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An Efficient Algorithm for Removal of Noise of Medical Images Using Complex Double Density Wavelet

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Abstract

In digital image processing the wavelet transforms are used extensively because of it uses a set of filters for analysis and synthesis. The separable wavelet transform suffers from the problem of lacking shift invariance property and in multiple dimensions it cannot distinguish between orientations because of this the extensions of wavelet transform are required. Here we are proposing an extension of wavelet transform which uses both the properties of double density wavelet transform and dual tree complex wavelet transform. The double-density DWT is an improvement upon the critically sampled DWT with some properties such as it has one scaling function and two distinct wavelets, which are designed to be, offset from one another by one half and it is also shift invariant.

This Paper uses complex double density wavelet transform for removal of noise and then determines Peak Signal to noise ratio (PSNR) and Root mean square error (RMS).

INTRODUCTION:

Anything that deteriorates the quality an image is called noise. For noise removal the main focus is on noise removal and how much the particular image is preserved. Noise could be occurred in the image during its capture, acquisition and transmission. Generally, removal of noise is very important part of image processing. An efficient denoising model means the one which will remove noise while preserves the edges and the quality of the image so that the required information can be aquired. The wavelet transform is an elegant tool which can be used in various digital signal and image processing applications. The wavelet transform provides a multi resolution representation using a set of analyzing functions that are dilations and translations of a few functions (wavelets). The wavelets Transform are of different types. The critically-sampled form of the wavelet transforms provides the most compact representation; however, it has various limitations. It does not have shift-invariance property, and in multiple dimensions it has a problem of distinguishing orientations, which is necessary in image processing. that is why, it turns out that improvements can be obtained by using an expansive wavelet transform . Image Denoising means removal various unwanted signals from an image.

Various methods are used for image denoising. In this method removal of noise and the actual reconstruction of image is very important. In image denoising, the DWT suffers the problems of shift invariance and directional selectivity. Because of this problem, the extensions of the DWT are used. A complex wavelet transform (CWT) is a tool which posses the solution of the shortcomings of the DWT. In Mallat-type algorithms there is problem of shift sensitivity. Kingsbury defines a Dual-tree complex wavelet transforms which is nearly shift-invariant. A double-density dual-tree DWT is introduced by Selesnick (1) . This combined structure in this thesis introduces the properties of both the double-density DWT and the dual-tree DWT. The main purpose of this paper is to uses the important properties of both the double-density DWT and dual-tree complex DWT for image denoising.

1. PROPOSED WORK

This paper demonstrates the implementation of extensions of Wavelet Transform for removal of noise from various images i.e. jpeg image, png image .The extensions used are Double Density Wavelet Transform and Dual Tree wavelet Transform. By using the properties of both the extensions a hybrid model has been implemented for denoising.

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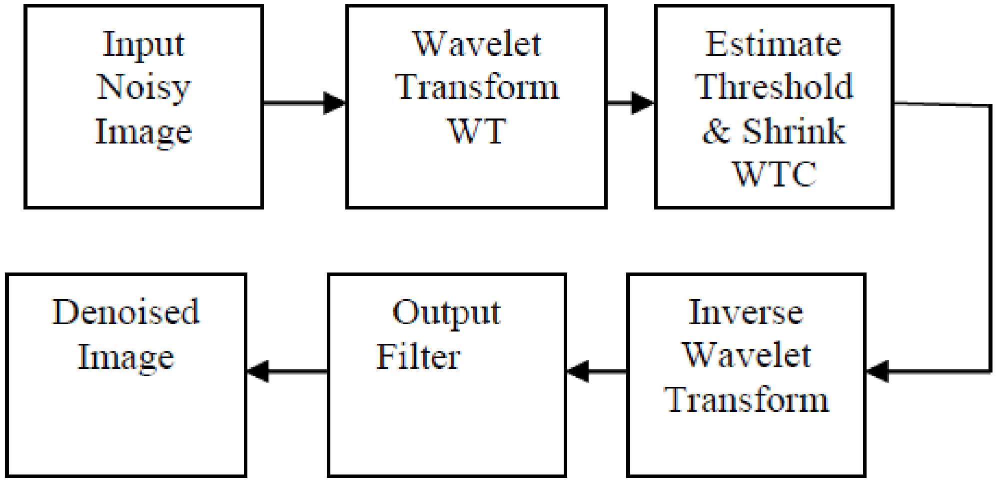

Figure 1: Block diagram of Image denoising using wavelet transform

2. DISCRETE WAVELET TRANSFORM

The filter banks are used for the wavelet analysis. The DWT decomposes the signal into wavelet coefficients and after that reconstruction is done. The wavelet coefficients represent the signal in various frequency bands. The coefficients can be processed different ways, giving the DWT attractive properties over linear filtering. There are two factors which represent the real line they are dilation factor and translation factor. For a particular dilation a and translation b, the wavelet coefficient $W_f(a,b)$ for a signal f can be calculated as, Where,

$$W_f(a,b) = \{f, \psi_{a,b}\} = \int f(x)\psi_{a,b}(x)\,dx \qquad \ldots\ldots..(1)$$

Where, $f(x)$ is the original signal and $\psi_{a,b}$ (x) is the wavelet function. Wavelet coefficients represent the information present in the signal at the corresponding dilation and translation. The original signal can be reconstructed by applying the inverse transform:

$$f(x) = \frac{1}{C_W}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} W_f(a,b)\,\psi_{a,b}(x)db\frac{da}{a^2} \qquad \ldots\ldots\ldots.(2)$$

Where, C_W is the normalization factor of the mother wavelet and $\psi_{a,b}(x)$ is the wavelet function [24]. The term discrete wavelet transform (DWT) uses several different methods. It must be noted that the signal itself is continuous; discrete refers to discrete sets of dilation and translation factors and discrete sampling of the signal. At a given scale J, a finite number of translations are used in applying multi resolution analysis to obtain a finite number of scaling and wavelet coefficients [6]. The signal can be represented in terms of these coefficients as,

$$f(x) = \sum_{k} C_{jk}\,(x)\emptyset_{jk}(x) + \sum_{j=1}^{j}\sum_{k} d_{jk}\,\psi_{jk}(x) \qquad \ldots\ldots.(3)$$

where C_{jk} are the scaling coefficients, d_{jk} are the wavelet coefficients, $\emptyset_{jk}(x)$ is the scaling function and $\psi_{a,b}(x)$ is the wavelet function. The first term in Equation (3) gives the low-resolution approximation of the signal while the second term gives the detailed information at resolutions from the original down to the current resolution.

3. BASICS TO THE DWT EXTENSIONS:

A filter bank is plays a integral part in image denoising applications. The two filter banks namely, analysis filter bank and synthesis filter bank. A schematic representation of a filter bank is shown in Figure below. In Figure x[n] is the input to the Analysis Filter Bank. The Vo[n] is the output of the Analysis Filter bank. The output of the Synthesis Filter Bank is y[n].

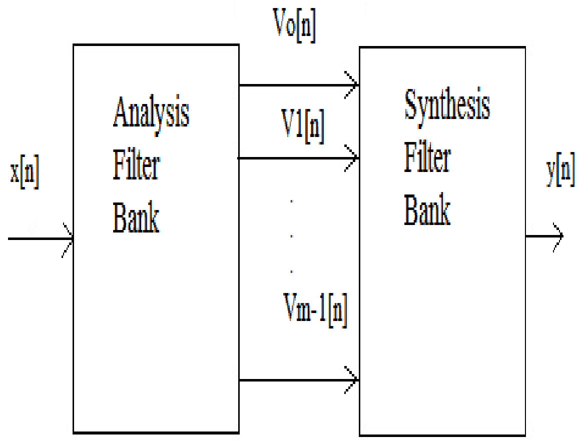

Figure 2: Analysis and Synthesis Filter Bank

Basic differences between the two DWT extensions: The basic differences between the dual tree DWT and double density DWT are given below.

1. For the dual-tree DWT there are fewer degrees of freedom for design, while for the double-density DWT there are more degrees of freedom for design.
2. The dual-tree and double-density DWTs are implemented with totally different filter bank structures.
3. The dual-tree DWT can be interpreted as a complex-valued wavelet transform which is useful for signal modelling and denoising (the double-density DWT cannot be interpreted as such).
4. The dual-tree DWT can be used to implement two-dimensional transforms with directional wavelets, which is highly desirable for image processing [31].

By introducing this concept in discrete wavelet transform (DWT) we can achieve dual-tree DWT system. Also combining the double-density DWT and dual-tree DWT we can achieve the complex double-density DWT system.

4. COMPLEX DOUBLE DENSITY WAVELET TRANSFORMS

We proposed the complex Double-Density DWT which is designed to simultaneously possess the properties of the Double-Density discrete wavelet transform and the Dual-Tree CWT. The Double-Density DWT and the Dual-Tree CWT are similar in several respects like they are both overcomplete by a factor of two, they are both nearly shift-invariant, and they are both based on FIR perfect reconstruction filter banks, but there exist a difference between them . Both wavelet transforms can outperform the critically sampled DWT for several signal processing applications. By using the important properties of both the dual tree CWT and double density DWT a single wavelet transforms is designed.

The Double-Density complex DWT is proposed which is designed to simultaneously possess the properties of the Double-Density DWT and the Dual-Tree DWT is based on two distinct scaling functions and four distinct wavelets where the two wavelets are offset from one another by one half and where the two wavelets form an approximate Hilbert transform pair. One pair of the four wavelets are designed to be offset from the other pair of wavelets so that the integer translates of one wavelet pair fall midway between the

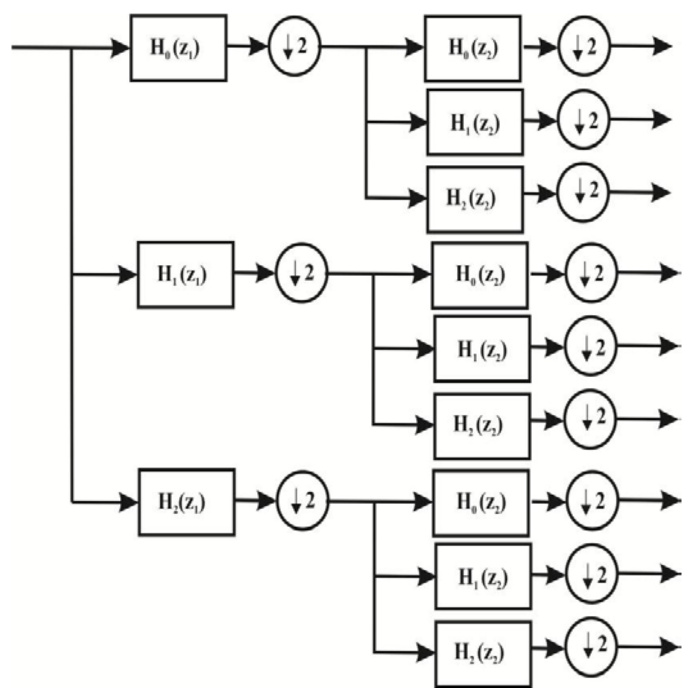

Figure 3: An over sampled Filter Bank

Integer translates of the other pair. Simultaneously, one pair of wavelets are designed to be approximate Hilbert transforms of the other pair of wavelets so that two complex (approximately analytic) wavelets can be formed. Therefore, they can be used to implement complex and directional wavelet transforms. The design procedure for the Double-Density CWT is based on the flat-delay filter, spectral and factorization filter bank completion.

The Double-Density Complex DWT proposed in this paper is based on using two oversampled DWTs. The filter bank structure corresponding to the Double-Density complex DWT consists of two oversampled iterated filter banks operating in parallel similar to the Dual-Tree DWT. The oversampled filter bank is illustrated in figure 5.

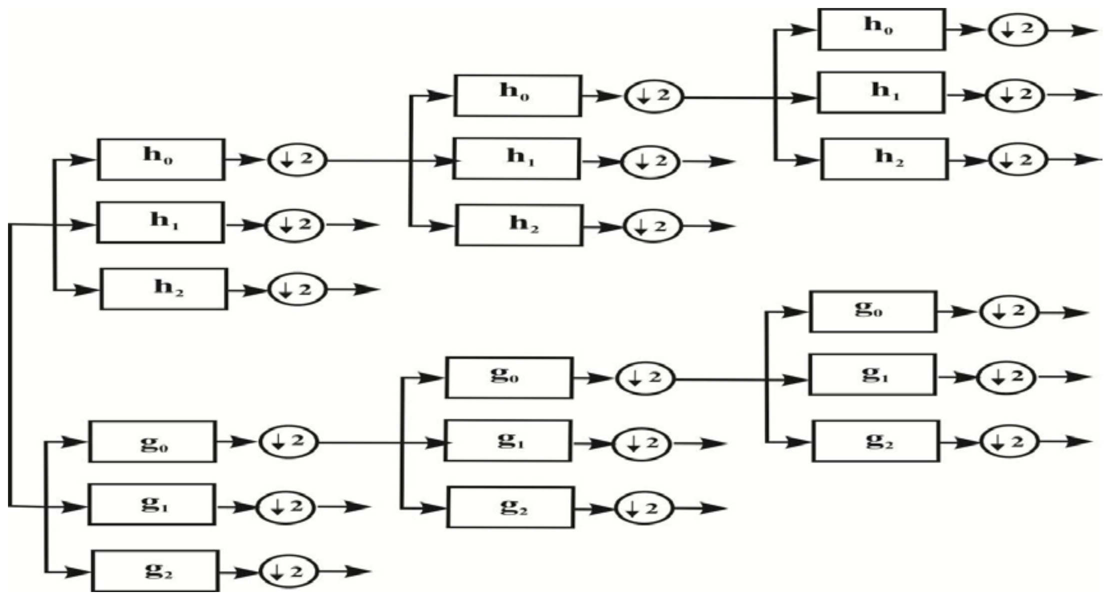

Figure No. 4 Iterated Filter Bank for Complex Double Density DWT

The iterated oversampled filter bank corresponding to the implementation of the Double-Density Dual-Tree is illustrated in figure We will denote the filters the first filter bank by $h_i(n)$ and the filters in the second filter bank by $g_i(n)$, for i=0,1,2

5. RESULTS & DISCUSSION

This work utilizes Matlab as the software program as it gives multi-paradigm Numerical computing environment. It has the capabilities of data visualization and analysis along with algorithm development. For testing, the grayscale images in jpef and png format are considered and are displayed using 'colormap (pink)' in MATLAB program. In the table given below for different noise variance and different thresholding points the calculated Peak signal to noise ratio (PSNR) and root mean square error (RMSE) are given.

Table 1 PSNR Values and RMS Error For Tooth image

Method	Method	Complex Double density DWT	Complex Double density DWT
Noise variance	**Threshold value**	**PSNR Value**	**RMS Error**
5	10	30.17	92.80
10	15	30.22	92.64
15	20	30.24	92.58
20	25	30.29	92.44
25	30	30.34	92.27
30	35	30.35	92.26
35	40	30.37	92.19
40	45	30.40	92.11
45	50	30.42	92.05
50	55	30.48	91.86

For constant noise variance of 30 and different thresholding point the double density CWT results for PSNR and RMS errors are shown in Table 1

Table 2: For Constant noise variance PSNR value and RMS Error

Method	Complex Double density DWT	Complex Double density DWT
Threshold value	**PSNR Value**	**RMS Error**
20	30.228	92.6301
40	30.3917	92.152
60	30.4748	91.9146
80	31.5132	91.7967
100	31.5721	91.625

For constant noise variance of 20 and different thresholding point the double density CWT results for PSNR and RMS errors are shown in Table 2

Table 3: For Constant noise variance PSNR value and RMS Error

Method	Complex Double density DWT	Complex Double density DWT
Threshold value	**PSNR Value**	**RMS Error**
20	30.2592	92.5404
40	30.3775	92.1937
60	30.4719	91.9175
80	30.5459	91.7011
100	30.6152	91.4933

The original images along with its histogram representation, noisy image along with its histogram representation and the denoised or image along with its histogram representation is given

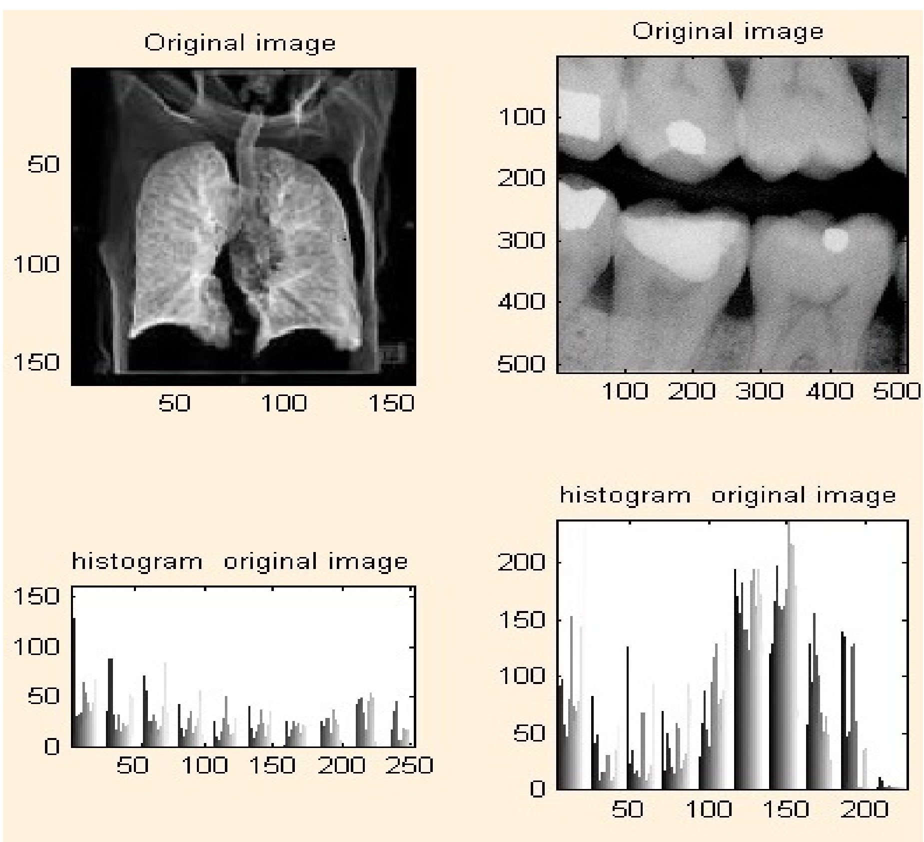

Figure 5: Original image with its histogram

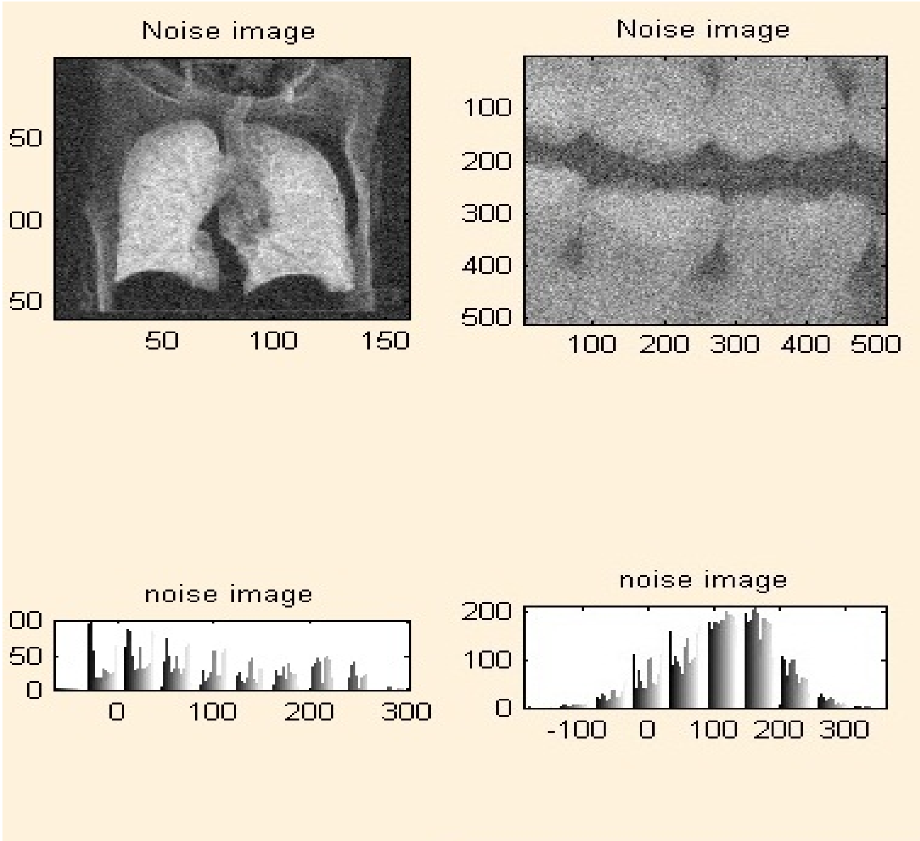

Figure 6 Noisy images with its histogram

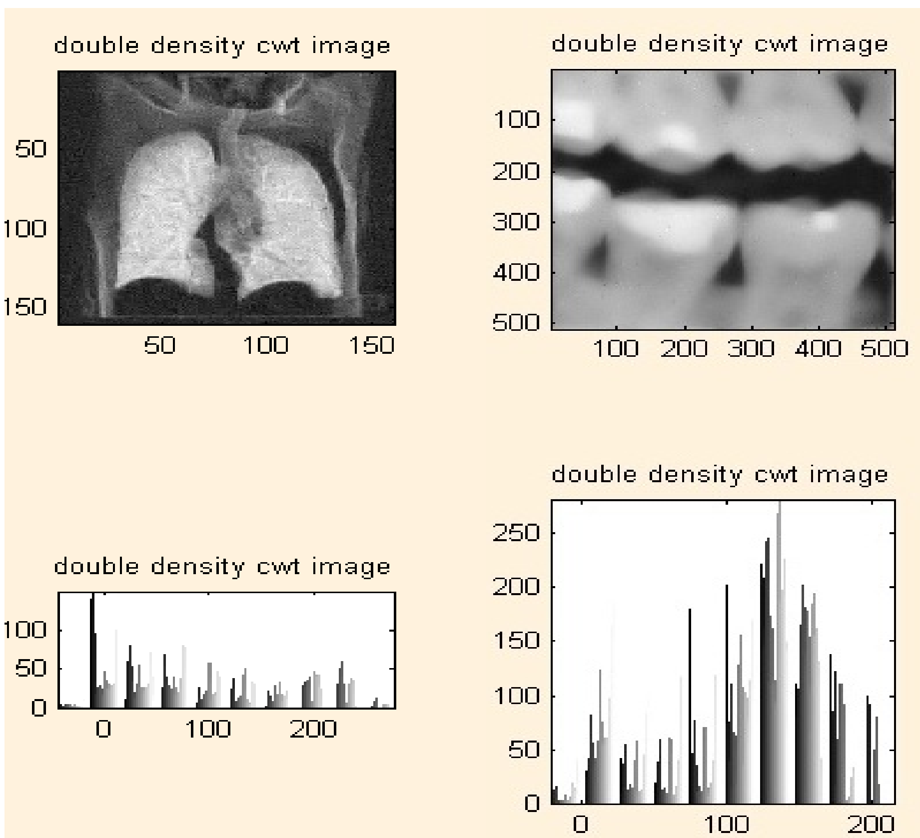

Figure 7: Double Density Complex DWT image with its histogram

The shift invariance and directionality properties of complex wavelet Transform are used in various areas of image processing like denoising, object segmentation, feature extraction and image classification. Here we are considering the Double Density Complex DWT for denoising and consider its effect on jpeg and png images different thresholds points and noise variance were selected are used on these images. But optimal thresholds points gives the minimum root mean square error from the original image and we get more PSNR value for less noise variance, showing a great effectiveness in removing the noise compared to the classical discrete wavelet transform.

The images are corrupted with different noise variance .Initially the Gaussian noise present in form of additive noise is removed. The various results in form of PSNR and RMS error are shown in the table above along with its histogram representation.

6. REFERENCES

1. Ivan W. Selesnick —The Double-Density Dual-Tree DWT IEEE transactions on signal processing, vol. 52, no. 5, may 2004
2. Rahul K. Sarawale and Dr. S. R. Chougule , —Noise Removal Using Double-Density Dual Tree Complex DWT IEEE second international conference on Image information processing pp. 219 – 224 , 2013
3. Ivan W. Selesnick, Member, IEEE — A Higher Density Discrete Wavelet Transform IEEE TRANSACTIONS ON SIGNAL PROCESSING, VOL. 54, NO. 8, AUGUST 2006
4. N. G. Kingsbury, —The dual-tree complex wavelet transform: A new technique for shift invariance and directional filters, Proc., 8th IEEE DSP Workshop, Salt Lake City, UT, Aug. 1998.
5. Yogesh Bahendwar and G R Sinha — A MODIFIED ALGORITHM FOR DENOISING MRI IMAGES OF LUNGS USING DISCRETE WAVELET TRANSFORM IETE sponsored National Conference on Innovative Paradigms in Engineering & Technology,p.31-34 28 January, 2012,Nagpur India. Proceedings published by International Journal of Computer Applications® (IJCA) [5] R. K. Sarawale and Dr. S.R. Chougule "Image Denoising using Dual-Tree Complex DWT and Double-Density Dual-Tree Complex DWT International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 6, June 2013
6. S.Kother Mohideen ,Dr.S. Arumuga Perumal and Dr. M.Mohamed Sathik —Image De-noising using Discrete Wavelet transform IJCSNS International Journal of Computer Science and Network Security, VOL.8 No.1, January 2008
7. S. Sezen and A. Ertuzun —2D Four-Channel Perfect Reconstruction Filter Bank Realized with the 2D Lattice Filter Structure" Hindawi Publishing Corporation EURASIP Journal on Applied Signal Processing Volume 2006, Article ID 42672, Pages 1–16 ,2006
8. Sathesh and Samuel Manoharan A dual tree complex wavelet transform Construction and its application to image denoising International Journal of Image Processing (IJIP) Volume(3), Issue(6) pp.293 -300
9. R.gomathi and S.Selvakumaran — A bivariate shrinkage function for complex dual tree dwt based image denoising International Conference on Wavelet Analysis & Multirate Systems, Bucharest, Romania,pp.36-40 , October 16-18, 2006
10. Yogesh Bahendwar and G R Sinha —Efficient Algorithm For Denoising Of Medical Images Using Discrete Wavelet Transforms Mathematical Methods and Systems in Science and Engineering Series , proceedings of the 17th International conference, Tenerife Spain ISBN: 978-1-61804-281-1 p. 170-174 January 10-12 2015
11. Lakhwinder Kaur Deptt. of CSE —Image Denoising using Wavelet Thresholding SLIET, Longowal Punjab (148106), India
12. Bogdan Dumitrescu, Ali Bahrami Rad —A METHOD FOR DESIGNING THE DOUBLE-DENSITY DUALTREE DISCRETE WAVELET TRANSFORM Department of Signal Processing Tampere University of Technology
13. Florian Luisier, Thierry Blu, Senior Member, IEEE, and Michael Unser, Fellow, IEEE —A New SURE Approach to Image Denoising: Interscale Orthonormal Wavelet Thresholding IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 16, NO. 3, MARCH 2007
14. Sudipta Roy, Nidul Sinha & Asoke K. Sen —A NEW HYBRID IMAGE DENOISING METHOD International Journal of Information Technology and KnowledgeManagement July-December 2010, Volume 2, No. 2, pp. 491-497
15. Shashank Kumar, Prof. Yogesh Bahendwar — Image Denoising using Double Density Complex DWT International Journal of Engineering Technology and Management (IJETM) Available Online at www.ijetm.org Volume 2, Issue 3, May-June 2015, Page No. 34-40, ISSN: 2394-6881