International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 3, Issue 4, April 2014

Satellite Image Resolution Enhancement Using Dual-Tree Complex Wavelet Transform and Adaptive Histogram Equalization

Ms.M.Merlin Bhakiya, Ms.N.T.Sasikala

***Abstract*- Satellite images are used in many applications such as geosciences studies, astronomy, and geographical information systems. One of the most important quality factors in images comes from its resolution. Interpolation in image processing is a well-known method to increase the resolution of a digital image. Interpolation has been widely used in many image-processing applications such as facial reconstruction, multiple-description coding, and resolution enhancement. In this project, we propose a new satellite image resolution enhancement technique based on the interpolation of the high-frequency sub bands obtained by dual tree complex wavelet (DTCWT) transform and the input image. The proposed resolution enhancement technique uses DTCWT to decompose the input image into different sub-bands. Then, the high-frequency sub-band images and the input low-resolution image have been interpolated, followed by combining all these images to generate a new resolution-enhanced image by using inverse DTCWT. In order to achieve a sharper image, an intermediate stage for estimating the high-frequency sub bands has been proposed. The proposed technique has been tested on satellite benchmark images. The quantitative peak signal-to-noise ratio and root mean square error and visual results show the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques. Adaptive Histogram Equalization is the algorithm which have improved the image resolution. The PSNR improvement of the proposed technique is up to 19.79 dB.**

***Index Terms*— Dual-tree complex wavelet transform (DT-CWT), Lanczos interpolation, resolution enhancement (RE), Adaptive histogram equalization(AHE).**

Manuscript received Apr , 2014.

***Ms.Merlin Bhakiya**, Electronics and Communication, Sri muthukumaran institute of technology Chennai, Country India, 9600039713*

***Ms.N.T.Sasikala**, Electronics and Communication, Sri muthukumaran institute of technology , Chennai, India, 9791313930.,*

I. INTRODUCTION

Resolution is the limiting factor for the utilization of remote sensing data. Spatial and spectral resolutions neighbours. The *lanczos interpolation* is superior than its counterparts due to increased ability to detect edges and linear features. It also offers best compromise in terms of reduction of aliasing, sharpness and ringing. Methods based on vector-valued image regularization with partial differential equations and inpainting and zooming using sparse representations are now state of the art in the field.RE schemes suffer from the drawback of losing high frequency contents which results in blurring. Resolution enhancement in the wavelet domain is a new research area and recently, many algorithms, discrete wavelet transform (DWT), stationary wavelet transform (SWT), and *dual-tree complex wavelet transform (DT-CWT)* have been proposed. An RE scheme was proposed in using DT-CWT and bi cubic interpolations and results were compared with the conventional schemes. Finally *Adaptive histogram equalization (AHE)* is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast of an image and bringing out more detail. However, AHE has a tendency to over amplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) prevents this by limiting the amplification.

II. EXISTING IMAGE ENHANCEMENT TECHNIQUES

A. Image Enhancement Technique Using DWT

The existing resolution enhancement technique uses DWT to decompose the input image into different sub bands. Then, the high-frequency sub band images and the input low-resolution image have been interpolated, followed by combining all these images to generate a new resolution-enhanced image by using inverse DWT. In order to achieve a sharper image, an intermediate stage for estimating the high-frequency sub bands has been proposed. The existing technique has been tested on satellite benchmark images. The quantitative (peak signal-to-noise ratio and root mean square error) and visual results show the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques. The disadvantages are lack of adaptivity and poor frequency resolution, shift variance, wavelet coefficients behave unpredictably when the signal is shifted DWT lacks phase information.

III. PROPOSED SYSTEM

A. *Image Enhancement Technique Using DT-CWT*

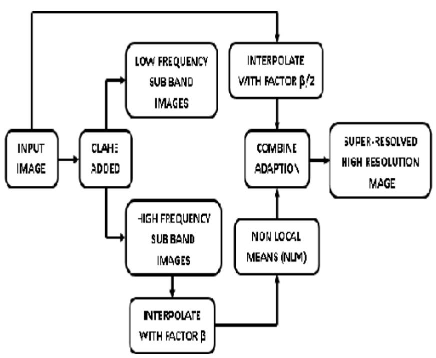

FIG: BLOCK DIAGRAM OF IMAGE ENHANCEMENT USING DT-CWT

The discrete wavelet transform-based (DWT) RE scheme generates artifacts (due to a DWT shift variant property). 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 decomposed by DT-CWT (which is nearly shift invariant) to obtain high-frequency subbands. The high-frequency subbands and the low-resolution (LR) input image are interpolated using the Lanczos interpolator**.** The high frequency subbands are passed through an NLM filter to cater for the artifacts generated by DT-CWT (despite of its nearly shift invariance). The filtered high-frequency subbands and the LR input image are combined using inverse DT-CWT to obtain a resolution-enhanced image. Objective and subjective analyses reveal superiority of the proposed technique over the conventional and state-of-the-art RE techniques.

It turns out that, for some applications of the discrete wavelet transform, improvements can be obtained by using an expansive wavelet transform in place of a critically-sampled one. (An expansive transform is one that converts an N-point signal into M coefficients with M > N.) There are several kinds of expansive DWTs; here we describe the dual-tree complex discrete wavelet transform. The dual-tree complex DWT of a signal x is implemented using two critically-sampled DWTs in parallel on the same data, as shown in the figure.

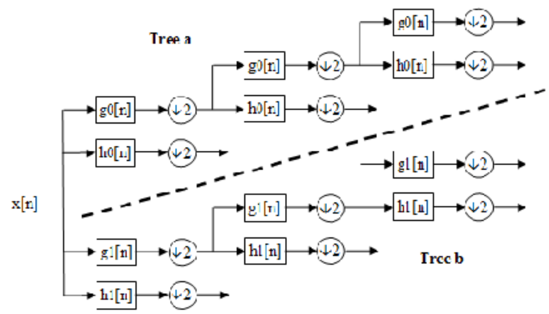

FIG: BLOCK DIAGRAM FOR A 3-LEVEL DTCWT

The transform is 2-times expansive because for an N-point signal it gives 2N DWT coefficients. If the filters in the upper and lower DWTs are the same, then no advantage is gained. However, if the filters are designed is a specific way, then the sub-band signals of the upper DWT can be interpreted as the real part of a complex wavelet transform, and sub-band signals of the lower DWT can be interpreted as the imaginary part.

Equivalently, for specially designed sets of filters, the wavelet associated with the upper DWT can be an approximate Hilbert transform of the wavelet associated with the lower DWT. When designed in this way, the dual-tree complex DWT is nearly shift-invariant, in contrast with the critically-sampled DWT. Moreover, the dual-tree complex DWT can be used to implement 2D wavelet transforms where each wavelet is oriented, which is especially useful for image processing. The dual-tree complex DWT outperforms the critically-sampled DWT for applications like image de-noising and enhancement.

The Dual-tree complex wavelet transform (DTCWT) calculates the complex transform of a signal using two separate DWT decompositions (tree a and tree b). If the filters used in one are specifically designed different from those in the other it is possible for one DWT to produce the real coefficients and the other the imaginary.

This redundancy of two provides extra information for analysis but at the expense of extra computational power. It also provides approximate shift-invariance (unlike the DWT) yet still allows perfect reconstruction of the signal.

IV. RESULTS AND DISCUSSIONS

To ascertain the effectiveness of the proposed DT-CWTNLM-RE algorithm over other wavelet-domain RE techniques, different LR optical images were tested.

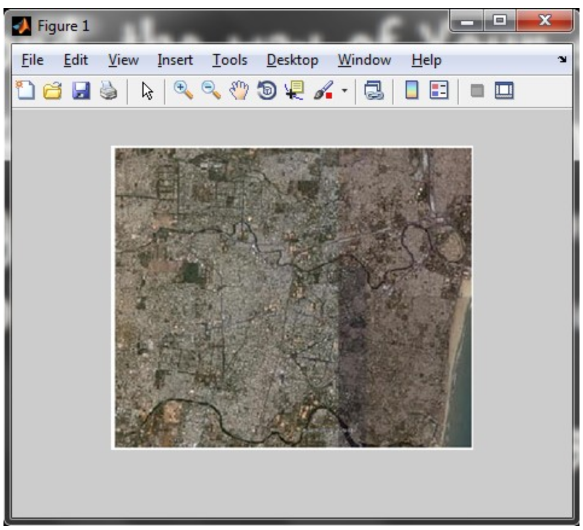

FIG: INPUT IMAGE

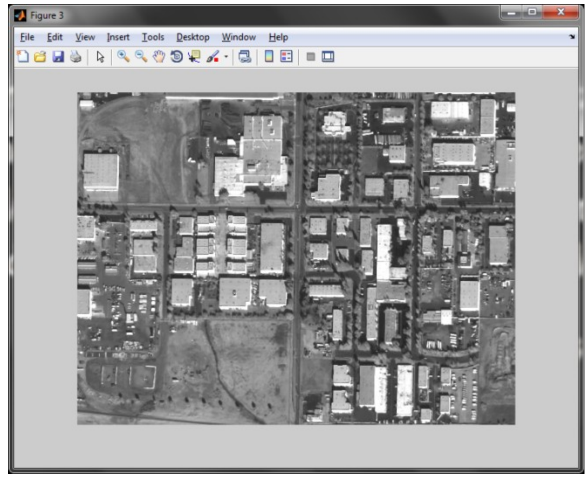

FIG: OUTPUT IMAGE AFTER APPLYING DT-CWT

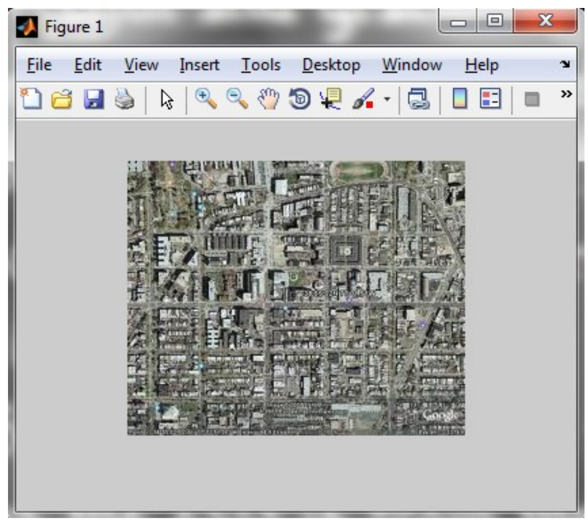

FIG: INPUT IMAGE BEFORE APPLYING ADAPTIVE HISTOGRAM EQUALIZATION

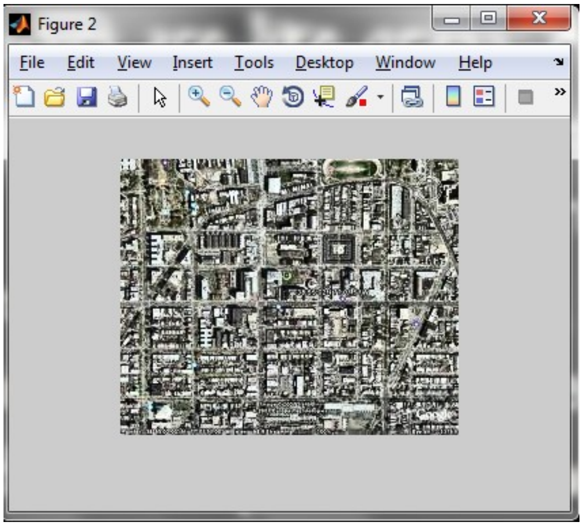

FIG: IMAGE AFTER INCREASING CONTRAST

V. CONCLUSION

An RE technique based on DT-CWT and an NLM filter has been proposed. The technique decomposes the LR input image using DT-CWT. Wavelet coefficients and the LR input image were interpolated using the Lanczos interpolator.DT-CWT is used since it is nearly shift invariant and generates less artifacts, as compared with DWT. NLM filtering is used to overcome the artifacts generated by DT-CWT and to further enhance the performance of the proposed technique in terms of MSE, PSNR, and *Q*-index. Simulation results highlight the superior performance of proposed techniques.

REFERENCES

[1] Y. Piao, I. Shin, and H. W. Park, "Image resolution enhancement using inter-subband correlation in wavelet domain," in *Proc. Int. Conf. Image Process.*, San Antonio, TX, 2007, pp. I-445–I-448.
[2] C. B. Atkins, C. A. Bouman, and J. P. Allebach, "Optimal image scaling using pixel classification," in *Proc. Int. Conf. Image Process.*, Oct. 7–10, 2001, pp. 864–867.
[3] A. S. Glassner, K. Turkowski, and S. Gabriel, "Filters for common resampling tasks," in *Graphics Gems*. New York: Academic, 1990, pp. 147–165.
[4] D. Tschumperle and R. Deriche, "Vector-valued image regularization with PDE's: A common framework for different applications," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 27, no. 4, pp. 506–517, Apr. 2005.
[5] M. J. Fadili, J. Starck, and F. Murtagh, "Inpainting and zooming using sparse representations," *Comput. J.*, vol. 52, no. 1, pp. 64–79, Jan. 2009.
[6] H. Demirel and G. Anbarjafari, "Discrete wavelet transform-based satellite image resolution enhancement," *IEEE Trans. Geosci. Remote Sens.*, vol. 49, no. 6, pp. 1997–2004, Jun. 2011.
[7] H. Demirel and G. Anbarjafari, "Image resolution enhancement by using discrete and stationary wavelet decomposition," *IEEE Trans. Image Process.*, vol. 20, no. 5, pp. 1458–1460, May 2011.
[8] 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.
[9] H. Demirel and G. Anbarjafari, "Image super resolution based on interpolation of wavelet domain high frequency subbands and the spatial domain input image," *ETRI J.*, vol. 32, no. 3, pp. 390–394, Jan. 2010.
[10] 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.
[11] 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.
[12] 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.
[13] J. L. Starck, F. Murtagh, and J. M. Fadili, *Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity*. Cambridge, U.K.: Cambridge Univ. Press, 2010.
[14] A. Buades, B. Coll, and J. M. Morel, "A review of image denoising algorithms, with a new one," *Multisc. Model. Simul.*, vol. 4, no. 2, pp. 490– 530, 2005.
[15] 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.
[16] M. Protter, M. Elad, H. Takeda, and P. Milanfar, "Generalizing the non local-means to super-resolution reconstruction," *IEEE Trans. Image Process.*, vol. 18, no. 1, pp. 36–51, Jan. 2009.

