Journal of Fiber Bioengineering and Informatics 8:2 (2015) 277–284
doi:10.3993/jfbim00101

Multi-threshhold Ultrasound Image Segmentation Based on Potential Function Clustering*

Bo Peng*, Fuliang Zhang, Xianfeng Yang

School of Computer Science, Southwest Petroleum University, Chengdu 610500, China

Abstract

Ultrasound image segmentation is an important task for clinical diagnosis. In this study, a multi-threshhold segmentation approach was proposed to enhance ultrasound image segmentation accuracy. More specifically, the proposed multi-threshhold segmentation approach, combining an opening-closing morphological filter and potential function clustering theory, attempted to provide better ultrasound image segmentation visibility. This proposed approach was tested using computer-simulated images and in *vivo* images. Computer simulation results demonstrated that the method significantly improved the accuracy of image segmentation. From in *vivo* images investigation, we have found that, as compared with the original images, better segmentation visibility were obtained. Our initial results demonstrated that this method could be useful for improving the segmentation quality of ultrasound images as a post-processing tool.

Keywords: Ultrasound Image Segmentation; Morphological Reconstruction Filter; Histogram Potential Function; Multi-threshhold Segmentation

1 Introduction

Ultrasound imaging is playing an increasingly important role in clinical diagnosis. Among the main imaging modalities in clinical diagnosis, ultrasound imaging is the most growth potential imaging modality due to its non-invasive nature, ability to image in real time and low cost. Ultrasound image segmentation is a very popular field in medical ultrasound image post-processing and the quality of segmentation can directly influence the accuracy and effectiveness of the image for clinical diagnosis.

Factors such as speckle characteristics [1], complex human tissue structures, and various pathological process that may lead to poor quality in the imaged tissues. They also increase the difficulty of medical ultrasound image segmentation. Although there are many image segmentation algorithms currently in use, it is becoming clear that none of the existing algorithms can meet all the requirements of medical ultrasound image segmentation. In order to achieve higher

*Project supported by the Scientific Research Starting Project of SWPU (No. 2014QHZ023).
*Corresponding author.
Email address: bopeng@swpu.edu.cn (Bo Peng).

accuracy and speed, more users are adopting novel methodologies in medical ultrasound imaging as well as a variety of methods for specific applications [2–4].

Based on the characteristics of ultrasound images, this paper proposes a novel multi-threshhold segmentation algorithm, which combines a morphological reconstruction filter and the potential function clustering. First of all, the morphological reconstruction filter was applied for speckle reduction in the image. Then, the potential function clustering was used to process multi-threshhold segmentation according to inherent statistics features of the ultrasound image.

2 Method

2.1 Opening-closing Morphological Filter

The opening-closing morphological filter [5] is an important nonlinear filter used to extract and analyze target information. The main advantages of this filter include: no production of false edges and new noise, ability to maintain the basic shape and edge of the target, and small influence on the contours of the target. The opening-closing morphological filter can remove irrelevant details, maintain the feature information of the target image and simplify the image at the same time. So, we selected the opening-closing morphological filter for pre-processing in this paper.

The key part in designing the morphology of the opening-closing reconstruction filter are the selection of the structural elements and mark image. In this paper, the structural element we chose is a disk. This is because the disk will not lead to eigenvalue aberration when the image rotates, therefore it will prevent the geometrical shape from changing. In order to improve the algorithm's de-nosing ability, our proposed method uses two different kinds of structural elements for the opening and closing reconstruction operation. For the selection of the mark image, we used the image produced by the erosion operation as our initial mask image, because the mask image should fully reflect the feature. The specific processes for the opening-closing morphological filter in this paper are as follows:

1) Select the structural element. In this paper, the specific sizes of the structural elements (SE1, SE2) are decided by the noise in the image and the requirements in practical clinical diagnosis. Generally, we use smaller structural elements when the noise is lower and more details need to be preserved. But if the noise is higher or we want to make the contour features more prominent, we must use a larger structural element.

2) Erosion operation. Perform the erosion operation for initial image according to the SE1.

3) Opening operation. Set the erosion operation-processed image as the mark image and the original image as a mask image, perform the opening reconstruction operation.

4) Dilation operation. Use the SE2 to perform the dilation operation for the processed image by opening operation.

5) Closing operation. Perform the closing reconstruction operation for the processed image by dilation operation.