Improved Region Growing based Breast Cancer Image Segmentation

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ABSTRACT
Image segmentation is vital part for any pattern recognition applications like medical imagine for disease detection, biometric recognition etc. Accurate image segmentation leads to accurate method for particular application purpose. In this paper, novel robust and efficient segmentation method introduced for breast cancer image segmentation for early detection of disease. Our main research is to present framework for automatic and accurate diagnostic method for early detection of breast cancer. For any detection process, there are three main phases such as segmentation, feature extraction and detection (recognition). Feature extraction and detection is out of scope of this paper. This paper is focusing and evaluating the new proposed segmentation method. Before segmentation, we first performed the preprocessing step in order to remove the internal noises and getting smoother image. In preprocessing, first image is resized to 256 * 256 in standard size, and then RGB image is converted to grayscale. Grayscale image is filtered using Laplacian and average filters for noise removal. The preprocessed image is given input to segmentation method. Segmentation method proposed is this paper is based on existing region growing method. For breast cancer image segmentation, improved region growing method is introduced in this paper. This improved segmentation method considering constrain of orientation along with existing intensity constrain.

Keywords
Breast Cancer, Preprocessing, Segmentation, Region Growing, Noise Removal, Filtering, Orientation.

1. INTRODUCTION
Cancer is the major threat for human being health and its number of patients increasing word wide due to the global warming, even if there are new therapies and treatments proposed by research doctors, but level of cancer defines the ability of its cure. There are different types of cancers from which human being is suffering [male and female]. In this paper we are focusing on breast cancer in women, rest all cancers are out of scope of this paper. Large number of women population is affected by the breast cancer. A different type of reasons causes the breast cancer such as X-Ray. For women's, breast cancer is most common cancer, and it has been increasing since from last decade. The early detection of breast cancer helps to completely cure it through the treatment. The early detection is done by self-exam which can be done by woman in each month. This process is refereed as breast cancer early detection. However currently many hospitals and doctors uses the mammography test and resulted as effective technique for breast cancer early detection. The aim of this test is to perform early detection of breast cancer using characteristic masses detection as well as micro calcifications as these characteristics are considered as most important factor of breast cancer. Mammography test is performed by undressing the patient upper part in front of X-ray machine. Further both breasts are compressed among two plates in order capture two photos of each breast using the X-ray pulse. Apart from the Mammography test, there are some more methods used for early breast cancer detection such as computer aided detection (CAD), blood tests, clinical breast exam etc.

Recently use of CAD based detection techniques use is increasing in which image processing concepts are used on input photos from X-ray for automatic detection of breast cancer with its level. This type of approach saves lots of time and efforts required from the doctors. Image processing is the physical method which is applied to convert the breast image signal into the physical image. The image signal is also known as digital image signal, and output of this process is either physical image or its related characteristics. Breast cancer detection is wide range of research in which different researchers preparing their research articles and proposing the new techniques and solutions for breast cancer detection with practical evaluation using the image processing concepts. CAD based techniques are composed of several steps to detect the early detection of breast cancers such as image acquisition, image preprocessing, image segmentation, feature extraction and finally detection using classifiers.

In this paper we are discussing and presenting about first three steps image acquisition, preprocessing and segmentation. For segmentation we are introducing the new modified region growing method which is based on existing region growing. Image acquisition is done by taking input medical images of breast from X-ray machines. In our case we are using the publically available research dataset images. Once image acquisition done, next step is to preprocess the input image using conversion, resizing and filtering. These operations are done to remove the noises and make image smooth for segmentation process. This paper is focusing on efficient and robust segmentation technique for breast images. Image segmentation is nothing but extracting different parts of digital image. Main aim of image segmentation is to change the representation of original image to another image which is suitable for further image analysis. Many image processing based applications uses the image segmentation as core concept for analysis. The performance of image processing applications is depends on accurate image segmentation methods also. There are many different image segmentation methods presented so far by various researchers such as morphological operations, binarization, threshold based, histogram based, region growing etc. In this paper we

introduced new segmentation technique which is based on existing region growing segmentation technique. As image segmentation allows locating the objects and their boundaries in original image, our aim with new segmentation technique is to extract the breast part from original image. In improved region growing technique, we have added the orientation constraint along with existing constraint of original region growing method. This proposed segmentation method is outperforming existing region growing technique in terms of accuracy in previous application evaluation. In rest of this paper, section II is discussing about the different methods of image segmentation and breast image segmentation. Section III is showing the proposed algorithm, its steps, and inside details for breast image segmentation. Section IV is showing the practical results for this segmentation work on different breast cancer images. Section V presents the conclusion and future work.

2. RELATED WORK

For breast cancer analysis, segmentation plays an important role. Main goal of segmentation process is the extraction of region of interests (ROIs) which is having all masses breast as well as suspicious mass candidate is located on extracted ROI. In breast image, suspicious regions segmentation is prepared in order to have more number of false positives and high sensitivity as those are expected to be eliminated in next algorithm stage. There are different methods proposed and used by many researchers for segmentation. In this section we listed and discussed some methods used for image segmentation.

In [1], author introduced the global thresholding method for image segmentation. This is frequently used method for image segmentation. This method uses the global information for segmentation like histogram. For breast image, the intensity value of masses region is more than other regions of image. This helps to compute value of global threshold. Using histogram, the areas with disease part is having more peaks whereas normal areas are having only one peak. Once the determination of threshold value is done, segmentation of abnormal regions on image is done. This method of image segmentation is resulted into good for extracting the ROI due to the fact that masses of image are frequently superimposed over tissues of similar level of intensity. The performance of this method is good if it is used as first step in some other methods of segmentation. On the other hand, local thresholding method is more accurate than global thresholding as this method is locally defined for every pixel using the neighboring pixels intensity values.

In [2], author Li et al. uses the local adaptive thresholding method for mammographic image segmentation in order to extract the regions corresponding to similar classes as well as to refining the segmented results.

In [3], author introduced the MRF (Markov random field) and GRF (Gibbs random field) methods for image segmentation. These methods fall into segmentation category called iterative pixel classification. MFR and GRF are statistical techniques.

In [4], author Székely et al. introduce the MRF technique for fine segmentation in order to gain the preliminary outputs by coarse segmentation. The process of coarse segmentation computes the feature vector and then passing this feature vector to decision trees which classifies the region of image. Once the fine segmentation done, three various segmentation methods are used together such as modified radial gradient index technique, dual binarization technique and Bezier histogram technique in order to segment image mass.

The methods like region clustering and region growing are come under the category of pixel classification based segmentation.

In [5], author Zheng et al. introduced the algorithm of adaptive topographic region growing in order to define the contour of initial boundary of mass area. After that active contour method with goal of modifying the contour of last mass boundary is applied. Whereas the region clustering method finds the region directly without any initial seed point.

In [6], author Pappas used the basic k-means clustering technique for image segmentation. K-means clustering extracts the pixels into the different clusters as segmented masses.

In [2], author Li et al. introduced refinement method called adaptive clustering to refine the segmented results obtained using local adaptive thresholding method.

In [7], author Sahiner et al. introduced the modified k-means clustering technique in which selection of object is done in order to detect the initial mass area in ROI after k-means clustering.

The methods of edge detection are based on image discontinuities of gray level. Derivatives or Gradients are used to measure rate of change of gray level.

In [8], Rangayyan presented the different operators for edge detection like sobel operator, Log (Laplacian of Gaussian) operator, prewitt operator and Roberts's operator.

In [9], author Fauci et al. proposed the method of edge based segmentation which is based on iterative process called ROI hunter method for extracting the ROIs. ROI Hunter technique is uses the concept of searching of intensity maximum within square windows those constructing the image of mammographic.

In [10], author uses the DWCE (Density contrast enhancement) method with Laplacian method in Gaussian filtering. Aim of DWCE technique is enhancing mammographic image structures for detecting the objects boundaries using edge detection method.

In [11], author Zou et al. introduced the segmentation method which is based on use of GVF (gradient vector flow field). GVF is nothing but the model of parametric deformable contour. Adaptive histogram equalization is applied on image for enhancement, and then GVF is applied to get ROI.

3. PREPROCESSING AND SEGMENTATION

For breast image segmentation we have used below steps:

3.1. Image Acquisition

- Photos of breast are generated through the X-machines.
- Photos of breast are then electronically converted into image format to further process.

3.2. Preprocessing

- **Algorithm 1: Preprocessing Algorithm**
- The input raw image needs to be preprocessed.
- The input image is first resized into 256 * 256 size using the MATLAB function immersive ().

- 2D conversion, if the input image is 3 dimensional (3D) then it is first converted into 2D, as most of image processing methods are applied on 2D images only. In short, RGB image is converted into gray scale image.
- This conversion is done by MATLAB function rgb2gray ().
- The next task of preprocessing phase is image smoothing and denoising. This can be done by using two filters as mentioned below
- Out_1 = apply Laplacian filter on grayscale image
- Out_2 = apply mean filter on grayscale image
- Out_3 = Out_1 – Out_3
- Out_3 is final preprocessed image
- End

3.3. Image Segmentation: Improved Region Growing

- **Algorithm 2: Improved Region Growing Segmentation**
- **Input:** Out_3 image [Preprocessed Image]
- **Step 1**: Out_3 is preprocessed image from gradient is extracted over X and Y axis in variables OutX and OutY.
- **Step 2:** Combining gradient values using the below equation to get gradient vector Gval.
- Gval =[1/(1+(OutX+OutY))]
- **Step 3:** Gval is in radians; hence it is converted to values of degrees in order get orientation information of image pixels.
- **Step 4**: Image Out_3 is divided into grids GRi.
- **Step 5:** Define the threshold values for intensity and orientation in variables Ti and to respectively.
- **Step 6:** for each GRi do

  6.1. Compute the histogram Hi of each pixel Pj over grid GRi.

  6.2. Searching the frequent histogram of Find the most frequent histogram of GRi grid and referred as FreqH.

  6.3. Choose any pixel Pj related to FreqH value, and then assign that pixel information seed point (SP) which is having Ip [Intensity value] and Op [Orientation value].

  6.4. Checking the constraint such as intensity and orientation constraints for neighboring pixel.

  6.5. If both a constraint satisfied, then region is grown, else next GRi grid is taken for further processing.
- **Step 7:** Segmented Image

Following figure 1 is showing the steps for image segmentation

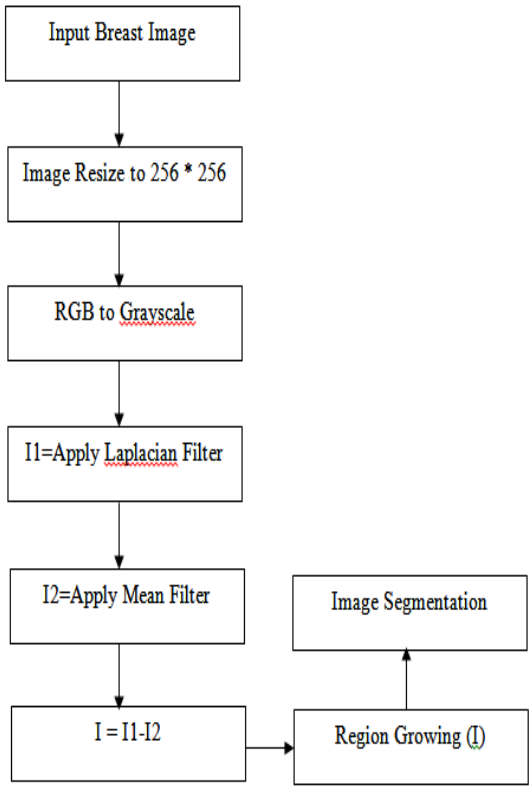

Figure 1: Architecture for Image Segmentation

Figure 1 is showing all details for phase 1 process of our research. All this steps are implemented in MATLAB for we have shown results below.

4. PRACTICAL RESULTS AND ANALYSIS

4.1. Dataset Information

There are many publically available, but most of it is not available for free use. MIAS (Mammographic Image Analysis Society) and DDSM (Digital Database for Screening Mammography) are frequently accessed datasets for evaluation of research algorithms. The MIAS database information is available on below link: http://peipa.essex.ac.uk/info/mias.html . The DDSM database information is available on link http://marathon.csee.usf.edu/Mammography/Database.html.

For preprocessing and segmentation, we have collect 10 breast cancer images sample from MIA's dataset.

4.2. Performance Results

The process which we used for preprocessing in this paper is evaluated using three performance metrics such as PSNR (Peak to Signal Ratio), MSE (Mean Square Error) and Mutual information by taking two images as input such as one is before preprocessing image and another is after preprocessing image. The performance metrics used here indicates the quality improvement in preprocessed image. Below table 1 is showing the performance for sample five images.

Table 1: Preprocessing Image Performance Analysis

Images	Mutual Information	MSE	PSNR
Image 1	0.2124	164.99	67.324
Image 2	0.1977	189.21	65.389
image 3	0.1823	184.43	67.442
image 4	0.2045	174.87	68.934

4.3. Segmentation Results

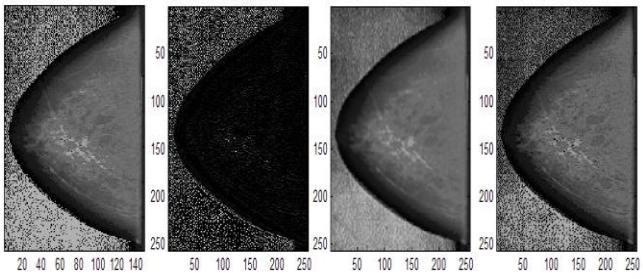

Figure 2: Preprocessing result

Figure 2 is showing the result of preprocessing steps, first image is showing original input image, then second image is result of applying Laplacian filter, then figure 3 is result of mean filter and finally preprocessed output is in 4th image. After preprocessing we applied improved region growing method for segmentation which is having below output in figure 2. We applied edge detection of segmented image as showing 4th image in figure 2.

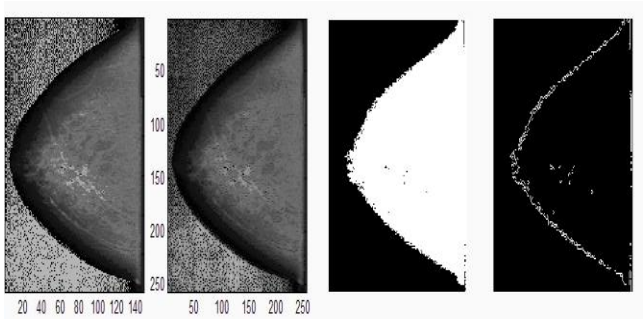

Figure 3: Segmentation result

5. CONCLUSION AND FUTURE WORK

The goal of this paper is to present the new improved segmentation method for breast cancer detection research. The algorithm for image segmentation is proposed based on existing region growing method. In existing region growing method, only one constraint was considered, but in proposed region growing method orientation constrain is also considered. The results for image segmentation and preprocessing are shown in above section of this paper. For preprocessing we used double filtering technique for improving the quality of input raw image of breast cancer. The preprocessed image is then used further for segmentation with improved region growing method. For future work we will work further on efficient feature extraction methods and detection methods.

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