Denoising Of Ultrasonographic Images Using DTCWT

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ABSTRACT

Digital image acquisition and processing pays a very important role in current medical diagnosis techniques. Medical images are corrupted by noise in its acquisition and transmission process. Ultrasound has historically suffered from an inherent imaging artifact known as speckle. Speckle significantly degrades the image quality. It makes it more difficult for observer to discriminate fine details of the images in diagnostic examination. Dual tree complex wavelet transform is an efficient method for denoising of ultrasound images. It not only reduces the speckle noise but also preserves the detail features of image. In this paper denoising of ultrasound images has been performed using Dual tree complex wavelet transform. In experimental analysis, it is found that the performance in terms of PSNR for a set of acquired medical images brain and mammogram is better with DTCWT as compared to the performance with DWT.

Keywords

DTCWT, Medical image, PSNR, speckle, ultrasound.

1. INTRODUCTION

Medical images are usually corrupted by noise during their acquisition and transmission. Noise tends to degrade the resolution and contrast of ultrasound images. It may lead to elimination of some useful and important diagnostic information. The main objective of image denoising techniques is to remove such noises with the retention of information signal. Speckle cannot be directly correlated with specific reflectors or cells, in the body. It is necessary to analyze an ultrasound system to understand the origins of speckle. Various techniques have been raised for the ultrasound denoising. Conventional speckle suppression methods are based on temporal averaging and median filtering. The adaptive filters are widely used in ultrasound image restoration because they are easy to implement and control. the Speckle Reducing Anisotropic Diffusion (SRAD) was introduced and involves a noise-dependent instantaneous coefficient of variation [1] ,[2]. The adaptive weighted median filter [3] can reduce speckle but it does not preserve useful details such as edges of the image properly. The dual-tree complex wavelet transform (DTCWT) is a relatively recent enhancement to the discrete wavelet transform (DWT), with important additional properties; it is nearly shift invariant and directionally selective in two and higher dimensions. It achieves this with a redundancy factor of only 2d for d-dimensional signals. It is substantially lower than the undecimated DWT. This is an appropriate method for speckle reduction which enhances the signal to noise ratio while conserving the edges and lines in the images.

2. TOOLS AND METHODOLOY

Dual tree complex wavelet transform is preferred to improve the human interpretation of ultrasound images. Speckle reduction makes an ultrasound image cleaner with clearer boundaries. Despeckling is a preprocess step for many ultrasound image processing tasks like segmentation and registration. Speckle reduction improves the speed and accuracy of automatic and semiautomatic segmentation & registration. In this paper for the despeckling of ultrasound images, the wavelet transform has been proved a more effective tool than the Fourier transform. The discrete wavelet transform lacks the shift-invariance property, and in multiple dimensions it does a poor job of distinguishing orientations, which is important in image processing. For these reasons, to obtain some applications improvements, the Separable DWT is replaced by Complex dual tree DWT which has been done by using self build function. The peak signal-to-noise ratio (PSNR) and mean square error (MSE) are the parameters that have been used to compare the performance of DWT & DT-CWT.

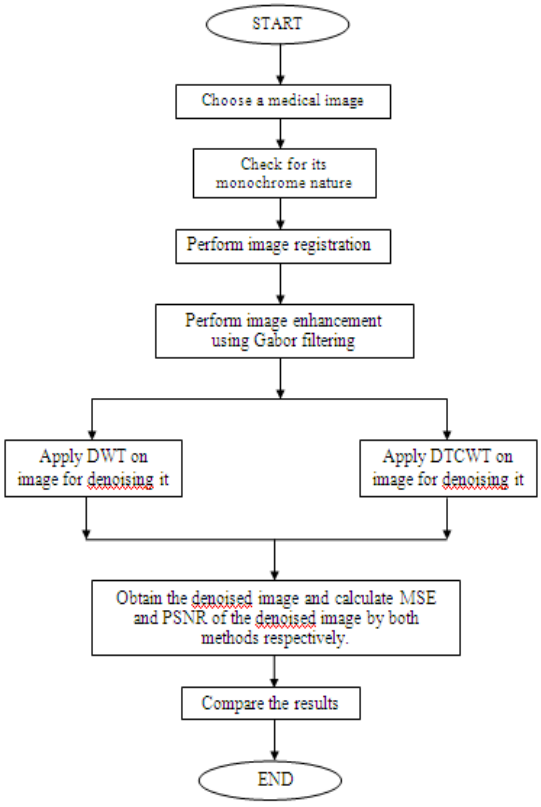

Fig 1. Flow chart for dual tree complex wavelet transform

Table 1: Calculated MSE and PSNR values for image of Brain

PERFORMANCE PARAMETERS	WAVELET TRANSFORMATION METHODS	
	DWT	DTCWT
MSE	0.252252	2.2483
PSNR	54.1419	81.8521

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The flowchart for the DTCWT to despeckle the noise in medical images is given in Fig. 1.The term MSE is the difference between the original image and the recovered image and it should be as low as possible. It is given by;

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (1)$$

The term, PSNR, is the ratio between the maximum possible power of a signal and the power of corrupting noise signal. The PSNR is defined as

$$PSNR = 10\,Log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20.log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \quad (2)$$

where, MAXI is the maximum possible pixel value of the image. Matlab as a toolbox is used for ultrasound image despeckling. Testing is made on a set of medical images.

3. RESULT

The analysis has been carried out in terms of PSNR and MSE. The calculated values of both these parameters for the image of brain are given in table 1 On comparison of the performance parameters, MSE and PSNR shown in table 1, it is found that DTCWT is more robust and efficient than DWT. The Simulation results of applying DWT and DTCWT on image of brain are shown in Fig. 2

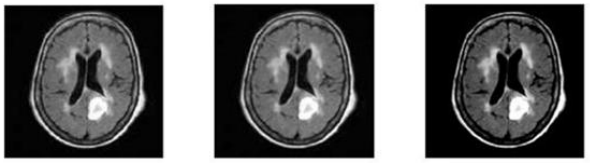

Image after registration (a) Denoised image DWT (b) Denoised image using DTCWT (c)

Fig.2. Simulation results of applying DWT and DTCWT on image of brain.

Table 2: Calculated MSE and PSNR values for image of mammogram

PERFORMANCE PARAMETERS	WAVELET TRANSFORMATION METHODS	
	DWT	DTCWT
MSE	0.099319	3.4424
PSNR	58.1945	89.992

The calculated values of MSE and PSNR for the image of mammogram are given in table 2.On comparison of the performance parameters, MSE and PSNR shown in table 2, it is found that DTCWT is more robust and efficient than DWT. The Simulation results of applying DWT and DTCWT on image of mammogram are shown in Fig. 3.

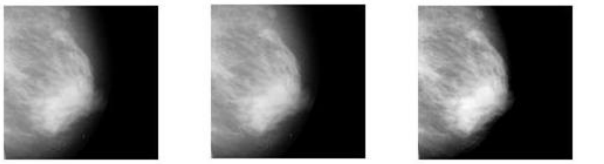

Image after registration (a) Denoised image using DWT (b) Denoised image using DTCWT (c)

Fig.3: Simulation results of applying DWT and DTCWT on image of mammogram

4. CONCLUSION

Speckle reduction improves the speed and accuracy of automatic and semiautomatic segmentation & registration. In this paper despeckling of ultrasound images has been performed using Dual tree complex wavelet transform. This transform has been proved that an efficient technique for the required purpose. From the experimental results it is concluded that the performance in terms of PSNR and MSE for a set of acquired medical images is better with DTCWT as compared to the performance with DWT.

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