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A Review Of Image Fusion Using IHS With Wavelet Transform

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ABSTRACT

Image fusion is the technique of combining two or more image of different features to form a single fused image of good quality. This technique is widely used in military application, remote sensing, surveillance and medical application. For combining or fusing the image different author proposes several techniques such as IHS, DT-CWT etc. In this paper; we present the literature study about the image fusion using intensity hue saturation (IHS) for fusing the images by different proposed or suggested and also discuss the advantages and disadvantages of these techniques.

Keywords **—** Image Fusion, IHS, DT-CWT, Remote Sensing.

I. INTRODUCTION

Image fusion [1] is emerging as an imperative technology in many military, surveillance and medical applications. It is a sub area of the more all-purpose issue of data fusion, dealing with image and video data. The potential to combine harmonizing information from a range of scattered sensors with unusual modalities can be used to provide better-quality performance for apparition, recognition or categorization tasks. Multi-sensor data frequently present complementary information about the prospect or object of interest and thus image fusion provides an effective method for comparison and analysis of such data. There are several benefits of multi-sensor image fusion: wider spatial and temporal coverage, extended range of operation, decreased uncertainty, improved reliability and increased robustness of the system performance. In several application scenarios, image fusion is only an introductory stage to another task, e.g. human monitoring. Therefore, the performance of the fusion algorithm must be measured in terms of improvement in the following tasks. For example in categorization systems the common evaluation quantify is the number of the correct classifications. This system evaluation requires that the "accurate" correct classifications are known. Nevertheless, in experimental setups the ground truth data might not be obtainable. In many applications the human surveillance of the fused image is of elementary significance and as a result the fusion results are typically evaluated by discriminatory criterion. An objective of image fusion performance evaluation is a tedious task due to different application requirements and the lack of a clearly defined ground-truth. Various fusion algorithms existing in this project numerous objective performances procedures for image fusion have been proposed where the awareness of ground-truth is not tacit. Several techniques has been proposed to fuse the image together to form single and good quality image such as IHS, wavelet based, GHIS, PCA based DT-CWT etc. In this paper we presented the literature of the image fusion technique using wavelet transform. The remaining section of the paper is organized as follows: section II presents the literature of the related work done. Section III explained about the image fusion techniques and last section give conclusion of the paper.

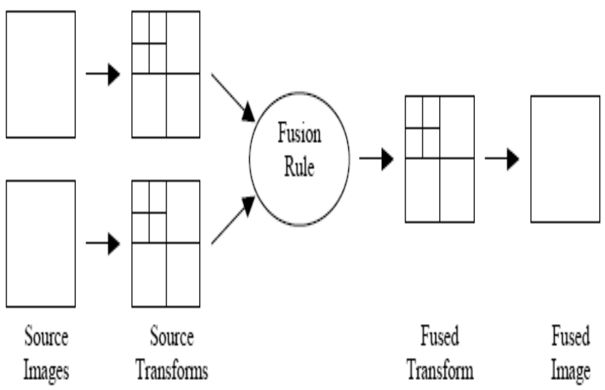

Fig. 1 shows the fusion process of the images

II. RELATED WORK

This section gives an extensive literature survey on the existing image fusion method based on IHS and DT CWT and integrating techniques proposed by different authors.

Miloud Chikr El Mezouar et al. [2] proposed a method to adjust partially the I image, in the existing area only, in order to get grey values in the similar range as those of the Pan image. In this paper author used the normalized difference vegetation index (NDVI) to recognize the vegetation area and augment the green band by using the red and the NIR bands. They obtain an intensity image with grey values analogous to the PAN's grey values. Thus the colour distortion in the fused image is reduced. Visual and statistical analyses states that the concept of the proposed method is able, and it appreciably improves the fusion quality as compared to traditional IHS techniques.

Kanaka Raju Penmetsa et al. [3] proposed a method DT-CWT which is used for denoising of colour images. C-DWT is a structure of DWT in which fused coefficients (real and invented parts) are generated by using a dual tree of wavelet transform. An experiment on a number of standard colour images carried out to estimate reading of the planned method. Its result shows that the DT-CWT method is better than that of DWT method in terms of image visual primacy.

Patil Gaurav Jaywantrao et al. [4] proposed the novel relevance of the shift invariant and directionally discerning Dual Tree complex Wavelet Transform (DT-CWT) to image fusion. The successful fusion of images acquires from various modalities or instruments are of great importance in many applications, such as medical imaging, microscopic imaging, remote sensing, computer vision, and robotics. With 2D and 3-D imaging and image indulgence becoming widely used; there is a growing need for novel 3-D image fusion algorithms accomplished of combining 2D & 3-D multimodality or multisource images. Such algorithms can be used in areas such as 2D & 3-D e.g. fusion of images in Target tracking system, Synthetic Aperture Radar (SAR) etc. In case of target tracking system the time is the very vital factor. So we take time as a comparison factor to compare unlike methods which we execute. In order to get better the competence of the project, a far time for the fusion to scuttle is being formulated.

O. Kumari et al. [5] proposed an algorithm which is extremely straightforward, simple to implement and could be used for real time applications. A Novel region- based method increase flexibility. A dual tree complex Wavelet transforms (DT-CWT) is used to segment the features of input images to manufacture region map uniqueness of each region are anticipated and a region based advance is used to blend the images, region-by-region , in the Wavelet region. This technique gives results comparable to pixel based fusion methods, but regardless of an augment in complexity.

Pavithra C et al. [6] presented a method for fusing two dimensional multi-resolution 2-D images using wavelet transform under the combine gradient and smoothness reason. The usefulness of the method has been illustrate using various experimental image pairs such as the multi- focus images, multi-sensor satellite image and CT and MR images of cross-section of human brain. The results of the proposed method have been compared with some widely used wavelet transform based image fusion methods both qualitatively and quantitatively. An experimental result expose that the proposed method produces better fused image than the other method. The use of mutually gradient and relative smoothness criterion ensures two fold effects. While the gradient criterion ensure that edges in the images are included in the fused algorithm, and the relative smoothness criterion ensures that the areas of uniform intensity are also incorporated in the fused image thus the effect of noise is minimized. It should be noted that the proposed algorithm is domain-independent.

Myungjin Choi et al. [7] Proposed a new method based on a curvelet translation, which represents edges enhancement than wavelets. Since edges play a straightforward role in image representation, one effective means to enhance spatial promise is to enhance the edges. The curled-based image fusion method provides more affluent information in the spatial and spectral domains concurrently. They performed landsat ETM+ image fusion and generate that the proposed technique provides optimal fusion results.

Hasan Demirel et al. [8] In this paper author says (CWT) Complex Wavelet Transform is used in image processing. CWT of an image produces two complex-valued low-frequency sub-band images and six complex valued high-frequency sub-band images. DT-CWT decomposes original image into different sub-band images. Then high frequency sub-band images and original low frequency image are undergoes the interpolation. These two real-valued images are used as the real and imaginary components of the interpolated complex LL images, respectively, for the IDT-CWT operation. This technique does not interpolate the original image but also interpolates high frequency sub-band image resulting from DT-CWT. The final output image is high resolution of the original input image. Quality and PSNR of the super resolved image is also improves in this method. There are some problems with wavelet domain as it introduces artifacts like aliasing, any wavelet coefficient processing disturbs the delicate balance between forward and inverse transform leading to some artifacts in the images. It also fabricates lack of directional selectivity significantly complicate modelling and processing of geometric image features like ridges and edges. One solution to all these problems is Complex Wavelet Transform (CWT). CWT is only somewhat like magnitude or phase, shift invariant and free from aliasing.

Yinji Piao et al. [9] In this paper author used Inter sub-band correlation in wavelet domain uses correlation of sub-band with different sampling phases in DWT. In this enhancement technique sampling phase in DWT is taken into consideration. By analysing correlation between lower level sub-band and higher level sub-bands, interpolation filters are design. First filter are estimated by applying wavelet transform to low resolution image. Estimated filters are used to estimate bands in higher level. And finally inverse wavelet transform is performed to enhance the resolution of input image.

Souparnika Jadhav et al. [10] presented a novel image fusion technique based on dual-tree complex wavelet transform. Dual tree CWT is an extension to discrete wavelet transform (DWT). This methodology is based on a gradient domain method that conserves important local perceptual features which evades many problems such as ghosting, aliasing and haloing.

Ajeesh P Sasi et al. [11] this paper represent the intention of fusion is to create an image which describes a view better or even advanced than any single image with respect to some related properties providing an informative image. These fusion techniques are meaningful in diagnosing and treating cancer in medical fields. This paper focuses on the development of an image fusion techniques using Dual Tree Complex Wavelet Transform (DT-CWT). The result shows that proposed algorithm has a improved visual quality than the base methods. Also the importance of the fused image has been evaluated using a set of eminence metrics.

III. IMAGE FUSION TECHNIQUES

Image fusion is the process of combining the several images of different characteristic to get a better quality or resolution of image than the single image so to merge the image different techniques has evolved such as Intensity hue saturation (IHS), PCA based, pyramid based, DWT, DT-CWT etc. The techniques are explained below**:**

A. *Intensity hue Saturation Method of Image Fusion:*

As the MS image is represented in RGB colour space, we can separate the intensity (I) and colour information, hue (H) and saturation (S), by IHS transform. The I component can be deemed as an image without colour information. Because the I component resembles the PAN image, we match the histogram of the PAN image to the histogram of the I component. Then, the I component is replaced by the high-resolution PAN image before the inverse IHS transform is applied. The main steps, illustrated in Fig. 4.1, of the standard HIS fusion scheme are [12, 13, 14]:

(1). Perform image registration (IR) to PAN and MS, and resample MS.
(2). Convert MS from RGB space into IHS space.
(3). Match the histogram of PAN to the histogram of the I component.
(4). Replace the I component with PAN.
(5). Convert the fused MS back to RGB space.

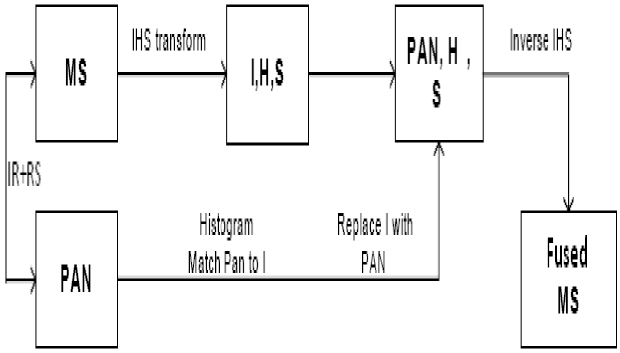

Fig.2 Image fusion using IHS method.

In step (1), image resampling (RS) is utilized so that the MS image has the same spatial resolution as the PAN image. IR and RS have introduced in Section 2. In step (3), because the mean and variance of the I component (I=(R+G+B)/3) are different to those of the PAN image, histogram matching is employed to prevent the change of the histogram of the MS image.

B. *Principal Component Analysis Method for image fusion:*

Principal component analysis (PCA) [15], [16], [17] is a vector space transform, often used to decrease dimensionality. PCA is the simplest true eigenvector-based multivariate analysis. It involves approaches for identifying and to show patterns in data, in such a way as to emphasize their similarities and differences, and thus trim down dimension without loss of data. In this technique first the column vectors are extracted, from respective input image matrices. The covariance matrix is calculated. Diagonal elements of covariance vector will contain variance of each column vector. The Eigen values and the vectors of covariance matrix are planned. Normalize column vector equivalent to larger Eigen value by dividing each element with mean of Eigen vector. Those normalized Eigen vector values act as the mass values and are multiplied with each pixel of input image. Sum of the two scaled matrices are calculated and it will be the result of fused image matrix.

C. *Pyramid Based Image Fusion:*

Pyramid Fusion Algorithms [15], [16], [18] is better in performance as it performs fusion in supernatural domain. It consists of a set of low pass or band pass copies of the input image. In this technique the size of the pyramids in each level would be sort the size of the pyramid in the previous level. The fundamental idea is to form the pyramid transform of the merged image from the pyramid transforms of the effort images; the fused image is obtained by taking the different pyramid transform. It provides sharp contrast changes and have spatial and frequency domain localization.

D. Discrete Wavelet Transform for Image Fusion:

A real continuous function f (t) is mapped into another real continuous signal Wf (a, b) by the standard wavelet transform, where 'a' is scaling parameter and' b' is the shift parameter [3].

The major disadvantages of standard wavelet (CO-WT) are redundancy (complexity due to large number of samples) and due to very large number of samples (as f (t) is continuous) it is impracticable to evaluate with computers. A discredited description of wavelet transform provides decomposition of the original signal based on constant-Q (equal BW on a logarithmic scale) basis functions with better multi-resolution characteristics in the time frequency plane. The discretization is carried out in such a way that the orthogonality is still fulfilled and the transform is done on a framework within the continuous (a, b) plane.

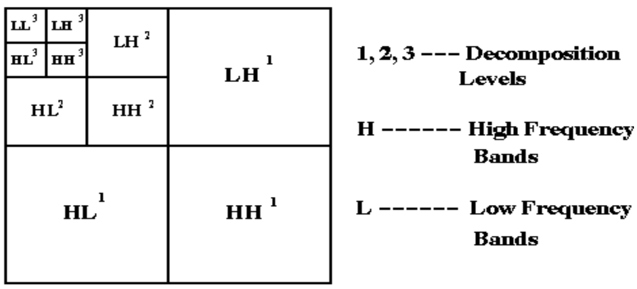

Fig. 3 Discrete Wavelet transforms [4]

E. Dual-Tree Complex Wavelet Transform:

The Dual-Tree Complex Wavelet Transform (DT-CWT) has been introduced to overcome the disadvantages of real DWT. The overall performance of the DT-CWT design ensures the following properties [19]:

i. Approximate shift invariance,
ii. Good directional selectivity in 2-D with Gabor-like filters also true for higher dimensionality (m-D),
iii. Perfect reconstruction using short linear-phase filters,
iv. Limited redundancy: self-governing of the number of scales: 2:1 for 1-D (2m :1) for m-D,
v. Efficient order-N computation - only twice the simple DWT for 1-D (2m times for m-D)

The overall performance of the DT-CWT design ensures the shift invariance property of the transformation. Moreover, it improves the directional selectivity compared to the DWT since it produces six directional sub-bands at each scale oriented at $\pm 15^0, \pm 45^0, \pm 75^0$ compared to the three directional sub-bands of the DWT. Fig. 1 shows a two-level decomposition of 1-D signal f(x) using DT-CWT. A DT-CWT transformation of 1-D signal f(x) in terms of shifted and dilated wavelet function $\varphi(n)$and scaling function $\phi(n)$ is given by the following equation [20]:

$$f(x) = \sum_{l \epsilon Z} s_{j_0,l}\phi_{j_0,l}(x) + \sum_{j \geq j_0} \sum_{l \epsilon Z} c_{j,l}\psi_{j,l}(x) \qquad (1)$$

Where Z is the set of natural numbers, j and l refer to the index of shifts and dilations, respectively, is the scaling coefficient, and $C_{j,l}$ is the composite wavelet coefficient. To work out the 2-D DT-CWT of images, the two trees are functional to the rows and then to the columns of the image as in the basic DWT. This procedure results in six complex high-pass sub-bands at each level and two complex low-pass sub-bands on which successive stages iterate. The decomposition of 2D signal can be expressed in the same manner like the 1-D decomposition in [20] as follows:

$$f(x) = \sum_{l \epsilon Z^2} s_{j_0,l}\phi_{j_0,l}(x,y) + \sum_{\theta \epsilon \Theta} \sum_{j \geq j_0} \sum_{l \epsilon Z^2} c^{\theta}_{j,l}\psi^{\theta}_{j,l}(x,y) \qquad (2)$$

Where $\theta \in \Phi = \{\pm 15°, \pm 45°, \pm 75°\}$ which determine the complex wavelet directionality.

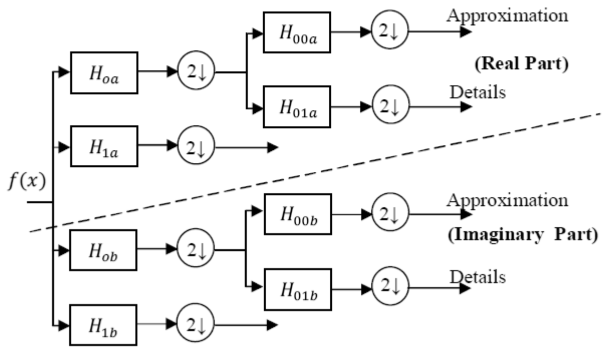

Fig. 3 Image fusion using DT-DWT

The actual 2-D dual-tree DWT of an image x is implemented with two critically-sampled detachable 2-D DWTs in parallel. Then for each pair of sub-bands we take the sum and difference. The complex 2-D DT-DWT also gives rise to wavelets in six divergent commands. The complex 2-D dual-tree is implemented as four critically-sampled detachable 2-D DWTs operating in parallel as shown in figure (4). 2-D structure needs four trees for analysis and synthesis. The pair of conjugate filters applied to two dimensional image (x, y) can be expressed as:

$$(h_x + jg_x)(h_y + jg_y) = (h_x h_y - g_x g_y) + j(h_x g_y + g_x h_y) \qquad \ldots(3)$$

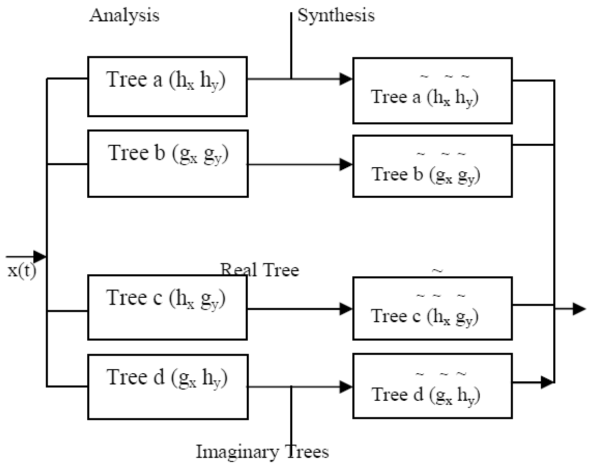

Fig. 4 Filter bank structure for 2-D DT-DWT

The complex wavelets are able to distinguish between positive and negative the diagonal sub-bands can be distinguished and horizontal and vertical sub-bands are divided giving six distinct sub-bands in each scale at orientations $\pm15^0$, $\pm45^0$, $\pm75^0$. The oriented and scale dependent sub-bands are visualized spatially in figure (5).

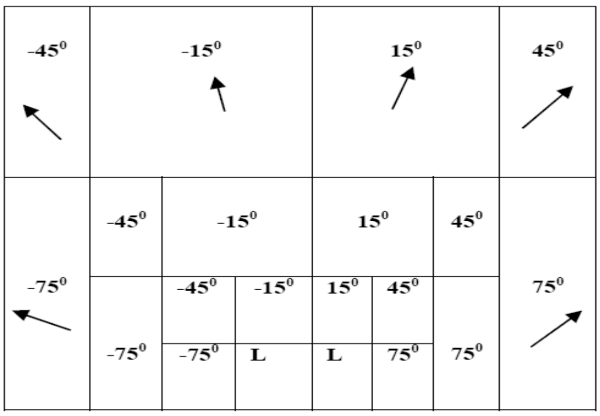

Fig. 4 Filter bank structure for 2-D DT-DWT

IV. CONCLUSION

Image fusion is one the extensively used method to get better quality of images after combining two images. In this paper we review the literature of various previous proposed techniques of different researchers such IHS, DWT, PCA and DT-CWT all techniques provides good results. We'll propose an image fusion method using IHS with 2D-dual tree-CWT.

Techniques	Advantages	Disadvantages
IHS	-Very fast and quickly process large volume of data	-It increases the storage cost -not able to retain the distortion
PCA	-easily transform the multivariate interrelated data	-Dominant and Weak colour information is the problem
DWT	-It reduce the storage cost -	Not able to retain the edge information clearly
DT-CWT	-It increases the shift invariance - bitterly retain the edge information -reduces the noise of images	It is complex to design.

Table 1 Advantages and disadvantages of Image fusion techniques

REFERENCES

[1] V Jyothi, B Rajesh Kumar, P Krishna Rao, And D V Rama Koti Reddy "Image Fusion Using Evolutionary Algorithm (GA)", Int. J. Comp. Tech. Appl., Vol 2 (2), 322-326, ISSN: 2229-6093.

[2] Miloud Chikr El Mezouar, Nasreddine Taleb, Kidiyo Kpalma, and Joseph Ronsin, "An Improved Intensity-Hue-Saturation for A High-Resolution Image Fusion Technique Minimizing Color Distortion", IJICT, Vol. 3, No. 1, February 2010 / ISSN: 0973-5836 / Serials Publications, India.

[3] Kanaka Raju Penmetsa, V.G.Prasad Naraharisetti, N.Venkata Rao "An Image Fusion Technique for Colour Images Using Dual-Tree Complex Wavelet Transform" International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 8, October – 2012 ISSN: 2278-0181.

[4] Patil Gaurav Jaywantrao, Shabahat Hasan, "Application of Image Fusion Using Wavelet Transform In Target Tracking System", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181Vol. 1 Issue 8, October – 2012.

[5] R.Vijaya Durga, O. Kumari, M. Surya prakash,P. Dileep kumar,Y. Tirupathi, "Region-Based Image Fusion Using Complex Wavelets", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834,p- ISSN: 2278-

8735.Volume 9, Issue 1, Ver. IV (Jan. 2014), PP 23-26.

[6] Pavithra C, Dr. S. Bhargavi, "Fusion of Two Images Based on Wavelet Transform", International Journal of Innovative Research in Science, Engineering and Technology. 2, Issue 5, May 2013.

[7] Myungjin Choi, Rae Young Kim, Myeong-Ryong NAM, and Hong Oh Kim, "The Curvelet Transform for Image Fusion".

[8] Hasan Demirel and Gholamreza Anbarjafari, "Satellite Image Resolution Enhancement Using Complex Wavelet Transform" IEEE Trans. Geo-science and remote sensing letters,vol.7,no.1,January 2010,pp 123- 126.

[9] Y. Piao, I. Shin, and H. W. Park, "Image resolution enhancement using inter-sub-band correlation in

[10] Wavelet domain" in Proc. ICIP, 2007, vol. 1,pp. I-445–I-448

[11] Souparnika Jadhav, "Image Fusion Based On Wavelet Transform", International Journal of Engineering Research ISSN: 2319-6890)(online),2347-5013(print) Volume No.3, Issue No.7, pp : 442-445.

[12] Ajeesh P Sasi, Dr. Latha Parameswaran, "Image Fusion Technique using DT-CWT", In proceeding of IEEE.

[13] M. Gonzáles Audícana and A. Seco, "Fusion of multispectral and panchromatic images using wavelet transforms Evaluation of crop classification accuracy," in Proc. 22nd EARSeL Annu. Symp. Geoinformation Eur.-Wide Integr., Prague, Czech Republic, 4–6 June 2002, T. Benes, Ed., 2003, pp. 265–272.

[14] V. Vijayaraj, N. H. Younan, and C. G. O'hara, "Quantitative analysis of PAN sharpened images," Opt. Eng., vol. 45, no. 4, pp. 046 202-1–046 202-12, 2006.

[15] Haixia Liu, Bing Zhang, Xia Zhang, Junsheng Li, Zhengchao Chen and Xiaoxue Zhou, "AN improved fusion method for pan-sharpening Beijing-1 Micro-Satellite images ," in IEEE IGARSS, 2009.

[16] Kingsbury, N. G. 1998a. The dual – tree complex wavelet transform: a new technique for shift invariance and directional filters, proc. 8th IEEE DSP Workshop, Bryce Canyon, UT, USA, paper no. 86.

[17] Petrovic V, Xydeas C, "Gradient based Multi-resolution Image Fusion" IEEE Transaction on Image Processing, Vol. 13, No 2. In feb. 2004.

[18] Lindsay I Smith, "A Tutorial on Principal ComponentAnalysis"http://www.cs.otago.ac.nz/cosc453/studnenttutorials/" principal_components.pdf.

[19] Zhang Zhong, "Investigations on Image Fusion", PhD Thesis, University of Lehigh, USA. May1999.

[20] N. G. Kingsbury, "The dual-tree complex wavelet transform: a new technique for shift invariance and directional filters. " Proc. 8th IEEE DSP Workshop, 1998.

[21] T.Celik and K.-K. Ma, "Unsupervised change detection for satellite images using dual-tree complex wavelet transform", Geo-science and Remote Sensing, IEEE Transactions on, volume 48,pp.1199-1210.2010