IMAGE RESOLUTION ENHANCEMENT TECHNIQUE BY INTERPOLATION IN WAVELET DOMAIN

Aparna Gupta[1], Miss Sonika[2]
[2]Professor, Department of ETC, CSIT, Durg
Email:[1]apanagupta.gupta6@gmail.com, [2]sonikaarora@csitdurg.in

Abstract— Increasing the number of pixel in an image is one of the crucial operation in image processing and known as image resolution enhancement. Image resolution enhancement is very useful for satellite and medical image where sometimes minute details of image is required. Interpolation is one of the method to increase the resolution of the image but its performance is not satisfactory. This paper present an resolution enhancement algorithm which is a combination of DWT (Discrete Wavelet Transform), SWT(Stationary Wavelet Transform) and Interpolation method. Comparison of this method with past method ascertain its better performance over past method.

Keywords— Discrete wavelet transform, image super resolution, stationary wavelet transform, wavelet zero padding.

I. INTRODUCTION

Main object of Image resolution enhancement is to surpass the limitation posed by poor image acquisition device and inadequate acquisition condition[1]. Image with high resolution is very useful in many application. Resolution is one of the important characteristics of an image and high resolution image can be used for extracting minute details from the image. This is very useful for satellite as well as the medical image. Since satellite images carry some vital information about the object therefore it is essential to have high resolution satellite image [1-2]. Since these images are captured by the satellite, therefore these images are greatly affected by the atmospheric characteristics of the space at the time of image acquisition. Image resolution enhancement of these images can be used for better perception of the image. In the same way, with the use of advanced medical equipment in the medical field, forced much attention to enhance the medical image. Limitation of image acquisition devices, noise, low contrast and illumination condition degrades the quality of the medical image to that extent that it becomes impossible for the radiologist to interpret the image. Enhancement in the resolution of the image is one of the solutions of this problem which make the radiologist to interpret the medical image correctly [3-4]. In order to enhance the resolution of the image, an appropriate algorithm is required which must be able to enhance the resolution without degrading the details of the image. Resolution of the image can be enhanced by increasing number of pixel that represents the image. Interpolation is one of the techniques which is used to increase the number of pixel. Interpolation techniques is widely used in various image processing application like reconstruction of facial image

[3], in multiple description coding[4], as well as in image resolution enhancement[5-7]. For long, interpolation has been used for enhancing the resolution of the image and different interpolation based method has been proposed in the past to improve the quality of this work.

There are basically three interpolation method which are used most frequently i.e. Nearest neighborhood, Bi-liner and Bi-cubic. Among the three, bi-cubic interpolation technique is best in interpolating the most accurate missing pixel values. Though these techniques are easy but fail to give enhanced resolution image because being not able to produce high frequency part of the image. Recently, image resolution enhancement in frequency domain has emerged as a new research topic in this field. Different algorithm for image resolution enhancement has been proposed [8-11] . Discrete wavelet transform has been used in image processing for several years [8]. Discrete wavelet transform (DWT) divides the images in to different frequency sub-bands i.e. Low frequency band (LL), Mid Frequency Band (LH, HL) and high frequency band (HH).

Regularity preserving interpolation of image[11],HMM based super resolution approach for image[12][13],Wavelet zero padding(WZP) and cycle spinning based approach for resolution enhancement[14], wavelet zero padding and cycle spinning with edge rectification[15].

A new technique of image resolution enhancement has been proposed by G.Anber Jafari [6] which is combination of interpolation and wavelet transform. This technique is able to overcome the drawback of the interpolation based image resolution enhancement to greater extent. But since in this technique, interpolation is used to approximate the missing high frequency coefficient, therefore it also produce aliasing phenomenon [16, 17]

Stationary wavelet transform [17] is another variants of wavelet transform which is same as the DWT with the exception that it does not down-sample the image and hence all the frequency bands has the size of original image. Stationary wavelet transform is also used in various image processing application.

This paper present a resolution enhancement algorithm which is able to produce a sharp high resolution image. Proposed method utilize the properties of DWT(Discrete wavelet transform) and SWT(Stationary wavelet Transform).

Proposed method starts by decomposing the low resolution image in to different frequency sub-bands. All the three high frequency coefficients are then interpolated with the help of bi-cubic interpolation. SWT is used in this algorithm to obtain the high frequency component of the input image which is then added to the interpolated high frequency component for correct estimation of the high frequency component. At last, Inverse discrete transform is applied to get the high resolution enhancement techniques.

II. METHODOLOGY

Block diagram of proposed methodology is shown in the figure1. The procedural steps are described in the next section.

Step 1: first of all high resolution image of dimension 512x512 is taken and then with the help of Gaussian smoothing filter it is down sampled by factor 2 to produce low resolution image of dimension 256x256.

Step 2: Low resolution image obtained in the first step is divided in to 4 frequency sub-bands i.e. LL (Low frequency component), LH (Low high frequency Component), HL (High-low frequency component) and HH (HIGH frequency component). All the 4 frequency sub-bands obtain in this step has the dimension size which is half of the dimension size of input low resolution image.

Step 3: SWT(Stationary wavelet Transform) is also applied to the low resolution input image to get the 4 frequency sub-bands i.e. LL(Low frequency component), LH(Low high frequency

Component) ,HL(High-low frequency component) and HH(HIGH frequency component) . Dimension size of these frequency sub-bands is same as the size of low resolution input image.

Step 4: Frequency sub-bands LH,HL and HH obtained by DWT decomposition is then undergoes interpolation operation (Bi-cubic) by a factor of 2 to get the double dimension size frequency sub-bands. Now these sub-bands are added to the corresponding frequency component obtained by the SWT in the previous step to get the estimated LH,HL,HH frequency component.

Step 5: In this step, estimated LH,HL,HH frequency component are again interpolated by factor ½.At the same time input low resolution image is also interpolated with the factor ½ . This Interpolated image work as the estimated LL frequency component.

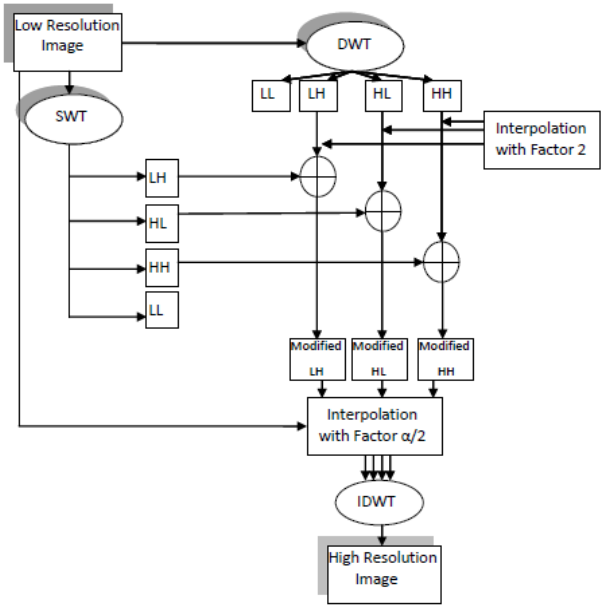

Figure 1. Block Diagram of Proposed Algorithm

Step 6: Frequency component obtained from previous two step i.e. LL,LH,HL and HH is taken and inverse discrete transform is applied to get the high resolution image. For performance comparison, Bi-cubic interpolation method and WZP(wavelet zero padding) method Is also applied to same low resolution image to get the high resolution image.

III. EXPERIMENTAL RESULTS

Since image resolution enhancement is very useful for satellite images and medical images for extracting out the minutes details therefore it is very important to test the performance of proposed method in different kind of images. Images of three different categories i.e. General image, Satellite image and medical image has been taken to test the performance of proposed method.

First of all high resolution images of all the three categories has been taken and then it is converted to low resolution image. Then proposed method is applied to these low resolution images to obtain the high resolution images. In order to compare the performance of proposed method, bi-cubic interpolation method and WZP method is also applied to these images to obtain the high resolution image from these methods. PSNR and MSE is computed for all the result obtain for all the three method. Whole process is performed under MATLAB Ver. 2009B for the system having 2GB RAM and Core2duo processor.

The result obtain by applying the bicubic, WZP and Proposed method to low resolution "Lenna.tif" is shown in figure 2.

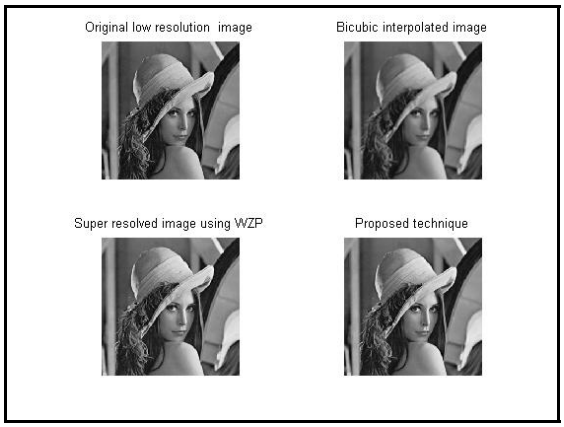

Figure 2. Result Illustration of low resolution "Lenna.tif (128x128)" image to high resolution image (256x256) for different techniques

Same methods are applied to the low resolution satellite image "Sattelite1.tif and obtained results is given in the figure 3.

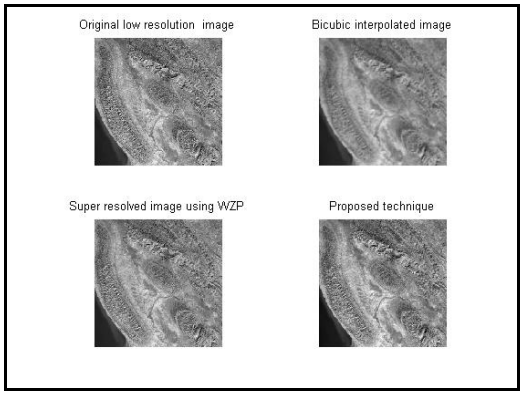

Figure 3. Results of low resolution "satellite.tif(128x128)" image to high resolution image (256x256) for different techniques.

For testing the proposed method for low resolution medical image, all the three method are also applied to medical image "brain.tif" and obtained high resolution image is shown in figure 4.

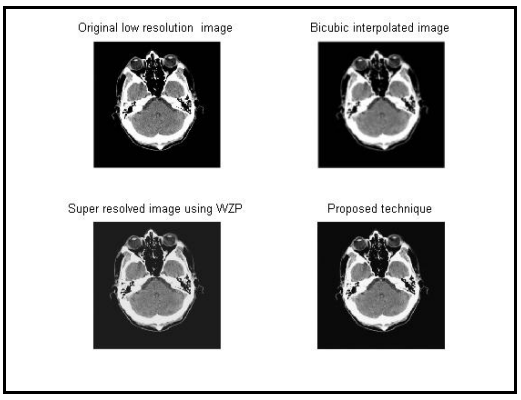

Figure 4 Results of low resolution "brain1.tif(128x128)" image to high resolution image (256x256) for different techniques.

Apart from visual comparison, statistical parameter were also computed for better understanding of performance. For this PSNR and MSE(Mean Square Error) is computed and tabulated in Table1 and Table2.

Table 1

Technique Used	PSNR		
	Lenna.tif	Brain1.tif	Satellite1.tif
Bi-cubic	28.14	30.27	29.19
WZP	36.12	36.01	34.29
Proposed	36.87	36.82	35.10

Table 2

Technique Used	MSE		
	Lenna.tif	Brain1.tif	Satellite1.tif
Bi-cubic	0.3913	0.2396	0.3073
WZP	0.0623	0.0639	0.0950
Proposed	0.0524	0.0530	0.0788

Figure 5 Shows the graph for PSNR for all the three methods.

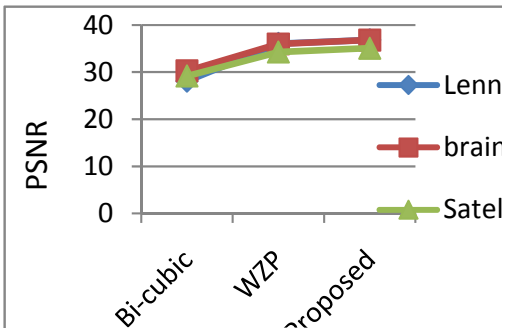

Figure 5. PSNR graph for different Techniques of Image Resolution Enhancement

IV. CONCLUSION

Image resolution enhancement is one of the significant operations of image processing aiming to get the high resolution image and extract out the details of the image. In this paper, Combination of DWT-SWT and Bi-cubic interpolation based method is implemented. Proposed method is compared with the past methods of resolution enhancement. PSNR and MSE metrics are used to compare the

performance of the proposed method. Visual results and the computed parameters value suggest the supremacy of the proposed method over past method. In future, other variants of wavelet transform can also be combined to explore the possibility of getting better results.

References

[1] P.Suganya, N.Mohanapriya, A.Vanitha "Survey on Image Resolution Techniques for Satellite Images" International Journal of Computer Science and Information Technologies, Vol. 4 no.6 , 2013, pp. 835-838.

[2] A. Abirami, N. Akshaya, D. Poornakala, D. Priyanka, C. Ram kumar, "Enhancement of Satellite Image Resolution With Moving Objects" IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)Volume 4, Issue 6 (Jan. - Feb. 2013), PP 22-27.

[3] Dr. Muna F. Al-Samaraie , Dr. Nedhal Abdul Majied Al Saiyd "Medical colored image enhancement using wavelet Transform followed by image sharpening" Ubiquitous Computing and Communication Journal, Volume 6 Number 5.

[4] Hanan Saleh S. Ahmed and Md Jan Nordin "Improving Diagnostic Viewing of Medical Images using Enhancement Algorithms"Journal of Computer Science, vol 7 no.12, 2011.

[5] W. K. Carey, D. B. Chuang, S. S. Hemami, "Regularity preserving image interpolation" IEEE Transaction on Image Processing, vol.8, no.9, pp.1293-1297, Sep-1999.

[6] H. Demiral and G. Anbarjafari, "Image super resolution based on interpolation of wavelet domain high frequency sub-bands and spatial domain input image" ETRI Journal, vol. 32, no. 3, pp.390-394, June 2010 .

[7] Z. Xie, "A wavelet based algorithm for image super resolution" B.S,university of science and technology of China 2003.

[8] Y. Piao, I. Shin, and H. W. Park, "Image resolution enhancement using inter-subband correlation in wavelet domain," in Proc. Int. Conf. Image Process., 2007, vol. 1, pp. I-445–448.

[9] H. Demirel and G. Anbarjafari, "Satellite image resolution enhancement using complex wavelet transform," IEEE Geoscience and Remote Sensing Letter, vol. 7, no. 1, pp. 123–126, Jan. 2010.

[10] 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, vol. 3, pp. 864–867.

[11] W. K. Carey, D. B. Chuang, and S. S. Hemami, "Regularity-preserving image interpolation," IEEE Trans. Image Process., vol. 8, no. 9, pp. 1295–1297, Sep. 1999.

[12] K. Kinebuchi, D. D. Muresan, and R. G. Baraniuk, "Wavelet- based statistical signal processing using hidden Markov models," in Proc. Int. Conf. Acoust., Speech, Signal Process., 2001, vol. 3, pp. 7–11.

[13] S. Zhao, H. Han, and S. Peng, "Wavelet domain HMT-based image super resolution," in Proc. IEEE Int. Conf. Image Process., Sep. 2003, vol. 2, pp. 933–936.

[14] A. Temizel and T. Vlachos, "Wavelet domain image resolution en- hancement using cycle-spinning," Electron. Lett., vol. 41, no. 3, pp. 119– 121, Feb. 3, 2005.

[15] A. Temizel and T. Vlachos, "Image resolution upscaling in the wavelet domain using directional cycle spinning," J. Electron. Imag., vol. 14, no. 4, 2005.

[16] Bagawade Ramdas , Bhagawat Keshav , Patil Pradeep, "Wavelet Transform Techniques for Image Resolution Enhancement: A Study", International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 4, April 2012.

[17] S.venkata ramana " A Novel Method to Improve Resolution of Satellite Images Using DWT and Interpolation", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 1, January 2014.