [2].Segmentation of image plays an key role in practical applications such as medical science. Medical images are important role for object recognition of the human organs. The purpose of image segmentation is to partition images which have different characteristic tissues into semantically interpretable regions, such that the characteristics of each region and extract interest objects [3].Image segmentation by mathematical morphology is a methodology based upon the notions of watershed transformation. Watershed transform is a powerful tool for image segmentation [4]. The objective of watershed transformation is to find the watershed lines in topographic surface. The region that the watershed separates called catchment basins [5].

The rest section of this paper are as follows : section 2:Related work ,section 3:Medical aspects, section 4:Morphology Image processing, section 5:Segmentation, section 6:Proposed work, Section 7: result, section 8: Discussion of results, Finally the conclusion will be at section 9.

2. Related work

In 2005, Zhao Yu-qian et.al, proposed a method to detect lungs CT medical image edge with salt and pepper noise. Clearly show the algorithm for medical image denoising and edge detection, and general morphological such as morphological gradient operation and dilation residue edge detector [15].

In 2008, K..Parvati et.al, proposed a method is based on gray- scale morphology. Implementation edge detection algorithm includes function edge and marker-controlled watershed segmentation. This study shows the

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watershed by foreground markers and ability the algorithm to segment or extract desired parts of any gray-scale images[19].

In 2011, Sharma proposed develop the method for image segmentation based on extraction of watershed lines from a topographic representation of input image. This method has been tested only on digital mammogram image to check if the masses detected are cancerous or not [1].

In 2011, J. Mehena implemented mathematical morphological edge detection algorithm such as Sobel, Prewitt, Robert and morphological gradient operation to detect medical MRI image edge[15] .

In 2011, Wen-Feng et.al, Implemented a new image segmentation technique that combines watershed algorithm and fuzzy clustering algorithms. This study show that the technique gives more promising segmentation result in comparison with the conventional watershed algorithm by means of several brain phantom and real data[3].

In 2013,P.P.Acharjya et.al, discussed a new approach of watershed algorithm using Distance Transform is applied to Image Segmentation. This paper focused on watershed algorithm implementation on three image and concluded the new approach through the difference in the PSNR and Entropy [17].

In 2013,N.R.Raajan et.al, implemented images collected from database of MRI/CT. First are enhanced by using Gabor filters to analyze the visual properties of cancer images. Then enhanced image is then segmented using marker controlled watershed segmentation then extracted the features from the segmented image. This project shows the watershed by foreground markers is able to segment real images
[7].

In 2013,HemantTulsani et.al, presented an approach for counting different blood cells during blood smear test by segmentation using morphological watershed transformation .this paper show a quite similar result for all the images. However, this method is only capable of small over lab in the image but unsuccessful for a big over lab [18].

3. Medical aspects

Cancer begins with uncontrolled division of one cell, which results in a visible mass named tumor. Tumor can be benign or malignant. Benign tumor is not cancerous. Benign tumors may grow larger but do not spread to other parts of the body. Malignant tumor is cancerous. Malignant tumor grows rapidly and invades its surrounding tissues causing their damage [7].The breast is made up of lobes and ducts. Each breast has 15 to 20 sections called lobes, which have many section called lobules. lobules end in dozen of tiny bulbs that can make milk. The lobes, lobules, and bulbs are linked by thin tubes called ducts [6].
Breast cancer is a malignant tumor. The malignant tissue beginning to grow in the breast. The symptoms of breast cancer include breast mass, change in shape and dimension of breast, differences in the color of breast skin, breast aches and gene changes. The early detection and diagnosis of breast cancer is the key to decrease rate and to provide prompt. In recent year, a variety of imaging techniques used to study breast tumor such as: magnetic resonance imaging (MRI), Computed Tomography (CT), Ultrasound, X_ray mammogram. Ultrasound and X_ray mammogram the most widely used techniques, because their ability to produce resolution images of normal pathological tissues. Mammogram is a low dose x-ray procedure for the visualization of internal structure of breast. Mammography has been proven to be the most reliable method and it is the key screening tool for the early detection of breast cancer. Ultrasound imaging is non- invasive, real time ,low cost, and convenient for patients[20].

4. Morphology Image processing

Morphology usually denotes a branch of biology that deals with the form and structure of animals and plants [10] .In image processing morphological is a collection of non-linear operations based on shapes or morphology of features in an image. Morphology operation apply a structuring element to an input image, an output image is creating in the same size. The value of each pixel in output image is dependent on a comparison of the corresponding pixel in the input image with its neighborhood of pixels[18].

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4.1 Mathematical morphology

Mathematical morphology uses concepts of set theory, geometry, and topology to analyze geometrical structures in images. The theory has been used in a wide range of applications including image processing , shape analysis, coding and compression automated industrial inspection, texture analysis and scale spaces [22].

Mathematical morphology is a very important tool for extracting image component that are useful in representation and description of region shape, such as boundaries, skeletons and convex hull. Matheron and Serra was the first developed mathematical morphology [12]. Since the Mathematical morphology is a powerful technique for the analysis of images, so that mathematical morphology uses structuring element, which is characteristic of certain structure and feature to measure the shape of image and then implementation image processing [13].

4.2Morphological operations

The basic mathematical morphological operators are dilation ,erosion, opening and closing .As the following morphological operators of gray scale images[14][15].

- **Dilation**

Dilation is defined as the maximum value in the window. Dilation adds pixels to the boundaries of objects in an image. Dilation of image f by structuring element s is given by $f \oplus s$.

The structuring element s is positioned with its origin at (x,y) and the new pixel value is determined by the Eq. (1). Dilation is a transformation of expanding, which the image after dilation will be increased in intensity.

$$g(x,y)= \begin{cases} 1 \; if \; s \; hits \; f \\ o \; otherwise \end{cases} \quad (1)$$

- **Erosion**

Erosion is opposite to dilation. Erosion is defined as the minimum value in the window. Erosion removes pixels on object boundaries in an image. Erosion of image f by structuring element s is given by $f \ominus s$.

The structuring element s is positioned with its origin at (x,y) and the new pixel value is determined by Eq.(2). Erosion is a transformation of shrinking ,which decreases the gray scale value of the image.

$$g(x,y)= \begin{cases} 1 \; if \; s \; fits \; f \\ o \; otherwise \end{cases} \quad (2)$$

- **Opening and Closing**

Opening consists of an erosion followed by a dilation ,which opening can be used to smooth the contour of an image. Opening of image F by structuring element S is shown as follows Eq. (3) ,while closing consists of a dilation followed by erosion.

Closing using to fuse narrow breaks and long thin gulfs, eliminating small holes, filling gaps in the contour and smoothing contours. Closing of image F by structuring element S is shown as follows Eq. (4) .[15]

$$F \circ S = (F \ominus S) \oplus S \quad (3)$$

$$F \cdot S = (F \oplus S) \ominus S \quad (4)$$

5.Segmentation

Image segmentation is an essential process for most subsequent image analysis process. In particular, many of the existing techniques for image description and recognition, image visualization, and object based image compression highly depend on the segmentation results [18].

Segmentation is an important way to extract information from medical image [3].In Segmentation the inputs are images and, outputs are the attributes extracted from those images. Segmentation divides image into its constituent regions or objects. Segmentation based on morphological operation, and watershed transform applied to grey level images is a fast, robust and widely used in image processing and analysis, but it suffers from over-segmentation [21].

5.1 Watershed transform

The watershed transform is a method of choice option for image segmentation based on mathematical morphology operation [3]. In gray scale mathematical the watersheds

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transform, proposed by Digabel and Lantuejoul and improved by Beucher and Lantuejoul [18].Watersheds are one of the classified region based segmentation approach. This segmentation method have considered necessary to solve some difficult and diverse image segmentation problem. Identically, breast medical image.

Since the idea underlying of watershed is straightforward comes from geography .When dealing topography representation of the image is consider filling over the region as a landscape or topographic which is flooded by water. Watershed being the divided lines of the domains of attraction of rain falling over the region. An alternative approach is to imagine the landscape being immersed in alake ,with holes pierced in local minima .Catchment basins will fill up with water coming from different basins would meet, dams are built .When the water level has reached the highest peak in the landscape ,the process is stopped .As a result, the landscape is partition into regions or basins separated by dams ,these regions are referred to as catchment basins and the dams are called the watershed lines dividing the given input image into a set of regions[1].Typically, watershed transformation as a powerful segmentation process due to its many advantages including simplicity, speed and complete division of the image .it allows detecting objects boundaries.

6.The proposed work

In this section the way of how to build a computer program for the diagnosis of medical images will be clarified. Breast cancer images was acquired by two types of images ultrasound and x-ray device works with gray level value among women aged between 40 and 60 years .Using Matlab to implement the proposed approach which is illustrated in this steps.

1:Pre-process:
- ❖ Read the input images to the gray scale image and then filter the image

2: Compute gradient image using edge detection function .Next compute the structure element before applying dilation and erosion operation.

3. Compute Watershed transform
- ❖ Compute the foreground object which connected blobs of pixels inside each of the foreground objects used the morphological opening by reconstruction and closing by reconstruction to clean up the image.
- ❖ Compute the background objects .In cleaned-up image, the background pixels are in black.
- ❖ Compute the watershed transform of the segmentation function .The function imimposemin can be used to modify an image so that it has regional minima only in certain desired locations.

4. Display

This procedure determine the color assign to each object based on the number of objects in the label matrix and range of colors in the color map. Finally, proposed algorithm obtained very similar diagnosis of breast tumor in the types of medical images the result obtained by diagnosis of medical breast cancer image. Fig. (1) illustrates this steps as shown below:-

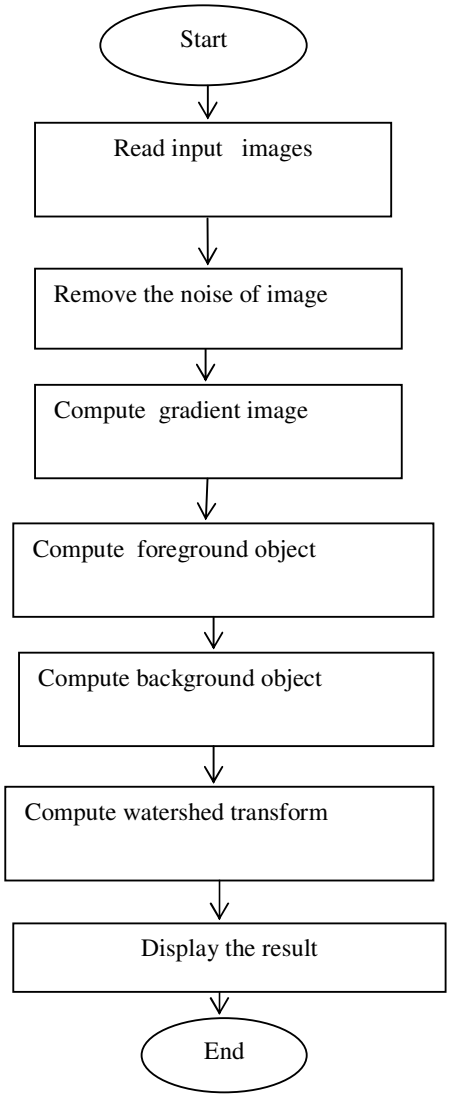

Fig. **1 Proposed work**

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7.Results

The results obtained by the implementation system of detection breast cancer as shown below in Fig. (2) to (4).

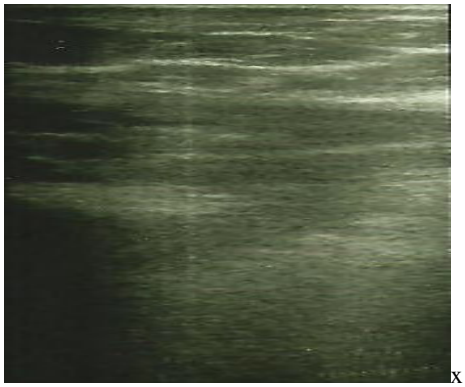

Fig.2 original image ultrasound

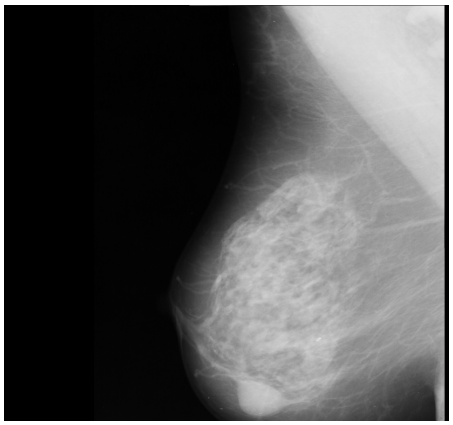

Fig.3 original image X-ray mammography

Upon implementation of the program shows the following the program interface and include the number of stages illustrated as follow

a:original medical image: When you press the images files are displayed then selected the images you want to input of diagnostic breast cancer.

b: gradient magnitude: at this stage, input image capture by ultrasound or x-ray then preprocessing this image.

c: opening& closing operation: at this stage, used the method of morphological techniques called opening by reconstruction and closing by reconstruction. These are connected blobs of pixels within each of the objects.

d :markers and object boundaries: The pixels that are not part of any object .

e: watershed label matrix: Compute the watershed transform of the modified segmentation function.

f :markers on original image: Finally, at this stage display the result of diagnosis of breast cancer. When you click on the box from (a) selected ultrasound original image to (f) show results as shown in Fig..4 .The result of X-ray mammography medical image as shown in Fig. 5

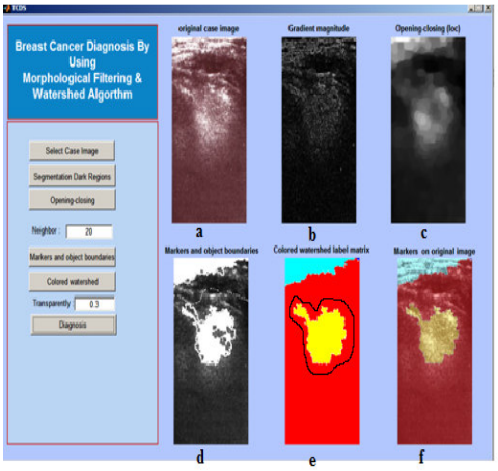

Fig..4 (a) original Ultrasound medical image (b)gradient magnitude(c) opening& closing operation (d) markers and object boundaries (e) watershed label matrix (f)markers on original image.

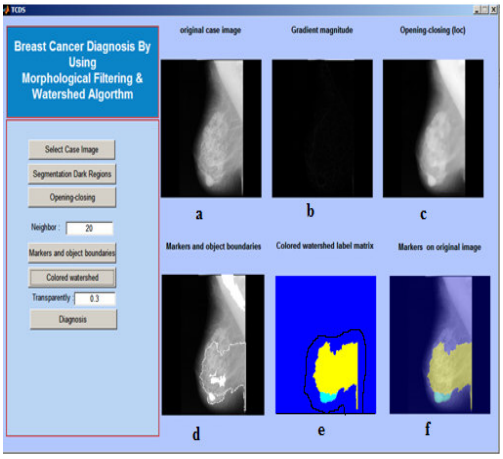

Fig.5(a)original X-ray mammography medical image (b)gradient magnitude(c) opening& closing operation (d) markers and object boundaries (e) watershed label matrix (f) markers on original image.

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8.Discussion of results

In this action the way of detection breast cancer among women age between 40 and 60 years old ,have been dealing with samples gray scale level medical image taken from Mosul Hospital Khansa education for two types of medical images namely , ultrasound and x-ray mammography .The data included (66) samples medical image .(33) cases captured by ultrasound and (33) cases captured by x-ray mammography .The obtained accuracy for the diagnosis of breast cancer by medical images , calculated with the number of correct and incorrect classification in each possible value of the images classified .The Sensitivity (SE), Specificity (SP) and Accuracy (ACC),validation metrics to evaluate the diagnosis algorithm. The value of SE, SP and ACC for testing data of the work as shown in table **1**

Table 1: Testing

	Cases with cancer		
	Positive	**Negative**	
Test Positive	True positive (TP)= 19	False positive (FP)= 3	Positive predicate value =TP/(TP+FP) =19/(19+3)=86.363%
Test Negative	False Negative (FN)=2	True Negative (TN)= 9	Negative predicate value =TN/(FN+TN) = 9/(2+9)=81.818%
	Sensitivity	Specificity	
	TP/(TP+FN) =19/(19+2) =90.47%	TN/(FP+TN) =9/(3+9)=75%	
Accuracy	TP+TN/(TP+ FN+TN+FP)=19+9/(19+2+9+3)=84.848		

Where
TP: the number of true positives. Predicts breast images are correctly.
TN: the number of true negatives. Predicts non- tumor images are non- tumor.
FN: the number of false negatives. Predicts tumor images are wrongly non- tumor.
FP: the number of false positives. Predicts wrongly breast images incorrectly.
Since the value of each point in the output image based on a comparison of the corresponding point in the input image with its neighbors .Through work and our choice of size and shape of the neighborhood, show the value of neighbor ranging from 20 to 25 have achieved successfully detection result .Table 2 and 3 as shown the result detection tumor according the range value of the neighborhood.

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T able 2: Neighborhood of Ultrasound image

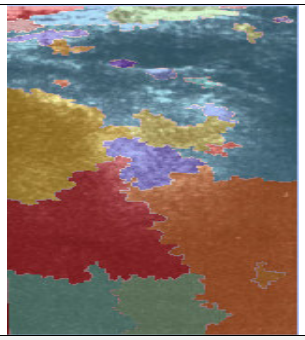
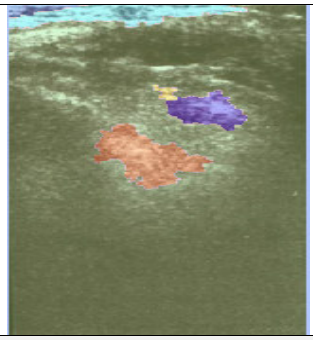
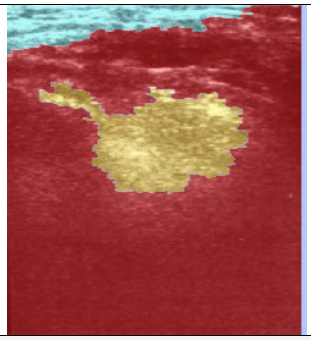
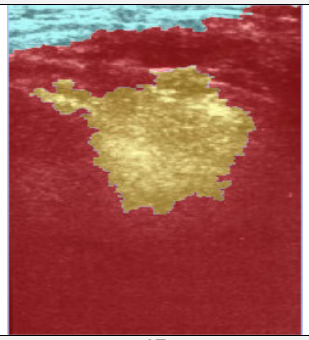
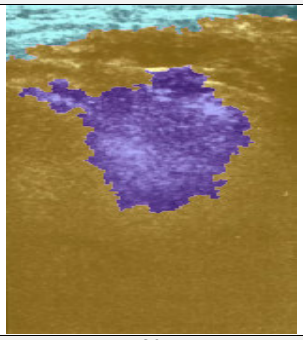
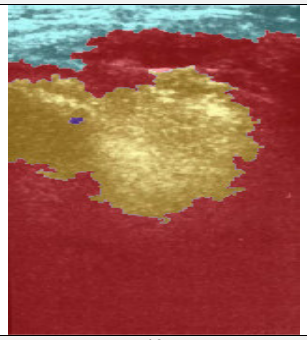
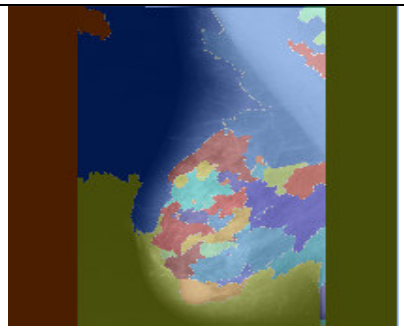
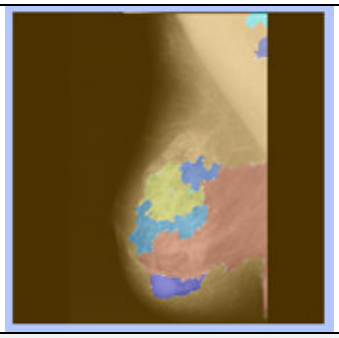
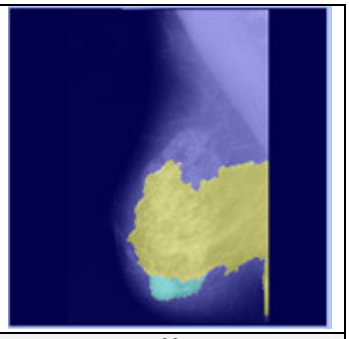
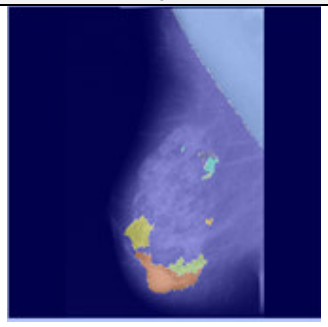
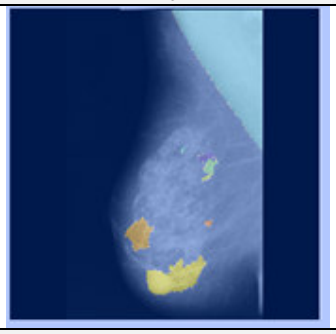
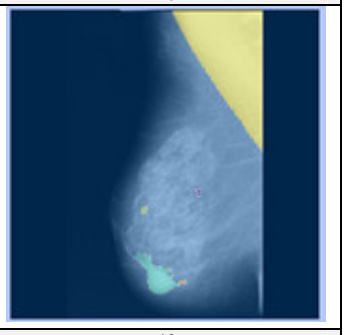
Object on original image			
Value	5	10	20
Object on original image			
Value	27	30	40

Table 3: Neighborhood of x-ray mammography image

Object on original image			
Value	5	10	20
Object on original image			
Value	27	30	40

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9. Conclusion

In this paper, use image processing techniques in the medical image. The proposed approach algorithm detection for breast cancer of medical image Ultrasound and x-ray. Since medical image are complex ,requirement pre-processing aids in gray scale image use the sobel operation. Then applied the watershed transform . The areas in the image are highlighted that could be analysis to detected are cancerous or non-cancerous. The proposed algorithm has been tested on standard digital image .Through the work the value of neighbor adopted has been reached a good results ratio. In future ,this work can be detection the tumors using any of techniques such as combined the watershed transform algorithm and clustering algorithm, Neural network system, Fuzzy logic

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