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Medical Image Denoising and Enhancement using DTCWT and Wiener filter

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ABSTRACT

Image denoising is the process to remove the noise from the image which contains noise. Wavelet transform technique is a unique mathematical manipulation framework used for medical image denoising and enhancement implementation. The wavelet techniques are effective to remove the noise due to their ability to capture the energy of a signal in a few energy transform values. A dual-tree complex wavelet transform is used to present the image enhancement process. The proposed technique has the cascaded structure of DTCWT used for generation of different frequency bands for analysis. In this paper, a denoising approach based on dual-tree complex wavelet and Wiener filter technique is used. The result has a better balance between smoothness and accuracy than the DWT and is less redundant than SWT. We used the SIM (Structural Similarity Index Measure) along with PSNR (Peak Signal to Noise Ratio) to assess the quality of denoised images.

Keywords: *Image Enhancement, DTCWT, PSNR, MSE, Interpolation, SSIM, Filter*

1. INTRODUCTION

Nowadays the quality of digital medical images becomes an important issue. To achieve the best diagnosis it is important that medical images should be sharp, clear, and noise free. Removal of noise is effective in medical imaging applications in order to enhance and recover very minute details which may be hidden in the data.

During transmission and reception, images are usually affected by noise which cannot be easily eliminated in image processing applications. This appears owing to the real signals getting corrupted by unwanted signals. These noises occur as random black and white snow-like patterns on screens. The purpose of the de-noising algorithm is to remove such noise. Image de-noising and image enhancement appear to be the same. But both are entirely different processes. Enhancement of an image is an objective process, whereas de-noising of an image is a subjective process.

In image de-noising by using prior knowledge of the degradation process attempts are made to recover the degraded image. Image enhancement does manipulation of the image characteristics to make it more appealing to the human eye. Image de-noising techniques are broadly classified into spatial domain and transform domain techniques. The spatial domain techniques use simple spatial filters such as Lee, Kalman, foster, median, mean filters etc. In this technique, data operation is carried out on the original image by processing the grayscale value.

In this paper, we have proposed a modified technique which is based on dual-tree complex wavelet transform and interpolation. The main focus is to enhance the resolution of a low-resolution medical image. After obtaining the high-resolution output image, classification results and various quality assessment parameters like PSNR, SSIM, and MSE are used to test this resolution enhancement technique.

1.1 PSNR, MSE, SSIM

1.1.1 PSNR: PSNR stands for peak signal to noise ratio, is a ratio between the maximum power of a signal and the power of corrupting noise that affect the fidelity in the image signal. It is generally measured in decibel scale as the signals are having wide dynamic range. Higher the value of PSNR indicates that the image reconstruction is of higher quality. Mathematically the PSNR in terms of MSE can be given as:

PSNR = 10 log10 (MAX2 i) \ MSE

Where, the MAX is the maximum possible pixel value present in the image.

1.1.2 SSIM: Structural Similarity Index Module (SSIM) is again a perceptual metric that quantifies the image quality degradation caused by processing images. It is a full reference metric that requires two images from the same capture.

1.1.3 MSE: Mean squared error is used to determine the quality of the image. It is another parameter to check the quality of the reconstructed image.

1.2 Wavelet transform

A wavelet transform is a tool that cuts up the data, function or operation into different frequency components and then studies each component with a resolution matched to its scale.

The generalized form of Wavelet Transform is given by:

$$f(a,b) = \oint_{-\infty}^{\infty} f(x),\ \varphi^{*}(a,b)(x)dx$$

Wavelet is a mathematical function that divides the data into different frequency components where each component are a scaled version of some predefined sample signal called basis functions. these basis functions are having limited duration called wavelet. these basis functions are scaled with respect to frequency.

Various sample signals in wavelet collectively called wavelet family. Many of the wavelet families are proven to be very useful. Wavelet families are Daubechies, Haar, symlet, biorthogonal, morlet, Mexican hat.

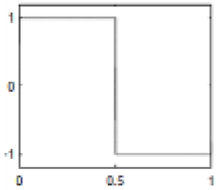

Fig. 1: Haar

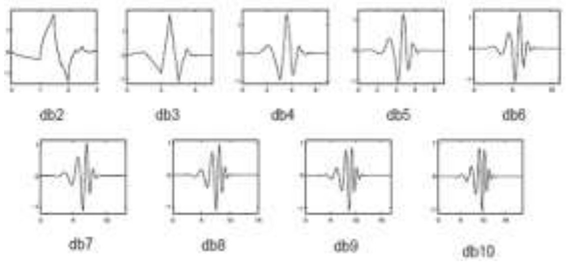

Fig. 2: Daubechies

1.3 Dual Tree Complex Wavelet Transform

Dual-Tree Complex Wavelet Transform obtains complex coefficients further obtained their real parts and imaginary parts. The DTCWT have properties of shift invariance and good directional selectivity. These two properties are important for many applications in image processing i.e. denoising, deblurring, super-resolution, watermarking, segmentation and classification. It is a filter bank structure formed by using a parallel combination of two DWTs. This combination can be used into multiple levels like 1 level, 2 level, 3 level and so on where the parallel combination is arranged in tree form.

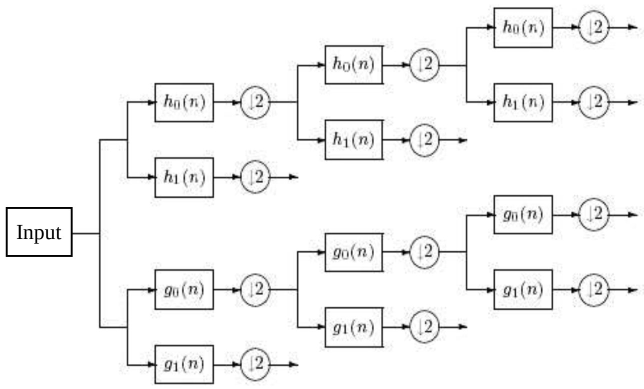

Fig. 3: Dual-Tree Complex Wavelet Transform

1.4 Image Interpolation

Image interpolations [5] based resolution enhancement increases the number of pixels in the images, there are three main techniques i.e. nearest neighbor interpolation, bilinear interpolation and bi-cubic interpolation. The application of these methods results in the softening of edges, creating a blurring effect on the image.

A bi-cubic interpolation is an extension of cubic interpolation for interpolating data points on 2D regular pixel grids. The bi-cubic interpolation results much smoother image results than bilinear and nearest neighbor interpolation. In the bi-cubic, the average value of the interpolated pixel is calculated using surrounding 16 pixels in a grid image.

1.5 Wiener Filter

The Wiener filtering executes an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously. The Wiener filtering is optimal in terms of the mean square error. In other words, it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. The Wiener filtering is a linear estimation of the original image. The orthogonality principle implies that the Wiener filter in Fourier domain can be expressed as follows:

$$W(f_1,f_2) = \frac{H^{*}(f_1,f_2)S_{xx}(f_1,f_2)}{|H(f_1,f_2)|^2 S_{xx}(f_1,f_2) + S_{\eta\eta}(f_1,f_2)}$$

2. PROPOSED SYSTEM

Any de-noising algorithm that uses the wavelet transform consist of three steps: first calculate the wavelet transform of the noisy signal image, modify the noisy wavelet coefficient according to some value and finally compute the inverse transform using the modified coefficients. We decompose the Low Resolution (LR) input images into different frequency sub-bands using six decomposition level. These sub bands are high frequency and low-frequency sub bands. These sub bands are assigning the values that are the wavelet coefficients of the respective frequency bands.

In case of multichannel case, each channel is separately treated. these sub bands are applied to a de-noising filter called wiener filter used to remove noise present in the input database. The wiener filter output is then applied to inverse Dual tree complex wavelet transform to recover the distortionless image. After the de-noising process, the input image is once again applied to the dual-tree complex wavelet transform for decomposition into frequency sub-bands for enhancement purpose. These sub bands are then applied to image interpolation. These sub bands after interpolation applied to the inverse dual-tree complex wavelet transform to get final enhanced output image.

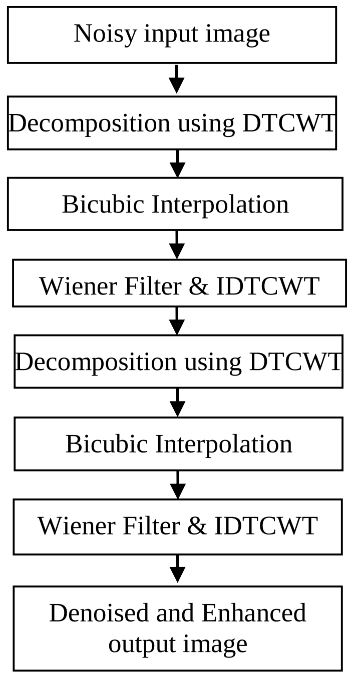

Fig. 4: Image Enhancement Model

3. RESULT

To implement the image enhancement for medical input images a cascaded form of two dual-tree complex wavelet transform structure along with image interpolation and Wiener filter is used.

Some of the input images taken are as follows:

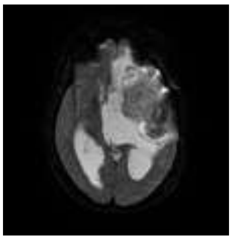

Fig. 5: Input Image 1

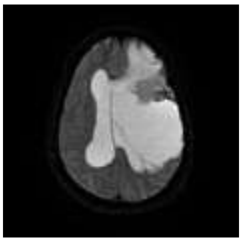

Fig. 6: Input Image 2

The output of image 1 is shown below:

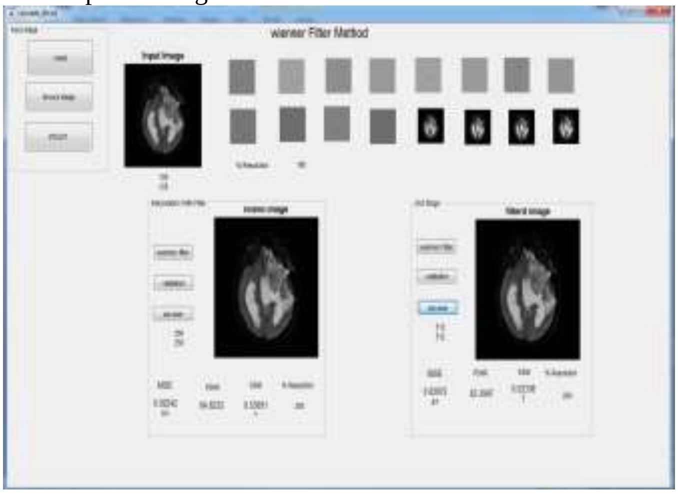

Fig. 7: Output image

4. OBSERVATION TABLE

Table 1: Stage I observation table

Stage I			
Input_Image	**MSE**	**PSNR**	**SSIM**
A	0.02342	64.8732	0.52091
B	0.01902	65.3373	0.52008
C	0.03244	65.4303	0.46431
D	0.01191	64.1398	0.57501
E	0.01813	65.5465	0.48042

Table 2: Stage II observation table

Stage II			
Input_Image	**MSE**	**PSNR**	**SSIM**
A	0.02862	63.9897	0.53
B	0.02609	63.6502	0.52905
C	0.02709	64.9824	0.4617
D	0.03624	62.288	0.5796
E	0.02605	63.9712	0.46032

5. CONCLUSION

It is concluded that the results obtained from the implemented DTCWT structure have better image quality formation than that of other methods.

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7. REFERENCES

[1] Du-Yin Tsai, Yongbum, "A Method of Medical image enhancement using wavelet coefficient mapping function" department of radiological technology, 2014

[2] S.Arulmozhi1, D.N.Keerthikumar,"Noise Reduction of Enhanced Images Using Dual-Tree Complex Wavelet Transform and Shrinkage Filter" Vol. 4, Issue 5, May 2015

[3] Vineet vilas naik, Dr. saylee Gharge, "Satellite image resolution enhancement using DTCWT and DTCWT based fusion", a conference on advances in computing, communication and informatics ICACCI, sept 21-24, 2016.

[4] P. Karunakaran, V. Praveen, "Discrete wavelet transform based satellite image resolution enhancement" advances in electronics and electrical engineering, ISSN 2231-1297, vol 3, 2013.

[5] Namita Naik, Agya Mishra, "Low contrast image enhancement using wavelet transform based algorithm: A literature survey, IJETR, ISSN 2321-0869, vol 3, 2015.

[6] Kirti khatkar, Dinesh Kumar, "Biomedical image enhancement using wavelet" International conference on intelligent computing, communication and convergence ICCC-2015.

[7] Hasan Demirel, Gholamreza Anbarjafri, "Image resolution enhancement using Discrete & stationary wavelet decomposition" IEEE transaction on image processing vol 20, may 2011.

[8] Pejman Rasti, Hasan Demirel, "Image Resolution enhancement by using interpolation followed by iterative back projection".

[9] Sabahaldin Hussain, Sai Jorashi, "Image denoising based on spatial/wavelet filter using hybrid thresholding function", International Journal of computer application(0975-8887) vol 42, 2012

[10] A. Abirami, A. Akshaya, "Enhancement of satellite image resolution with moving object" IOSR journal of electronics and communication Engineering, Issue 2278-2834, vol 4, Jan-Feb 2013.

