AN IMAGE PROCESSING TOOL FOR ULTRASOUND DECISION SUPPORT SYSTEM

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Abstract. This paper presents a software tool, which assists the physician-ecographist to retrieve substantial information from ultrasound images. Being a part of information system in ultrasound diagnostics, it permits one to obtain some statistical descriptors, which are necessary for image clusterisation in image database. All algorithms were tested on the gall-bladder ultrasound images. The comparative analysis of the results is presented.

Keywords – ultrasound diagnostics system, image processing, segmentation methods.

INTRODUCTION

Ultrasound is a widely available technique of diagnostics providing simplicity in use, low cost and ability to visualize anatomy in real-time. In [6] we prove the necessity of the elaboration of an Ultrasound Decision Support System. Image interpretation task, which includes the ultrasound image processing, is an important part of our diagnostics system.

Besides its advantages the ultrasound method has a serious drawback – ultrasound images are often affected by noise, possess poor contrast, and suffer from variations in illumination that result in masking the regions of interest [8].

Developing the system for both an experienced ecographist and inexperienced one, we put as the main scope quick and relevant image retrieval. Therefore, our system will achieve two kinds of images – the original image and the processed one. This processed image can be obtained as a result of the application of image processing operations.

Image clusterisation. All images from database are classified depending on the organ diagnosis, basing on organ characteristics, which are determined by a physician-ecographist. In gall-bladder investigation these characteristics are – the location, form, tonicity, countur and others. Such a classification helps one to extract images from image database, which have the same characteristics as the current (investigated) image. So, in the simplest case images from database can serve as “well done” illustrations for some fixed organ diagnosis.

Another clusterisation will help in classification of images depending on image statistics with the purpose of image query (where query is itself an image). It is necessary to specify the region of interest, then will be computed the distance between the query image and the images in the database. The advantage of the statistical descriptors is that they are direct image related and independent of the specific physician’s experience. An efficient iterative clustering method of ascendant hierarchical classification, which can be applied in the case of quantitative descriptors, is described in [5].

RESULTS AND DISCUSSION

Image processing methods and results. The creation of our software tool for ultrasound image processing is aimed to accomplish the following principle tasks: 1. noise reduction; 2. contrast adjustment; 3. borders and organ contours determination; 4. structure and texture analysis. First two tasks are directed to improve general image aspect. Automatic image segmentation with borders detection helps to avoid manual time-consuming and tedious work, which requires expert knowledge; while structure and texture analysis is useful in detecting pathology (e.g. tumors and cysts).

There are a number of image processing methods, many of them being problem-specific or organ-specific oriented. We suppose that an 'ideal' segmentation algorithm must incorporate many families of the image models. So, we press towards implementation of different segmentation methods, and their combination will provide the acceptable results for every specific organ.

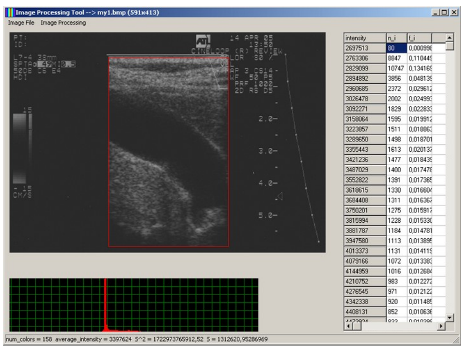

Figure 1. Image Statistics submenu (with specified region of interest).

Image Statistics. This submenu (Figure 1) gives the useful statistical representation of the loaded ultrasound image, e.g. histogram of frequency, average and standard deviation of the image intensity. In the case of complex images which may consist of up to 256 gray levels, the resulting histograms will consist of many peaks. The distribution of these peaks together with the magnitude can reveal some significant data about the information content of the image.

Noise Reduction. Speckling presented in ultrasound images make accurate segmentation difficult, therefore noise reduction step is performed usually in the beginning. Gaussian and median filters were used with success in [8] for fetal ultrasound image smoothing. Currently we have realized this task by using *Neighborhood Averaging Algorithm* and *Median Filter* [5]. For ultrasound images the averaging filter gives sometimes not better and often quite worse image, than the original one.

Contrast Adjustment. This approach renders the image more acceptable for the eye. We have implemented two methods to perform this task. *Thresholding of Intensity* is often used as an initial step in a sequence of the image processing operations. The effectiveness of the method depends on the histogram of the gray level distribution on the original image. This technique was successfully used to segment ovarian cysts [4].

Another method of contrast enhancement is the *Histogram Equalization*. This process increases the dynamic range (the ration between the minimum and the maximum of intensities) of intensities.

Borders and Organ Contours Determination. This task is quite difficult one for ultrasound images. Automated segmentation is used with possibility of the initial learning [1] or in combination with genetic algorithms. Another interactive approach is more frequent, when physician-ecographist has possibility to determine the region of the interest [2]. Thus, we have implemented some different algorithms.

Region Growing technique may be used for delineation of small and simple structures as tumors and lesions. Usually it is used within a set of image processing operations. The major disadvantages of this algorithm are that it requires the initial point to be manually selected and it is sensitive to noise. *Split and Merge Algorithm* does not require the initial point, so it can be used for "ideal" automated functioning. For the gall-bladder images these techniques give the promising results (after initial noise reducing).

Deformable models can be applied for boundary detection using closed parametric curves [4]. It is an interactive technique too, because close curve (circle) must first be placed near the desired boundary. The advantage of this algorithm is that it is robust to noise. Deformable models, which have good success in the segmentation of prostate boundaries [3], were used to determine boundary of the fetus and the fetus head respectively [7].

CONCLUSIONS

The software tool for ultrasound image processing represents a part of the information system in ultrasound diagnostics. In its current state it puts at disposal some basic techniques for image processing. In what follows we plan to include more methods, and their combination will provide the acceptable results for every specific organ.

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