ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

Multichannel Satellite Image Resolution Enhancement Using Dual-Tree Complex Wavelet Transform and NLM Filtering

P.K Ragunath[1], A.Balakrishnan[2]

M.E, Karpagam University, Coimbatore, India[1]

Asst Professor, Karpagam University, Coimbatore, India[2]

ABSTRACT: In modern technology, A wavelet-domain approach based on dual-tree complex wavelet transform (DT-CWT) and nonlocal means (NLM) is proposed for RE of the satellite images.A satellite input image is processed by DT-CWT (which is nearly shift invariant) to obtain high-frequency subbands. Lanczos interpolator is used between high-frequency subbands and the low-resolution (LR) input.The subbands other than low frequency sub bands are passed through an NLM filter to cater for the artifacts generated by DT-CWT.The filtered high-frequency subbands and the LR input image are combined using inverse DT-CWT to obtain a resolution-enhanced image.

KEYWORDS: Dual Tree Complex Wavelet Transform, Low-resolution image, Lanczos interpolator, Non Local Means filter, Inverse Dual Tree Complex Wavelet Transform.

I. INTRODUCTION

The Dual Tree Complex Wavelet Transform (DT CWT) in multichannel is a form of discrete wavelet transform which generates complex coefficients by using a dual tree of wavelet filters to obtain their real and imaginary parts.

The Dual Tree Complex Wavelet Transform (DT CWT) structure. Resolution is the limiting factor for the utilization of remote sensing data. Spatial and spectral resolutions of satellite images are compared (a high spatial resolution is associated with a low spectral resolution and vice versa) with each other. Therefore, spectral, as well as spatial, resolution enhancement (RE) is necessary. Interpolation has been widely used for Resolution Enhancement [2], [3]. Commonly used interpolation techniques are based on nearest neighbors (include bilinear, bicubic, and Lanczos).

Image Resolution and Enhancement plays a vital role in analyzing images in various engineering and bio medical fields. One of the important issues of these types of color images is their resolution. Satellite RGB image resolution enhancement technique based on the interpolation of the high-frequency sub bands obtained by discrete wavelet transform (DWT) is useful to attain optimum results enriched with brightness and contrast rise. The input image is decomposed into different sub bands through DWT. The subbands other than low frequency sub bands images and the input low-resolution color image have been interpolated, followed by combining all these color images to generate a new resolution-enhanced color image by using inverse DWT. To achieve a high contrast color image, a middle stage for calculating the high-frequency sub bands is required. The measurable parameters i.e., peak signal-to-noise ratio and root mean square error and visual results show the superiority of the proposed technique over the conventional and image resolution enhancement techniques.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

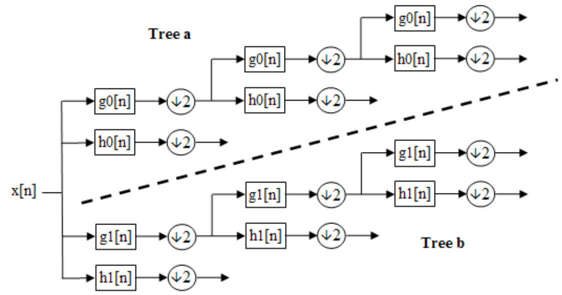

Figure 1:The Dual Tree Complex Wavelet Transform (DT CWT) structure

II. RELATED WORK

It is a multichannel Implementation, in this method; we propose a satellite image resolution enhancement technique based on the interpolation of the high-frequency sub bands obtained by discrete wavelet transform (DWT) and the inputmulti-channel image. The proposed resolution enhancement technique uses DWT to decompose the inputmulti-channel image into different bands. Then, the high-frequency subband images and the input low-resolution image have been interpolated, followed by adding all these images to generate a new resolution-enhanced image by using IDWT. In order to achieve a high contrast image, a middle stage for estimating the high-frequency sub bands has been proposed.Satellite images are being used in research. One of the major issues of these types of images is their resolution. The proposed technique has been tested on satellite benchmark images.RE image is suffered from the drawback of losing high-frequency contents.DWT-based RE schemes generate artifacts DWT is shift variant in the RE image.

III. EXISTING SYSTEM

The Dual Tree Complex Wavelet Transform (DT CWT) is a form of discrete wavelet transform which generates complex coefficients by using a dual tree of wavelet filters to obtain their real and imaginary parts.The dual-tree complex wavelet transform (DT- CWT) is known to exhibit better shift-invariance than the conventional discrete wavelet transform. We introduce amplitude to phase representation of the DT- CWT which among other things offers a direct illustration for the improvement in the shift-invariance. The implementation is based on the shiftingaction of the group of fractional Hilbert transform operators, which extends the notion of arbitrary phase-shifts from sinusoids to finite-energy signals (wavelets in particular). We characterize the shift abilityof the DT- WT in terms of the shifting property of the fHTs. The representation is certain fundamental invariances of the fHT, namely that of translation, dilation, and normalization, which play a decision role in establishing the key properties of the transform. It turns out that these fundamental invariances are exclusive to this group.By introducing a generalization of the Bedrosian theorem for the fHT operator, we explicitly understanding of the shifting action of the fHT for the particular family of wavelets obtained through the modulation of lowpass functions. This, in effect, links the corresponding dual-tree transform with the frame-work of windowed-Fourier analysis. We extend these ideas to the multidimensional setting by introducing a directional extension of the fHT. In particular, we evaluate a signal representation involving the superposition of direction-selective wavelets with appropriate phase-shifts, which helps explain the improved shift-invariance of the transform along certain preferential directions.

3.1 Issues

The disadvantage of this design DT-CWT is almost shift and rotation invariant. So output RE image, has a lack of directionality.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

3.2 Motivation

In order to avoid artifacts and rotation invariant, we use Lanczos Interpolation and non-local means filtering to acquire a high level resolution enhancement technique.

IV. PROPOSED SYSTEM

The proposed technique is used to overcome the major drawbacks of DWT, we use Dual tree complex wavelet transform, interpolation and NLM filtering.In Dual tree complex wavelet transform, more number of frequency sub bands are obtained, then the images are processed using interpolation and NLM filtering.

Lanczos filter is a mathematical interpretation and it is used to smoothly interpolate the value of a digital signal between its sample signals.

$$L(x) = \begin{cases} 1 & \text{if } x = 0 \\ \dfrac{a\sin(\pi x)\sin(\pi x/a)}{\pi^2 x^2} & \text{if } 0 < |x| < a \\ 0 & \text{otherwise} \end{cases}$$

Interpolation is the process of determining the values of a function at positions lying between its sample signals. It achieves this process by suitable a continuous function through the discrete input samples. This allows input values to be evaluated at arbitrary positions in the input, not just those defined at the sample signal points. Bandlimited, interpolation plays an opposite role: it reduces the bandwidth of a signal by applying a low-pass filter to the discrete signal. That is, interpolation reconstructs the signal lost in the sampling process by smoothing the data samples with an interpolation function.

The process of interpolation is one of the fundamental operations in image processing. The image quality highly depends on the used interpolation technique.

The interpolation techniques are divided into two categories, deterministic andstatistical interpolation techniques. The difference is thatinterpolation techniques assume a certain variability between the sample points, such as linearity in case of linear interpolation. Some of the Statistical interpolation methods approximate the signal by minimizing the estimation error. This approximation process may result in original sample values not being replicated. Since some of the statistical methods are computationally less efficient, in this article only deterministic techniques will be used.

The non-local means algorithm does not make the same assumptions about the image as other methods. Instead it assumes the multichannel image contains an extensive amount of self-similarity. Eros and Leung originally developed the concept of self-similarity for texture synthesis [4]. An example of self-similarity is displayed in Figure. For example, in Figure 1 most of the pixels in the same column as *p* will have similar neighborhoods to *p*'s neighborhood. The self-similarity assumption can be exploited to denoise an image. Pixels with similar neighborhoods can be used to determine the denoised value of a pixel.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

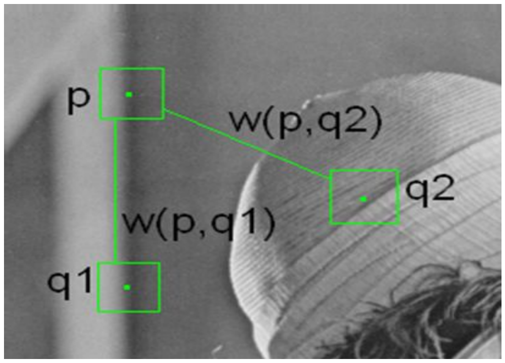

Figure4.1: Example of self-similarity in an image.

Pixels *p* and *q1* have similar neighborhoods, but pixels *p* and *q2* do not have similar neighborhoods. Because of this, pixel *q1* will have a stronger influence on the denoised value of *p* than *q2*.

V. EXPERIMENTAL RESULTS

During simulation different modules are processed and its results are shown below. Also its PSNR values are calculated and tabulated.

Figure 5.1: Low resolution image

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

difference Image

Figure 5.2: Difference image

DWT based Wavelet transformed for Original Image

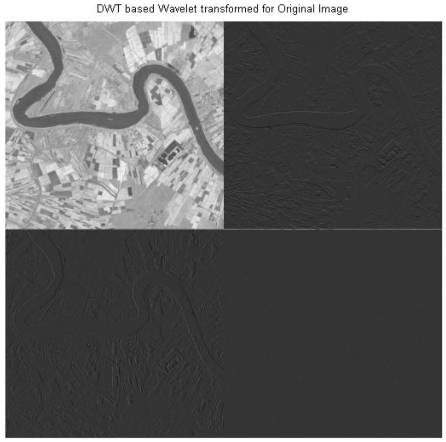

Figure 5.3: DWT Transformed image

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

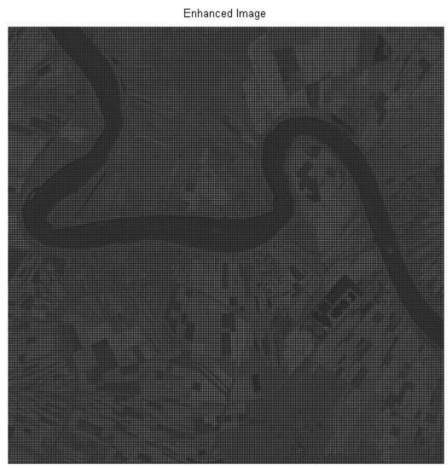

Figure 5.4: Enhanced image

Following are the results of DT-CWT technique, which includes the process of Lanczosinterpolation and non-local means filtering.


Figure 5.5: DT-CWT image without NLM

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) Vol.2, Special Issue 1, March 2014

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

Figure 5.6: DT-CWT image with NLM

Comparison results of DWT, DT-CWT without NLM and DT-CWT with NLM

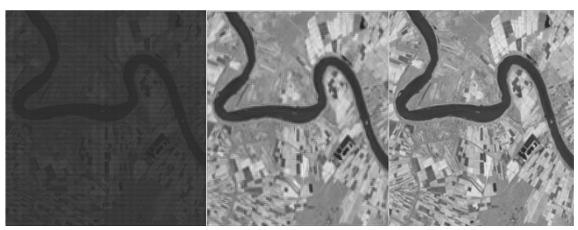

Figure 5.7: Comparison

Peak signal to noise ratio is calculated for all the algorithms and tabulated below

S.no	Algorithm	PSNR (db)
1	DWT	30.18
2	DT-CWT Without NLM	36.51
3	DT-CWT With NLM	36.73

Table I: PSNR values for various algorithm

VI. CONCLUSION

To ascertain the effectiveness of the proposed DT-CWT-NLM-RE algorithm over other wavelet-domain RE techniques, different LR optical images obtained from the Satellite Imaging Corporation webpage [1] were tested. The image of Washington DC ADS40 Orthorectified Digital Aerial Photography −0.15 m is chosen here for comparison with existing RE

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization) **Vol.2, Special Issue 1, March 2014**

Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14)

Organized by

Department of CSE, JayShriram Group of Institutions, Tirupur, Tamilnadu, India on 6th & 7th March 2014

techniques. Note that the input LR image has been obtained by down-sampling the original HR by a factor of 4. Fig. 2 shows the original "Washington DC" image, the downsampled input image, and the images obtained using SWT-RE [8], DWT-RE, SWT-DWT-RE [8], VVIR-PDE-RE [4], Lanczos interpolation, DT-CWT-RE [8], proposed DT-CWT-RE, and proposed DT-CWT-NLM-RE. The difference of the original image and images obtained using SWT-RE [8], DWT-RE [7], SWT-DWT-RE [8], VVIR-PDE-RE [5], Lanczos-RE, DT-CWT-RE [8], proposed DT-CWT-RE, and proposed DT-CWT-NLM-RE. It can be seen that the results of the proposed algorithm DT-CWT-NLM-RE are much better than the RE images obtained using other techniques. Table I shows that the proposed techniques provide improved results in terms of MSE, PSNR, and Q-index, as compared with other techniques.

REFERENCES

[1] H. Demirel ,G. Anbarjafari, "Discrete wavelet transform-based satellite image resolution enhancement," IEEE Trans. Geosci. Remote Sens., vol. 49, no. 6, pp. 1997–2004, Jun. 2011.
[2] H. Demirel and G. Anbarjafari, "Satellite image resolution enhancement using complex wavelet transform," IEEE Geosci. Remote Sens. Lett., vol. 7, no. 1, pp. 123–126, Jan. 2010.
[3] H. Zheng, A. Bouzerdoum, and S. L. Phung, "Wavelet based non-local means super-resolution for video sequences," in Proc. IEEE 17th Int. Conf. Image Process., Hong Kong, Sep. 26–29, 2010, pp. 2817–2820.
[4] A. Gambardella andM.Migliaccio, "On the superresolution of microwave scanning radiometer measurements," IEEE Geosci. Remote Sens. Lett., vol. 5, no. 4, pp. 796–800, Oct. 2008.
[5] I. W. Selesnick, R. G. Baraniuk, and N. G. Kingsbur, "The dual-tree complex wavelet transform," IEEE Signal Prcess. Mag., vol. 22, no. 6, pp. 123–151, Nov. 2005.
[6] A. Buades, B. Coll, and J. M. Morel, "Denoising image sequences does not require motion estimation," in Proc. IEEE Conf. Audio, Video Signal Based Surv., 2005, pp. 70–74.
[7] M. Protter, M. Elad, H. Takeda, and P. Milanfar, "Generalizing the nonlocal-means to super-resolution reconstruction," IEEE Trans. Image Process., vol. 18, no. 1, pp. 36–51, Jan. 2009.