ULTRASOUND MEDICAL IMAGES ENHANCEMENT ON THE BASE OF MORPHOLOGICAL PROCESSING

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Abstract

In the paper is presented an approach for ultrasound (US) medical images enhancement. The purpose is to demonstrate some techniques that enhance the appearance of US Images, including the nonlinear morphological filtering of single images to reduce noise and to solve complex problems with shape and contours of objects.

The post-processing of US images consists the following basic stages: changing the brightness of the image by equalization of the global histogram and contrast increasing by gamma correction of the obtained image. This increases the contrast of the small details in the investigated object. As next step is proposed selecting the region of interest (ROI) in the object and morphological processing of the selected ROI. The aim of algorithms, based on morphological operators, is noise suppression and detail preservation abilities of the selected ROI of US image. Some results of the experiments are presented, which are made by computer simulation in MATLAB environment.

1. INTRODUCTION

Due to its non-invasive nature and easily portable devices, ultrasound imaging is nowadays used for the diagnostic and clinical studies of many diseases. The quality of US images is very important by detection of some pathological modifications in a body structures and tissues.

The paper presents an approach for post processing of US image with the aim to improve its quality. For this is performed contrast preprocessing and detail preservation. The problem is solved changing the brightness of the image by equalization of its global histogram, following by gamma correction. For make best diagnosis is possible to select a region of interest of the object and detail preservation abilities on the base of morphological processing of the selected ROI [1], [2]. By properly choosing of dilatation, motion blur filtration and top & bottom hat filtration and suitable form of structuring element, local structures can be eliminated or local geometry of the investigated object can be modified. In the paper are analyzed some quantitative estimation parameters: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR) [3].

2. BASIC STAGES FOR US IMAGES ENHANCEMENT

The proposed image enhancement techniques are applied to real digital US images of the heart and abdominal tissues. US images processing consists of three basic stages, used to improve the image quality.

The first stage is increasing the contrast. For that step is necessary to increase the brightness of the image by equalization of its global histogram. The original images are presented in RGB system. The US apparatus work in this system. It is proposed with this approach to make the processing in YUV system for more effectiveness. So the procedure can be applied to Y decomposed component of the image. In addition the contrast can be adjusted by gamma correction of the processed Y component [3]. These operations increase the contrast of the small details in the investigated object.

The second stage in the processing is to define a ROI from the image. It can be selected in

interactive procedure from the operator (physician). The result of ROI image is written in file format that can be used in next processing.

Stage three includes morphological filtering by mean of three different morphological operators: dilation, motion blur filtration and top & bottom hat filtration. The morphological operators are compared together and one of them is estimated as a most effective method [5]. The top & bottom hat method is a well-suited. It increased the contrast of the object by means of increasing the details in the dark regions and near by contours. The top & bottom hat filtering extracts the original image from the morphologically closed version of the image. For this operation is studying the influence of three different flat structuring elements: line, disk and diamond. On the base of some quantitative estimations as: coefficient of noise reduction (CNR) signal to noise ratio in the noised image (SNR_Y), signal to noise ratio in the filtered image (SNR_F), effectiveness of filtration (E_{FF}), peak signal to noise ratio (PSNR) is selected a well-suited structuring element for US images. This algorithm includes following steps:

- Reading the ROI image and displaying it;
- Creating a flat structuring element, needed for morphological processing;
- Adding the original selected image to the top-hat filtered image, and than subtracting the bottom hat filtered image;
- Displaying the visual result of filtration;
- Determination of the quantitative estimations;
- Estimating the well-suited structuring element by minimum value for CNR and maximum values for PSNR and E_{FF} ;
- Writing the processed image in file format for next processing or data base preservation.

3. EXPERIMENTAL RESULTS

The formulated stages of processing are realized by computer simulation in MATLAB 7.2 environment by using of IMAGE PROCESSING TOOLBOX. IN experiments are used 20 real US images different file format: jpeg, tiff and bmp, but all of them are converted into bmp.

The obtained average results from the simulation are presented in Table 1.

Table1. Simulations results

Morphological Operations	PSNR [dB]	CNR	SNR_Y [dB]	SNR_F [dB]	E_{FF} [dB]
Top & Bottom Hat	26,3918	0,3617	15,5875	16,7779	1,1904
Dilatation	20,6402	0,8826	13,6167	14,3440	0,7273
Motion Blur	11,2418	0,1268	5,3170	6,2205	0,9035

The best results are obtained with the line structuring element in morphological processing. The values of PSNR and Effectiveness of filtration (E_{FF}) are maximum by use of top & bottom hat morphological operation. The value of CNR is 0.3 and shows that the noise is three times reduced. The graphical presentation of the PSNR-results for the three different morphological operations is shown in Figure 1. Figure 2 illustrates the diagram of E_{FF} and Figure 3 presents the diagram of CNR. On Figure 4 are illustrated the original (left) and brightness increased US image (right). Figure 5 presents original selected ROI of the image. In Figure 6, Figure 7 and Figure 8 are illustrated its morphological modifications by means of the three methods. It is shown the visible difference between the original and processed ROI, which is a result of the most effective morphological operation, applied to the image.

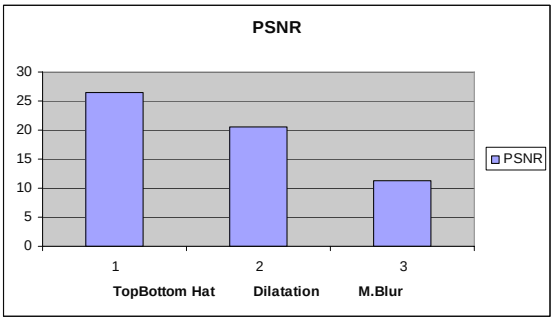

Figure 1. Diagram of PSNR in dB

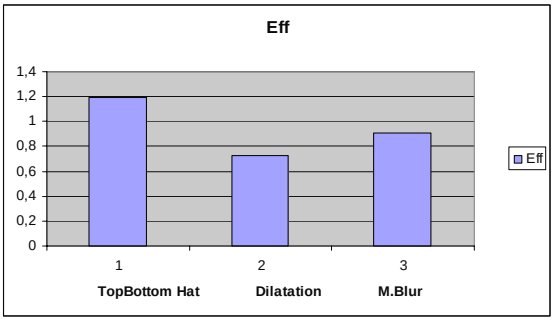

Figure 2. Diagram of E_{FF} in dB

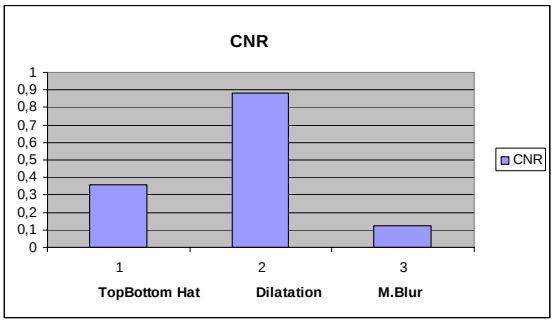

Figure 3. Diagram of CNR

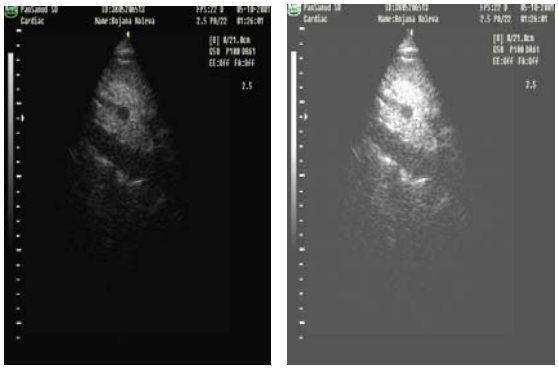

Figure 4. The original and the brightness increased US image

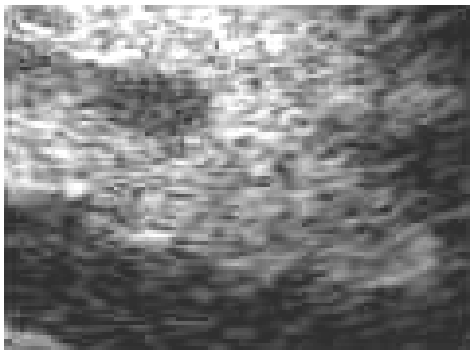

Figure 5. Selected ROI image

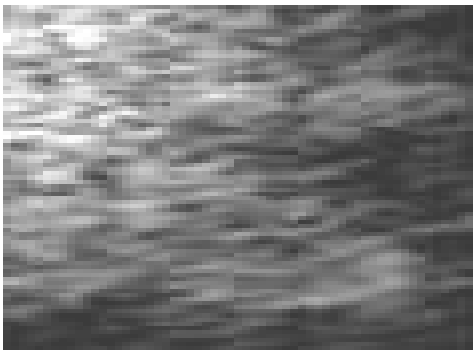

Figure 6. Processed ROI image by motion blur operation

Figure 7. Processed ROI image by dilatation

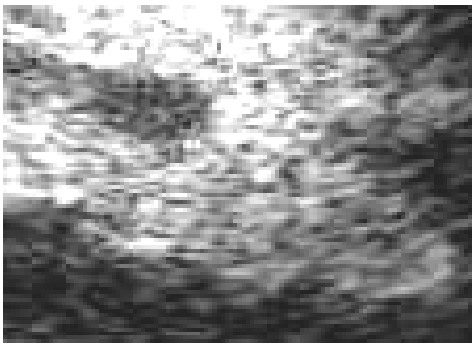

Figure 8. Processed ROI image by top & bottom hat operation

4. CONCLUSION

In the paper is proposed a new and effective approach for US image enhancement. The complex processing has an effect of brightness and contrast enhancement, and contours determination of objects for selected ROI of different parts of medical diagnostic US images. The implemented studying and obtained results by using of real images attempt to make diagnostic more obvious.

5. ACKNOWLEDGMENTS

I acknowledge to physicians from the Medical Center PanSanus, Sofia for providing of all ultrasound image data used in experiments and shown also in Figure 1.

References

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