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IMAGE IMPROVEMENT WITH LOW RESOLUTION USE OF SWT AND DWT WITH SWT

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ABSTRACT
In the field of image processing, satellite imaging is one of the challenging task. The different satellite remote sensors are available in very low resolution to high resolution range for obtaining satellite images. Resolution enhancement, is used to modify the resolution of satellite images so that modified images are of better quality with enhanced edges.This paper proposes two transform domain methods such as Stationary Wavelet Transform (SWT) and Discrete Wavelet Transform (DWT) with Stationary Wavelet Transform (SWT).DWT withSWT gives better resolution enhancement compared to SWT, because the high frequency components of SWT are added with high frequency components of DWT to generate estimated high frequency components. These methods compared in terms of Peak Signal to Noise Ratio (PSNR), Root Mean Square Error (RMSE), Mean Square Error (MSE), Mean Absolute Error (MAE) andTIME to show the quality of the particular methods.
KEYWORDS: Stationary Wavelet Transform, Discrete Wavelet Transform, Resolution Enhancement.

INTRODUCTION

In current situation, most of the applications need good quality of images.The applications that require better resolution images are astronomy, advertisement crime, object recognition, defense monitoring and medical etc. Image resolution enhancement is the one of the major applications of image processing. This application is applied to generate quality images for above mentioned applications. Image resolution enhancement is also important in some other applications such as recognition of bride, construction of building and GPS system etc. The resolution is the drawback of satellite images mainly due to instrument problem, high distance of satellite orbits and environment disturbance. Hence resolution enhancement is one of the better process to resolve resolution drawback of satellite images. Transform domain and spatial domain are considered to improve the resolution of satellite images. Transfer domain methods produce better resolution as compared to the spatial domain. Transfer domain methods preserve the edges in domain. But it is required to determine suitable transform that can be considered for better resolution enhancement of satellite images. In initial stage different interpolation techniques have been considered to improve resolution of satellite images such as nearest neighbour, bilinear interpolation. But they provide blurred image. Hence, the transform domain algorithms such as Discrete Wavelet Transform, Stationary Wavelet Transform and Discrete Wavelet Transform with Stationary Wavelet Transform are considered to overcome drawbacks.In this paper, we have implemented SWT and DWT with SWT and results are compared with evaluation parameters such as PSNR, RMSE, MSE, MAE and TIME. These parameters indicate which algorithm is superior in providing better resolution image.

METHODOLOGY

Wavelet is a small wave which has varying frequency and limited time duration, it acts asa tool for resolution enhancement. Wavelet provides the fine details in image and it can regularly denoise or compress a signalwith need in degradation. Two methods are proposed, in this paper, to enhance the resolution of the image.

1) StationaryWaveletTransform (SWT):

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Stationary Wavelet Transform (SWT) is one of the method for image resolution enhancement. SWT decomposes the input image intofour sub band frequency images(LL,LH,HL and HH). Then, bicubic interpolation is used for image resolution enhancement and performed on four sub bands, which produces smoothened edges with less blurring compared to other interpolation techniques. This method does not use down sample image, because input image and sub band images are of same size. The estimated high frequency LH,HL and HH sub band images along with low resolution input image is measured for winning IDWT to generate high resolution image.

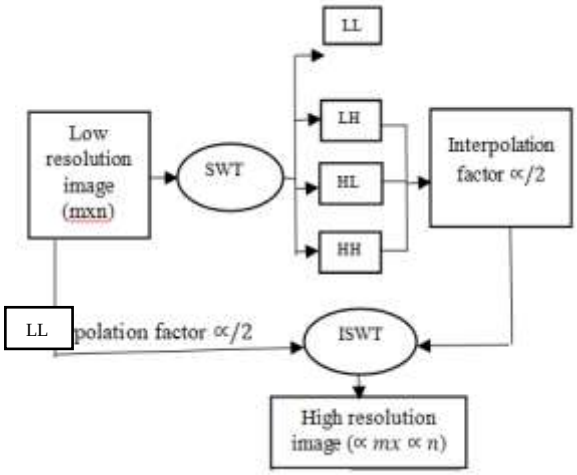

Figure 1: Block Diagram of SWT-based image resolution enhancement

2)Discrete Wavelet Transform (DWT) with Stationary Wavelet Transform (SWT):

In this method, low resolution image is given to both SWT and DWT as input image, which produce four frequency sub band images such as LowLow(LL), Low High(LH), High Low(HL), High High(HH). All the four sub band images are interpolated in DWT with factor 2, but it is not required in SWT, because input and sub band images are of same size.

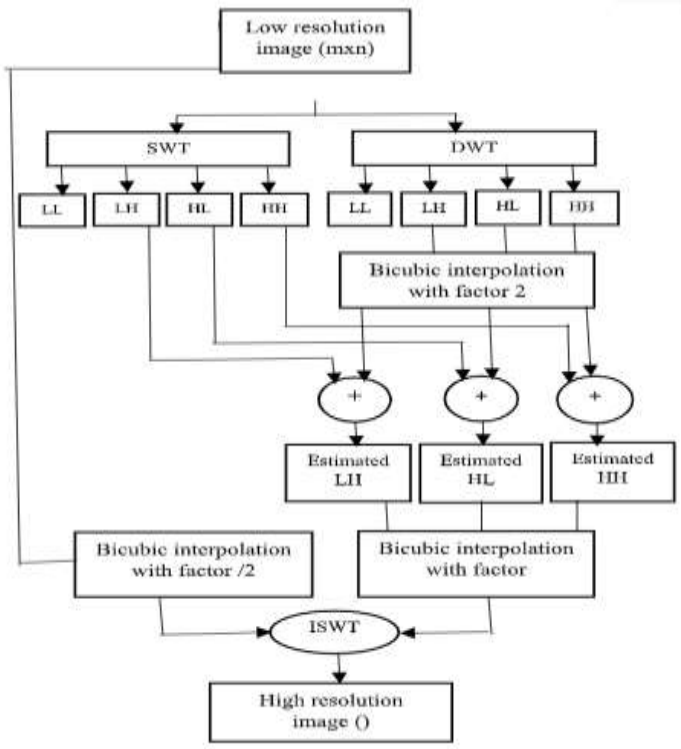

Figure 2: Block diagram of DWT with SWT-based image resolution enhancement

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All the high frequency sub band images are added to each other, to generate estimated high frequency sub band images and these are interpolated with factor $\propto/2$. Instead of LL band low resolution input image is interpolated with factor $\propto/2$. Inverse Discrete Wavelet Transform (IDWT) is applied on all interpolated sub band images and interpolated low resolution input image to generate high resolution image. High frequency contents are preserved in this method. PSNR is increased in this method and better quality image is obtained.

PERFORMANCE PARAMETERS

It is required to examineboth the applied resolution enhancement methods to show superiority of methods over satellite image. For this, the following parameters are considered,

1)Mean Square Error (MSE) :- MSE calculates the error between two images. MSE between input image and original image is measured by,

MSE $=\frac{\sum_{i,j}(I_{in}(i,j)-I_{org}(i,j)}{MXN}$, where M and N are the size of images.

2)Root Mean Square Error (RMSE) :- RMSE calculates the equivalent pixels in the reference image and obtained high resolution image (H_r). Less RMSE value indicates better quality image. It is mathematically represented as,

RMSE $= \sqrt{\frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left(H_r(i,j)-H(i,j)\right)^2}{MN}}$

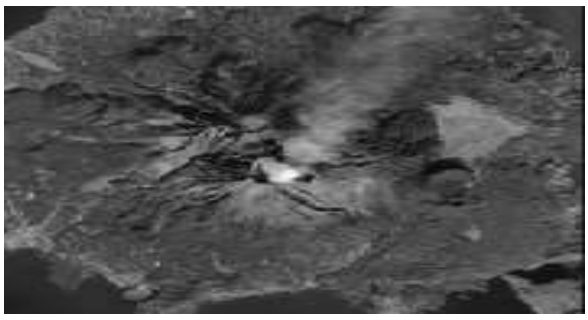
3)Mean Absolute Error (MAE) :- MAE is the absolute value of difference between the reference image and high resolution image. It is mathematically represented as,

MAE $= \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}|H_r(i,j)-H(i,j)|$

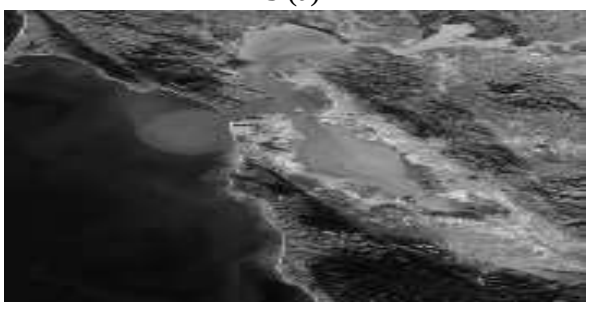
4)Peak Signal to Noise Ratio (PSNR) :- PSNR identifies the ratio between original image and reconstructed image. High PSNR indicate the better quality of image. PSNR is mathematically represented as, PSNR = 10 $\log_{10}(\frac{R^2}{MSE})$, where R is the maximum fluctuation of input image.

RESULTS

The following satellite images have been tested by using both methods. It is clear that DWT with SWT gives better result as compared to SWT, because PSNR is increased in second method.



3 (a)



3(b)

Figure 3: Original low resolution images

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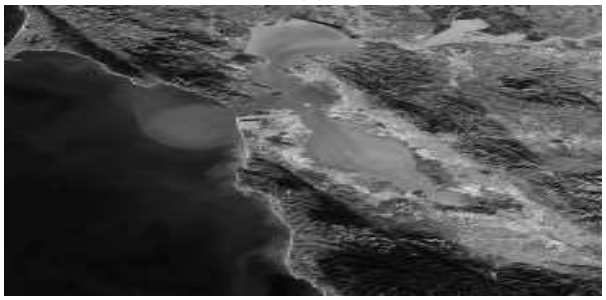
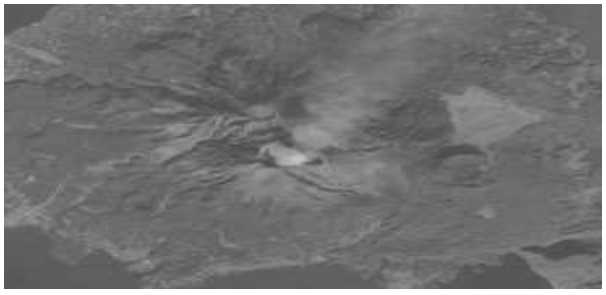
4 (a)



4 (b)

Figure 4 : Enhanced image using SWT



5 (a)

5 (b)

Figure 5 : Enhanced image using DWT with SWT

CONCLUSION

This paper has presented the resolution enhancement techniques in frequency domain for satellite images. High frequency sub band images are generated by using SWT and DWT with SWT. It is concluded that SWT with DWT produces better resolution enhancement of satellite images compared to SWT and db1 wavelet is applied for implementation.

REFERENCES

1. Ms.M.MerlinBhakiya, Ms.N.T.Sasikala “Satellite Image Resolution Enhancement using Dual-Tree Complex Wavelet Transform and Adaptive Histogram Equalization”,International research of Advances

in Electronics and Communication Engineering (IJARECE), Volume 3,Issue 4, ISSN:2278-909X,pp,467-470,April 2014.

2. Ammu Anna Mathew, S. Kamatchi "Brightness and Resolution Enhancement of Satellite Images using SVD and DWT", International Journal of Engineering Trends and Technology (IJETT)-Volume4, Issue4, pp.712-718, April 2013.
3. H.Demirel, G.Anbarjafari,"Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement",IEEE Geosciences and Remote Sensing,Vol.49,pp.1997-2004, June,2011.
4. H.Demirel, G.Anbarjafari, "Satellite image resolution enhancement using Complex Wavelet Transform", IEEE Geosci. Remote Sens. Lett. Vol.7, No.1,pp.123-126,Jan. 2010.
5. Atkins, C.B., C.A. Bouman, and J.P. Allebach. Optimal image scaling using pixel classification. in Image Processing, 2001. Proceedings. 2001 International Conference on. 2001.
6. Demirel, H. and G. Anbarjafari, Satellite Image Resolution Enhancement Using Complex Wavelet Transform. Geoscience and Remote Sensing Letters, IEEE, 2010. 7(1): p. 123-126.
7. Yinji, P., S. Il-hong, and P. HyunWook. Image Resolution Enhancement using Inter-Subband Correlation in Wavelet Domain. in Image Processing, 2007. ICIP 2007. IEEE International Conference on. 2007.
8. Demirel, H., G. Anbarjafari, and S. Izadpanahi. Improved motion based localized super resolution technique using discrete wavelet transform for low resolution video enhancement. in 17th European Signal Processing Conference. Aug. 2009. Glasgow, Scotland.
9. G. Anbarjafari and H. Demirel, Image super resolution based on interpolation of wavelet domain high frequency subbands and the spatial domain input image. ETRI Journal, 2010. 32(3): p. 390-394.
10. S A Desai et al, International Journal of Computer Science and Mobile Computing, Vol.3 Issue.10, October- 2014, pg. 344-348 © 2014, IJCSMC All Rights Reserved 348
11. Damirel, H. and G. Anbarjafari, Image super resolution based on interpolation of wavelet domain high frequency subbands and the spatial domain input image. ETRI Journal, 2011. 20(5).
12. Demirel, H. and G. Anbarjafari, IMAGE Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition. Image Processing, IEEE Transactions on, 2011. 20(5): p. 1458-1460.