SEGMENTATION OF UTERINE FIBROID USING MORPHOLOGICAL OPERATION

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Abstract

Segmentation of Ultrasound image is an important task in medical imaging system. Ultrasound imaging is a common modality used for detecting fibroids. Fibroid is predominant among woman of childbearing age where the secretion of estrogen hormone is significant. The most crucial factor is that the presence of fibroid can cause infertility and repeated miscarriage. Automatic segmentation of ultrasound image is a difficult task as it suffers from speckle noise. This paper proposes a method based on MMIC (Modified Morphological Image Cleaning) algorithm for filtering, canny edge detector and morphology methods. The proposed algorithm was implemented in MATLAB. It also extracts the necessary features of the fibroid which can be used to prepare the radiological report.

Keywords: B-mode Ultrasound (US) Uterine Fibroid, MMIC, Morphology, Segmentation.

I. INTRODUCTION

Ultrasound is a simple, atraumatic and safe method of examination of diseases. It is used for imaging soft tissues in organs such as liver, kidney, uterus, and breast. Ultrasounds scanning are safety, cost effectiveness, speed, easy handling and portability. Ultrasound is based on the principle of sound wave echoes. Sound wave travels from the probe to the object, passes through it and is continuously reflected back to the probe from multiple points inside the object. Ultrasound involves sound wave of frequency in the range of megahertz; typically this ranges between 1-5 MHz. The reflected sound wave is converted back to electrical signals in the probe and transmitted to the processing device which displays the image on the monitor. Bright or white areas in the image represent high reflectivity or reflective surfaces/interphases in the body. Bone, air and calcium containing lesions (e.g. stone) appear intensely bright (whiter) or hyperechoic. Anechoic structures are usually filled structures like blood, urine, etc.

This paper proposed the segmentation of uterine fibroid image. Uterine fibroids are the most common pelvic tumors in females. It is also known as uterine leiomyoma. This originates from the smooth muscle layer (myometrium) and the accompanying connective tissue of the uterus. Most fibroids are asymptomatic; they can grow and cause heavy and painful menstruation, pelvic pain, urinary frequency and urgency, in some cases, infertility [1]. Various techniques for speckle noise removal are available in the literature [2-6]. There are many segmentation algorithms for segmenting medical images [7]. A region-based segmentation method for ultrasound images using local statistics [8] produces results that are less sensitive to the pixel location and it also allows a segmentation of the accurate homogeneous regions. A new automatic seed point selecting method for new region growing algorithm is proposed in [9] for breast lesions. There are a number of research work which use morphological segmentation [10-11]. Watershed based segmentation and Region merging was presented [12]. To solve the over-segmentation of watershed algorithm associated with this method, different techniques have been used [13-14].

Some of automatic approach for ultrasound image segmentation using canny operators [15-16]. Some papers on uterine fibroid segmentation using mathematical morphological segmentation [17-18].

The following of this paper is organized as follows. In Section II, the proposed scheme modules are details explained in details. The results of the scheme are shown in Section III. Conclusion and future work in section IV.

II PROPOSED METHOD

This paper is combined with the following series of steps to detect and segment the fibroid.

Step 1: Image Acquisition through ultrasound machine.

Step 2: MMIC filtering algorithm used to reduce speckle noise.

Step 3: Creating closed region of fibroid using morphological operation.

Step 4: Extracting the edge data.

Step 5: Creation of concrete contour of the fibroid.

Step 6: Overlapping fibroid contour on original US image.

In the following subsections, each step will be discussed in details and all the steps are combined as a pipeline for a whole scheme.

A. Image acquisition

Ultrasound imaging is widely used in the field of medicine. Fibroids are almost always benign (not cancerous). Any how the symptoms caused by fibroid may cause certain inconvenience in women which needs to be treated. The use of ultrasound in diagnosis is well established because of its noninvasive nature, low cost, capability of forming real time imaging and continuing improvement in image quality. US waves are characterized by frequency above 20 KHz which is the upper limit of human hearing. In medical US applications, frequencies are used between 500 KHz and 30 MHz B-mode imaging is the most used modality in medical US. An US transducer which is placed onto the patient's skin over the imaged region sends an US pulse which travels along a beam into the tissue. It is shown in Fig.1.

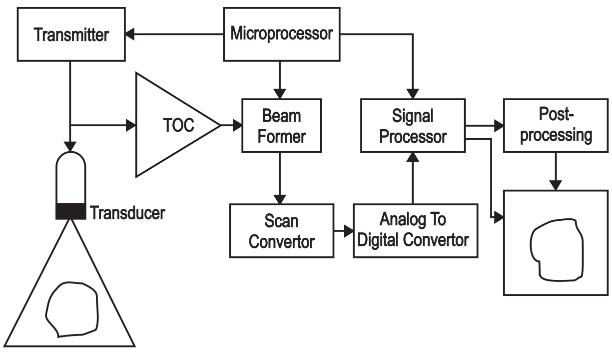

Fig. 1. Block Diagram of Acquisition of Image

Due to interfaces some of the US energy is reflected back to the transducer which converts it into echo signals. These signals are then sent into amplifiers and signal processing circuits in the imaging machine's hardware to form a 2-D image. This process of sending pulses launched in different directions is repeated in order to examine the whole region in the body.

B. Data source

The ultrasound uterine fibroid image is acquired from different patients in different hospitals. The database contains different cases that cover different types of abnormalities like submucosal, subsersoal. Every different abnormality indicator has different features in shape, brightness, size and distribution. Each image is accompanied with an expert radiologist diagnosis proved by a biopsy. The size of the image is 640 $\times$ 480 and it is reduced to 350 $\times$ 350.

C. Speckle reduction

US images have some inherent problems, including speckle noise and interference. Since the cleaning process takes much time the algorithm is modified such that it does less processing to get the result. First for filtering using a series of operation Opening, Closing, Closing, Opening (OCCO) the arbitrary structuring elements that resemble the shape of the speckle are used. The pre processing steps are shown in Fig.2.

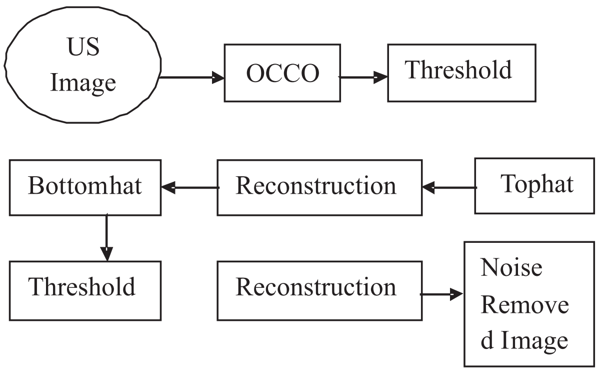

Fig. 2. Preprocessing steps

A speckle does not have regular shape. It is not appropriate to use predefined structuring elements like disk, rectangle, hexagon etc., for morphological processing. Therefore an arbitrary structuring element which resembles the speckle shape is designed. For this random speckle samples are taken from different ultrasound images and the structuring elements were designed as given in fig

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Fig. 3. Structuring Element

MMIC Algorithm

Step 1: Read the input image in the MATLAB.

Step 2: Convert the true color image into grayscale image.

Step 3: Initialize the structuring element.

Step 4: By using this structuring element a series of operation such as opening-closing followed by Closing-opening is done to remove noise.

Step 5: Top hat of the image is found by subtracting the original image with opening of the OCCO filtered image.

Step 6: Find the threshold value of the top hat image and binarized it using the standard deviation.

Step 7: Then reconstruct the image by closing of the binary image.

Step 8: Bottom hat of the image is found by subtracting the original image with closing of the OCCO filtered image.

Step 9: Find the threshold value of the bottom hat image and binarized it using the standard deviation.

Step 10: Then reconstruct the image by opening of the binary image.

Step 11: Add the input image with reconstruction of top hat image and subtract it with bottom hat image.

D. Morphological operations

Our aim is to find the contour of fibroid and segment the region enclosed by the boundary. Generally, OPENING smoothes the contour of an object, breaks narrow isthmuses, and eliminates thin protrusions. CLOSING tends to smooth sections of contours, as opposed to OPENING, and it generally fuses narrow breaks and long thin gulfs, eliminates small holes, and fills gaps in the contour. Therefore, in order to create concrete contour of the fibroid, CLOSING is reasonable. Gaps and holes in the plaque contour can be eliminated and sealed by using a morphological close function. Morphological operations like dilation, erosion, opening, closing [19] are used to extract the exact area of the fibroid. The following steps are used to extract the contour of the fibroid image. Binaries the noise removed image and apply erosion followed by dilation. Use the connected components to extract the area of the fibroid.

E. Edge detection

There are many edge operators such as Roberts, Prewitt, and Robinson. Edge-based techniques are computationally fast and do not require a priori information about the image content. Empirically, we found that Canny gave accurate representation of the true edge of the fibroid while helping eliminate the false lines due to speckle noise in the prior step of US images.

F. Image composition

The final contour is superimposed on the original US image. The desired segmented region can be selected and for further examined.

III RESULTS AND DISCUSSION

A whole scheme of our method was shown in the following pictures. (Fig.4.) The proposed method was implemented in MATLAB and tested on various fibroid images taken from different patient. The following images (Fig.5-9) show the algorithm works well in fibroid images.

Fig. 4. Original Image

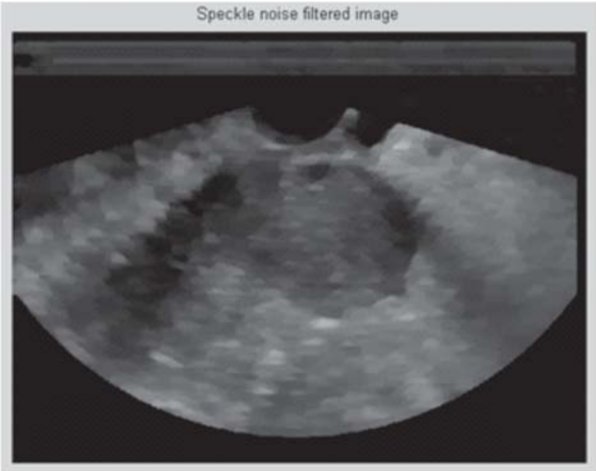

Fig. 5. Speckle Noise removed Image

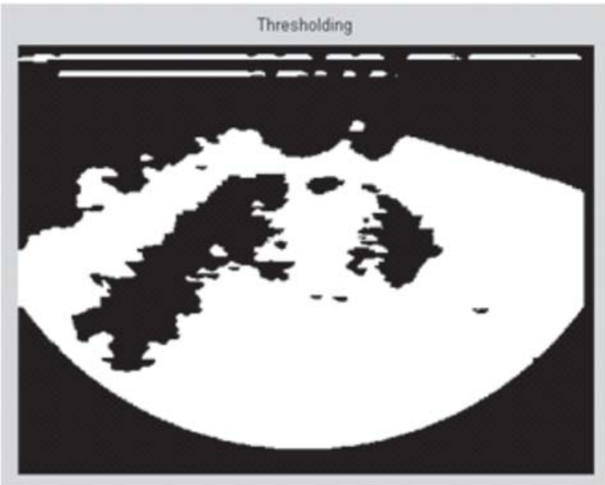

Fig. 6. Binarised Image

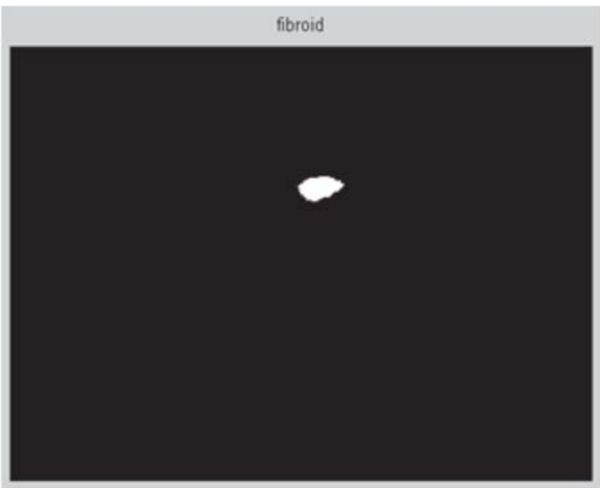

Fig. 7. Extraction of Area

Fig. 8. Fibroid Contour Extraction

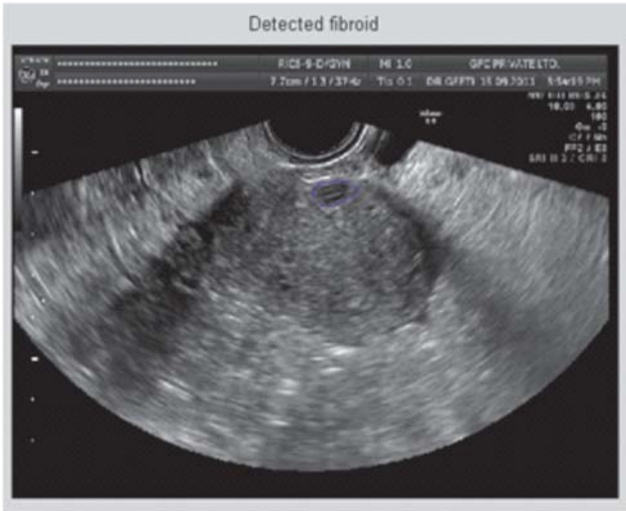

Fig. 9. Contour Imposed on Original Image

The area of the fibroid of different images were analyzed as shown below. Table and in Fig.10.

Table 1 Area of Fibroid

IMAGES	AREA
Image 1	1.7456
Image 2	2.6142
Image 3	1.9483
Image 4	1.7664
Image 5	2.4640
Image 6	2.0722
Image 7	2.0156
Image 8	1.3856
Image 9	1.2692
Image 10	2.7409

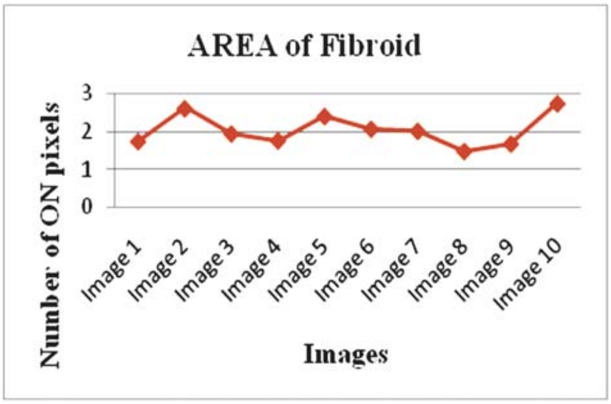

Fig. 10. Area of Fibroid

IV CONCLUSION AND FUTURE WORK

In this paper, an algorithm based on morphological operation is presented for the extractions of fibroid area were thus proposed. The method could extract the area of the fibroid based on canny edge detection and morphology methods. The subjective appearance of the output image was good. The performance of this algorithm was also good since it overcomes the over segmentation. There was no need to give the seed point to start segmentation. This method is useful for radiological planning of removal of fibroid. This automatic segmentation method will reduce the time of technicians to locate the fibroid on the screen. The algorithm is performed for 10 images to extract the features and it is more precise. The performance was done in MATLAB; it will be implemented in Lab VIEW in future.

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