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Comparative analysis of computer aided segmentation of ovarian images

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Abstract- Image segmentation is an imperative step toward examine and excerpts the consequential information from the image. The main part of the female reproductive system is the ovary which contains follicles in it. The follicles play a major role in fertility by developing eggs for conception. However, segmenting the follicles from the ovary image is a complicated task. Some researchers put their contribution to extract the follicles from the ultrasound ovarian images by using various image segmentation techniques. In this paper, Region growing, Edge detection and Active contour methods used for image segmentation are compared with human expert results and the performances of the methods are analyzed.

Keywords- Ovary image, follicles, region growing, active contour, edge detection, segmentation.

I. Introduction

Image segmentation methods have played an essential role in medical image diagnosis. The important features which are necessary for the diagnosis purposes are obtained from the segmentation results. As a matter of fact, the organs inside the human body are prospected and pictured based on various medical imaging techniques. By using these images, the radiologist can able to observe, treat, and analyze the diseases in earlier manner. Various medical imaging techniques like Ultrasound (US), Magnetic Resonance Imaging (MRI), and Computerized Tomography (CT) are mostly used in the medical field. Compare to further medical imaging systems, ultrasound imaging is widely used to monitor the female reproductive system. The important parts of the female reproductive systems are the uterus and ovary [1]. The ovary generates ovum and female sex hormones. Each month, ovary releases an ovum for fertility and the ovum travels through the fallopian tube to uterus. In this journey, the ovum is fertilized by male sperm [2]. The females who under infertility treatment, their ovaries are frequently monitor to analyze the follicles growth. Based on the size of the follicles, the ovary is classified as normal and abnormal. Furthermore, the mode of treatment is decided based on the follicles details [3]. Hence, exact segmentation of follicles from ovary image is very important for accurate finding. In this paper, different image segmentation technique used for ovarian image segmentation is analyzed. The performances of the segmentation methods are evaluated and the results are compared to each other to obtain the better method.

The remainder of the paper is arranged as follows. Literature survey is presented in Section II. Different image segmentation techniques are described in Section III. Section IV depicts the experimental results of ultrasound ovarian image segmentation. Conclusion is derived in Section V.

II. Literature Survey

Potonick et al. proposed kalman filter for the segmentation of 2D ovary image [4]. Yinhui Deng et al. developed region growing algorithm for the detection of follicles to identify the Polycystic Ovary Syndrome (PCOS) in ovarian images [5]. PCOS generates infertility troubles in female. Hence, correct recognition of follicles reduces the misdiagnosis. The radiologist, sologist, and gynecologist manually measuring the follicle details from the image, moreover this manual detection process makes the patient to feel uncomfortable. Initially, the image was despeckled by adaptive morphological filter. Then labeled watershed algorithm is applied on the denoised image and finally region growing algorithm is used to calculate the cost map. Yinhui deng et al. used 31 ultrasound images for experimentation. This algorithm achieves the recognition rate of 89.4% [6].

Ultrasound imaging system is commonly used in the analysis of fertility problems. Ultrasound having speckle noise, contourlet transform is applied to denoise the speckle. Then edge based method is applied on the image [7]. To avoid problems in the edge based method P.S Hiremath et al. presented active contour without edges method for the segmentation of ovarian images. The output of the segmented result is compared with the human experts. Also, the author proposed optimal thresholding method for segmentation purpose [8].

III. Ovarian image segmentation

a. Region Growing

In image segmentation, various methods have been used to segment the images, and on this, Region growing is a method which examines the neighboring pixels in order to comprise it in the region class if no edges are noticed. Region growing is iterative method in which the initial seed point is chosen manually. The seed point has been a region or a single pixel. By using Region merging algorithm the frail edges are dissolved and the strong edges are left pristine. To meet the homogeneity criterion, the algorithm incorporates the neighboring pixels as many as possible. Subsequently, the segmented regions are extracted [9]. Properly selecting the

initial seed point leads to the accurate segmented output. Also, how the neighboring pixels are examined has decided the final results. Region growing algorithm not only based on the selection of homogeneity criterion, it also based on the kind of image to be segmented. Region growing algorithm yields the many advantages than other conservative segmentation methods [9]. But, the major disadvantage of region growing algorithm is that the wrong choices of seed point results in poor segmentation.

Region splitting:
Region splitting technique starts with a complete image and splits it into many parts. The divided parts are the more identical than the full image [9]. For accurate segmentation merging followed by splitting is significant and this is known as Split and Merge algorithm.

Region splitting and Merging
The region-splitting-and-merging method is as follows.

Splitting:
The whole image is represented by 'I' and the predicate p. In the splitting phase, the images segregated into smaller quadrant regions. The splitting is in the form of quad tree [9]. The final division has have neighboring regions with identical properties and this drawback is overcome by applying merging phase.

Merging:
The split and merging algorithm starts with the complete image and if the variance of the image is high it is then divided into quadrants [9]. If neighboring regions have similar, the regions are merged together. These steps are repeated until no more splitting and merging happens.

b. Edge detection Method
Significant changes in the images are identified by using Edge detection technique. The points where sharp changes in the brightness happen can be identified using intensity differences calculations in local image regions and the changes in the brightness occur typically form the border between different objects [9]. Neighborhood with strong signs of change is computed using edge detection algorithm. To calculate the intensity gradient at a point in the image, different edge detectors can achieve the effect.

In image analysis, edge detection is known to be an important fundamental technique. This method identifies the large variations in the intensity occurs and these changes have related with the physical edge in the images [9]. Medical imaging field uses the edge detection technique for tumor segmentation. It is also used in the image registration and object detection of the image.

c. Active Contour
Active contour model is based on energy minimization problem. This method has widely used in medical imaging field and this method can able to segment all type of images. For segmenting brain tumors the active contour methods are mostly preferred [10]. To solve the problem in easier way, the active contour is reformulated in the level set formulation. The level set method needs initial contour, the initial contour can be placed anywhere in the image [11].

IV. Results and Discussions

The testing have been executed on Hp Pavilion dv5 with Intel® Core™ 2 Duo CPU @ 2.00GHz with 3 GB RAM running on Microsoft Windows 7 platform. The algorithms are coded using Matlab 2012.

The real time images and the images collected through internet are used for experimentation. Region growing method, Edge based method, and Active contour methods are applied on both real time images and the image obtained from the net. Each method has its own merits and demerits. Edge based technique efficiently segment the follicles from the images collected from net. But, it fails to segment the follicle from real time images. Segmented result of the Edge based technique is shown in Fig. 1. Fig. 1(a) shows the original image and Fig. 1(b) displays the segmented output by edge based method. The edges of the detected follicle are shown in Fig. 1(c). In case of Region growing technique, the method segments the follicles from all type of images. But, the resultant image contains more background regions with the follicles. Furthermore, choosing of initial seed point is significant. Wrong choice of selecting seed point segments the regions other than follicles. Also, fully automatic segmentation techniques are needed for follicle detection. Region growing methods needed human interaction. This is the major drawback in region growing. The results of the region growing technique are given in Fig. 2. The original ultrasound ovarian image is shown in Fig. 2(a) and the segmented follicle is given in Fig. 2(b). The results show that the region growing algorithm results in oversegmentation. Similar to region growing, active contour method also needs initial position. This method also needs human interaction. Fig. 3(a) shows the original image. The active contour result is as seen in Fig. 3(b), and the edge of the follicle is shown in Fig. 3(c). The comparison results of the above mentioned three methods are shown in Fig. 4.

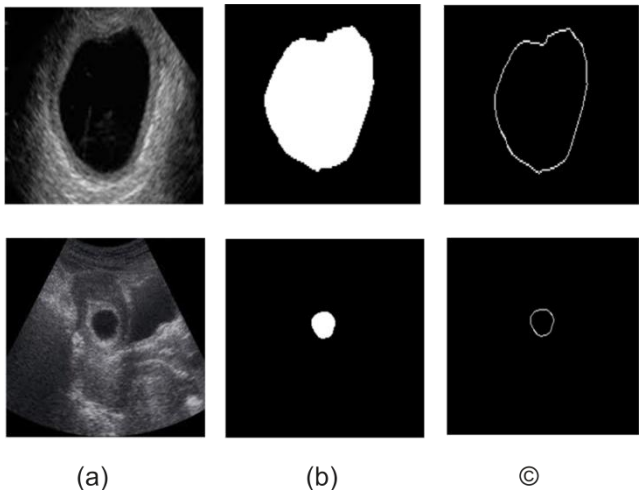

Fig 1. Segmented Result: Edge Based Method. a) Original image b) Segmented result c) Edge detected image

The Jaccard similarity coefficient is calculated from the output of various segmentation methods. Real time images are taken for testing. The output of the Region growing, Edge based method, and Active contour methods are compared with the ground truth. In this paper, the ground truth is

collected from expert radiologist. Experimental results show that the Active contour method performs better than the Region growing and edge based method. The Active contour achieves the maximum Jaccard Coefficient of 0.897.

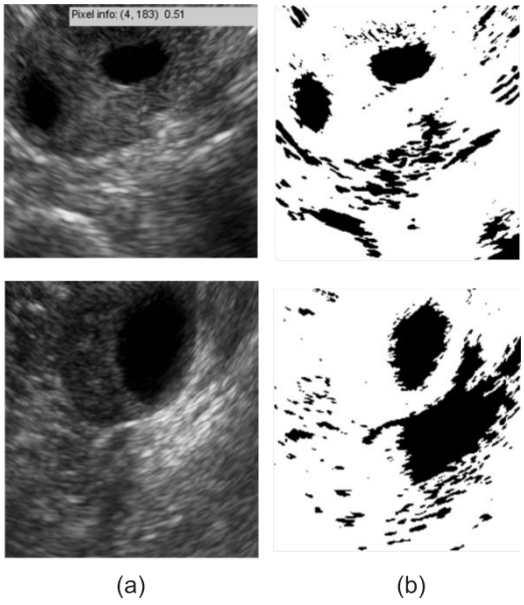

Fig 2: Segmentation result by Region Growing Method. a) Original image b) Segmented output

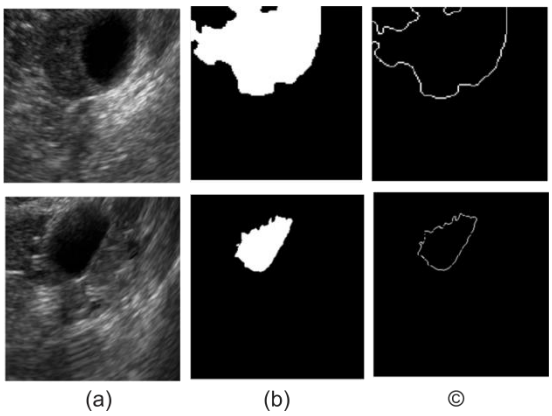

Fig 3. Segmentation Result: Active Contour Method. a) Original image b) Segmented result by active contour method c) Edge based method.

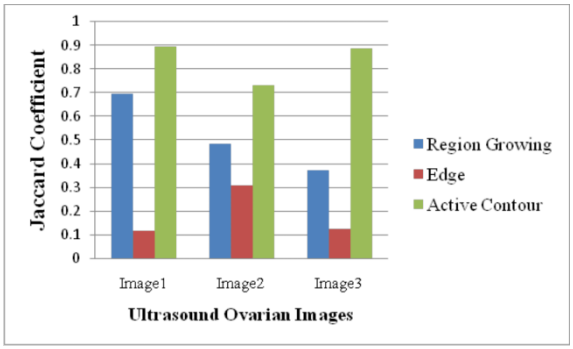

Fig 4. Jaccard simlarity coefficient for different image segmentation techniques

V. Conclusion and Future work

In the medical field, medical image segmentation is very significant for accurate diagnosis. In this paper, the image segmentation methods applied for ovarian image segmentation are considered. The Region growing, Edge based method and Active contour have been applied on ultrasound ovary images. From the results, the performances of the segmentation algorithms are evaluated. All the three algorithms are compared with ground truth value using Jaccard similarity coefficient. The results proved that the Active contour method produced better results. However, active contour method needs human interaction for initial position selection. Hence, a fully automatic segmentation is needed for ovarian image segmentation. In recent days, image segmentation is done mostly based on optimization techniques. In future, an efficient optimization algorithm will be developed for ultrasound ovarian image segmentation.

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