Seed Point Detection and Segmentation of Breast Tumor Images Using Region Growing Snake Contours

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Abstract- *Computer-aided-diagnosis (CAD) system can be used to assist the radiologists and the physicians analyses the overall images, and find tumors that a radiologist might not spot. Combining computer-aided-diagnosis with mammography will improve the ability to find cancer. Image segmentation plays a crucial role in CAD system by facilitating the delineation of the masses. There are number methods researched by scholars for medical image segmentation in which region growing and contour gradient based methods work efficiently at the tumor boundaries. But major requirement for such methods need a starting point or called as seed point in between the tumor. Their fore accuracy of actual tumor detection depends highly on the truly detected seed point. Not much literature has been found on seed point detection but which are found popular works not on all type of images especially when there are too many low intensity tumor like regions in the image. Also the second drawback is their location such that they found near the boundary areas of tumor which results in the leakage of segmentation algorithms through weak boundary points. All these limitations has been covered in this work. Iterative quad tree has been improved with the help of morphological operations which gives seed point at the centroid of the tumor. Also segmentation has been carried out using snake contouring which uses the detected seed point for segmentation. Experimental results shows that proposed method gives high accuracy in truly segmentation of breast tumors in collected dataset.*

Keywords- QTD algorithm, Snake contour segmentation, Ultrasound images, Tumor localization etc.

I. INTRODUCTION

Ultrasound imaging is one of the most commonly used approaches for early detection of breast cancer. For proper accuracy of computer-aided diagnosis of breast lesions segmentation plays a vital role [1]. Due to the nature of US imaging, the images always suffer from the poor image quality caused by speckle noise, low contrast, blurred edge and shadow effect. These make the segmentation of the interested lesions quite difficult. One of the frequently used segmentation methods is region growing . A seed point is the starting point for region growing and its selection is very important for the segmentation result. If a seed point is selected outside the region of interests (ROIs), the final segmentation result would be definitely incorrect. Due to the low quality of US images, most of these region growing methods require the seed point be selected manually in advance. In order to make the region growing segmentation fully automatic, it is necessary to develop an automatic and accurate seed point selection method for US images. All the existing methods take into account only the statistics texture features for a mass region (ie, the mass is darker than the surrounding tissues and more homogeneous than other regions), seldom considers spatial features of a US mass (such as a mass frequently appears at the upper part of image and is barely connected with the image boundary). Therefore, the probability of a selected seed point outside the lesion is high, especially in the noisy and low-contrast images.

There are many texture features that have been used in the literature (statistical, structural, model based, transform based/spectral). Common statistical approaches include the grey level co-occurrence matrix and the grey level run length matrix. Texture features derived from Haralick's co-occurrence matrices, although computationally intense, has performed well in a number of applications [2]. Segmentation of breast masses in ultrasound echography images is one of the key points in computer aided diagnosis of breast masses. The two main approaches of image segmenta- tion through active contours are edge based and region based. The edge based method of image segmentation is based on threshold or local filtering. Gradient method of edge detection detects edges by looking for maximum and minimum in the first derivative of an image. Laplacian method of edge detection searches for zero crossings in the second derivative of the image to find for edges. Region based active contour method looks for uniformity of intensity, texture or color within a sub region. It uses statistical information of image intensity within each subset instead of searching geometrical boundaries. Level set method of active contour was proposed by Osher and Sethian. This level set method drives an initial curve based on gradient or region information to the image boundaries. The geometric active contour method evolves a higher dimensional function whose zero-level set corresponds to the position of the propagating contour. This can handle merging and splitting of the evolving contour. However level set method has two limitations. First, this method is by solving PDE and is computationally intense. Second, selection of a seed point inside the lesion area and placement of an initial contour around the seed point occupies much of the computational task. A good initialization avoids local solutions and also reduces the iterative times the curve evolution takes [3].

BUS images are also used to discriminate benign tumors from malignant ones. Computer-aided diagnosis (CAD) systems are widely used to analyze masses in BUS images. A CAD system generally consists of three main components: segmentation of the region of interest (ROI), feature extraction and classification. Texture features are commonly used to characterize benign and malignant tumors. Unfortunately, BUS images suffer from several artifacts, such as speckle noise, which may distort the appearance of local structures and degrade the performance of texture analysis methods. Since the seminal work [4] snake contours have been applied to many segmentation problems derived from different applications. The accuracy and the computational time of segmentation produced by the snake contours depend on their initial positions (seeds). The seeds must be initialized close to the desired object. Otherwise the AC attach to false boundaries created by noise and artifacts. As accuracy of segmentation depends upon seed point detection, this has been researched in the proposed paper.

II. LITERATURE SURVEY

Makhanov et al. [5] proposed a novel initialization method designed for GVF-type snakes based on walking particles. At the first step, the algorithm locates the seeds at converging and diverging configurations of the vector field. At the second step, the seeds ''explode,'' generating a set of random walking particles designed to differentiate between the seeds located inside and outside the object. Gradient vector flow (GVF) snakes are an efficient method for segmentation of ultrasound images of breast cancer.

Selvan et al. [6] presented a new and novel algorithm to select a seed point inside the breast lesion and hence to trace an initial contour around the seed point automatically in US B-scan images. The seed point thus obtained is mapped to its corresponding elastography image pair. This technique is based on the idea that tissues in the breast have great variation in amplitudes of echoes. The grey levels on US B-scan images correspond to these intensity variations. We proceed to find texture features energy and entropy of image blocks of size (n*n) in the US B-scan image. The energy and entropy matrix are checked for a specified criterion for malignant solid masses, benign solid masses and cysts respectively. The gray run length features long run emphasis, short run emphasis and run length nonuniformity are also found to ensure that the seed point is within lesion area.

Wang et al. [7] propose a new, robust, fast and automatic seed point selection algorithm. The algorithm needs no prior information or training process. By taking into account both the homogeneous texture features and spatial features of the breast lesions, we successfully find the seed points for 100 images (95.2%) of the 105 images in the database and fail on only 5 images. The quantitative results demonstrate the robustness of our seed selection method. By studying the failed cases and seed-point-near-boundary cases, we found that most of those cases are caused by a shadow with similar intensity of the lesion and right below the lesion. Thus, the future work will focus on eliminating the shadow effect on automatic seed point selection.

Fan et al. [8] uses QTD algorithm for seed point location of the ultrasound breast tumor image. Furthermore, taking advantage of the proposed SGV criteria, the iterative QTD algorithm can be successfully utilized to identify the seed region with complete automation.

Verma et al. [9] proposed a method which uses the advantages of k-means segmentation based on pixel that help to overcome the energy minimization problem of active contour method. We also compared three boundary detection algorithm k-means, Otsu and active contour method. Though the active contour method has many advantages, but it is not able to properly detect the boundary in many images. The k-means algorithm has the capability for detecting accurate seed and boundary, but not in all the cases. In future, it can be extended by using fuzzy logic that gives accurate result in case of uncertainty as well.

III. PROPOSED ALGORITHM

It fragments the 2-D grayscale image into closer view (object) and foundation regions utilizing snake contour based division. The output image bw is a binary image where the closer view is white (logical true) and the foundation is black (logical false) [10]. The proposed method in this work is locating the seed point at the centroid of the tumor. The system module and steps for the proposed method has been given below.

Steps in the algorithm

- Read the ultrasound image
- SRAD filter for speckle reduction

- Histogram equalization for contrast enhancement
- Quad tree decomposition based on a threshold into sub image blocks
- Pre seed point detection based on minimum intensity maximum size block
- Active contour segmentation
- Connected component analysis for detecting centroid of the segmented region as seed point
- Performance evaluation

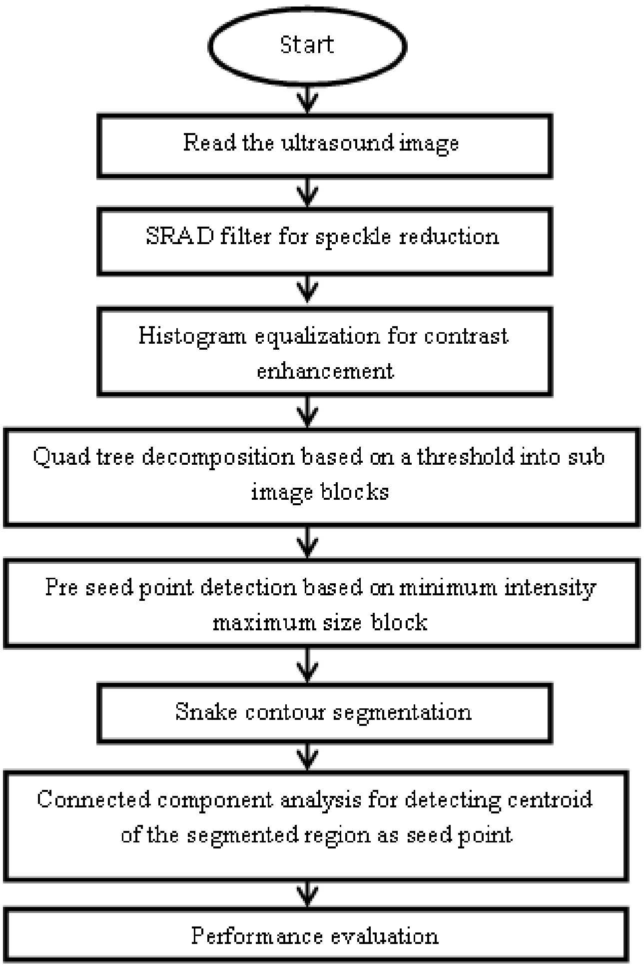


Figure 1: Flowchart of the proposed algorithm

IV. RESULTS AND DISCUSSIONS

In order to implement a completely automatic segmentation method for breast cancer US images, we propose a new, robust, fast and automatic seed point selection algorithm. The algorithm needs no prior information or training process. By taking into account both the homogeneous texture features and spatial features of the breast lesions; we successfully find the seed points for maximum number of images found in World Wide Web. The quantitative results demonstrate the robustness of our seed selection method. After seed point selection, snake contour segmentation has been applied which segments out the tumor region very efficiently. Experimental results show that snake contour based segmentation gives approx. 95% accuracy on the collected dataset in efficient detection of the tumor region in the breast images.

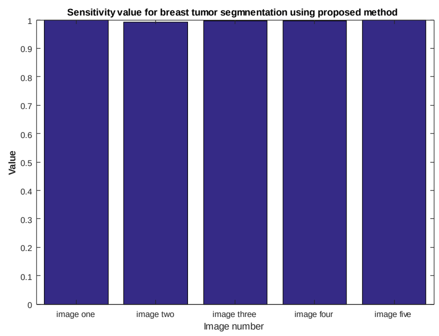


Figure 2: Image showing bar graphs of sensitivity values by snake contour based segmentation

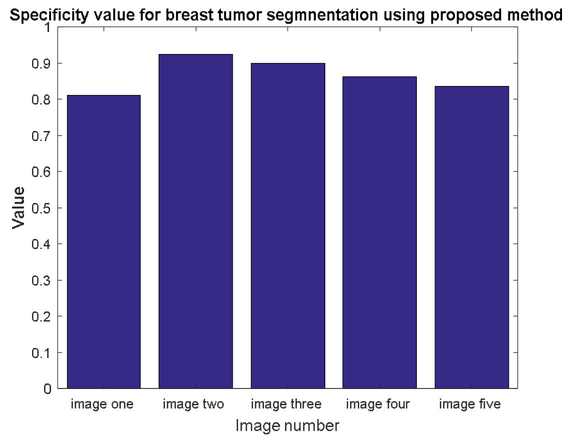


Figure 3: Image showing bar graphs of specificity values by snake contour based segmentation

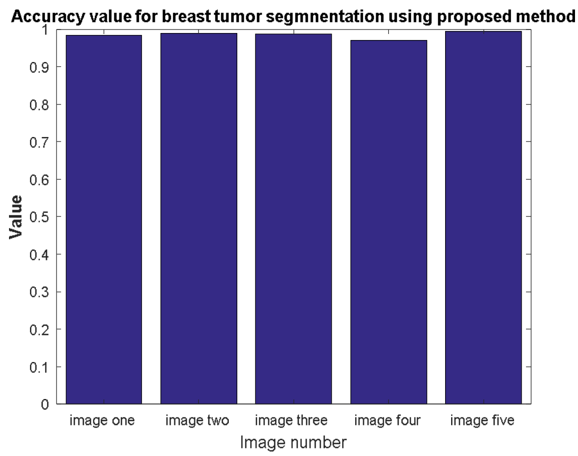
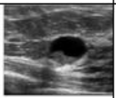
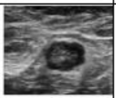
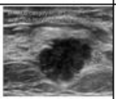
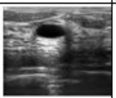


Figure 4: Image showing bar graphs of specificity values by snake contour based segmentation

Table 1: Sensitivity, specificity and accuracy parameters for the tested dataset

S. No.	Medical image	Tumor segmentation	TP	TN	FP	FN	Sensitivity	Specificity	Accuracy
1			241110	16936	3961	137	0.9994	0.81045	0.9843
2			244675	14436	1169	1864	0.9924	0.9250	0.9884
3			234318	24562	2724	540	0.9977	0.9001	0.9875
4			211306	43104	6847	887	0.9958	0.8629	0.9704
5			252418	8025	1569	132	0.9994	0.8364	0.9935

V. CONCLUSION

Breast segmentation is the first step in many Computer Aided Diagnosis methods, the process of segmentation allows to separate the breast from other objects in the mammogram Images. Though researchers introduced several images segmentation methods but, seeded region growing technique appears as the natural choice in the masses segmentation. A seed point is the starting point for region growing and its selection is very important for the segmentation result. Appropriate seed position selection in mammogram images can be difficult to achieve and requires a radiologist experienced with the algorithm and knowledge of the application field. To overcome this limitation, we introduce a new method to select a seed point automatically based on iterative quad tree decomposition of the image. First image has been divided into four similar size of blocks. Then its minimum and maximum values havebeen calculated. If the selected block has difference of min and max values greater then a threshold, then the chosen block is subdivided into further four blocks. Similar procedure has been adopted until it satisfies the required conditions. Then mean value has been compared form the developed blocks such the maximum sized block but having least mean intensity value has been chosen as a seed point. This seed point is used by region growing snake contour method in order to segment out the tumor in the image. Experimental results have been carried out on number of images collected from internet and method works on almost all types of images. Performance evaluation of the detected tumor has been carried out using sensitivity, specificity and accuracy metrics.

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