An Efficient Adaptive Image Enhancement Method in Wavelet Domain

V. Venkata Lakshmi [1], B. Ramu[2], M.Uma rani[3]
[1]Asst .Professor, Geethanjali College of Engineering & Technology, Cheeryala, T.S., India.
[2]Asst.Professor, Geethanjali College of Engineering & Technology, Cheeryala,T.S,India.
[3]Asst.Professor, Geethanjali College of Engineering & Technology, Cheeryala,T.S,India.

Abstract— **In this paper we propose an image resolution enhancement technique which generates sharper high resolution images. The proposed technique uses Discrete Wave Transform(DWT) to decompose a low resolution image into three high frequency sub-bands. Then these sub-band images have been interpolated with the help of bi-cubic interpolation. The high frequency sub-bands obtained by SWT of the input image are converted into the interpolated high frequency sub-bands. This helps in correcting the estimated coefficients. In addition the input image is also interpolated separately. Finally, corrected interpolated high frequency sub-bands and interpolated input image are combined by using a method called inverse DWT (IDWT) to achieve a high resolution output image. To achieve sharper images, we propose to use an intermediate stage to estimate the high frequency sub bands by utilizing the difference image obtained by subtracting the input image and its interpolated LL sub band.**

Keywords— **DWT, Image, Interpolation, Multi resolution transform.**

I. Introduction

Image interpolation[1][2] occurs in all digital photos at some stage — whether this be in bayer demosaicing or in photo enlargement. It happens anytime you resize or remap (distort) your image from one pixel grid to another. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur under a wider variety of scenarios: correcting for lens distortion, changing perspective, and rotating an image. Even if the same image resize or remap is performed, the results can vary significantly depending on the interpolation algorithm. It is only an approximation, therefore an image will always lose some quality each time interpolation is performed.

Common interpolation algorithms can be grouped into two categories: adaptive and non-adaptive. Adaptive methods change depending on what they are interpolating (sharp edges vs. smooth texture), whereas non-adaptive methods treat all pixels equally. Non-adaptive algorithms include: nearest neighbor, bilinear, bicubic, spline, sinc, lanczos and others. Depending on their complexity, these use anywhere from 0 to 256 (or more) adjacent pixels when interpolating. The more adjacent pixels they include, the more accurate they can become, but this comes at the expense of much longer processing time. These algorithms can be used to both distort and resize a photo. Adaptive algorithms include many proprietary algorithms in licensed software such as: Qimage, PhotoZoom Pro, Genuine Fractals and others. Many of these apply a different version of their algorithm (on a pixel-by-pixel basis) when they detect the presence of an edge — aiming to minimize unsightly interpolation artifacts in regions where they are most apparent. These algorithms are primarily designed to maximize artifact-free detail in enlarged photos, so some cannot be used to distort or rotate an image.

NEAREST NEIGHBOR INTERPOLATION: Nearest neighbor is the most basic and requires the least processing time of all the interpolation algorithms because it only considers one pixel — the closest one to the interpolated point. This has the effect of simply making each pixel bigger.

BILINEAR INTERPOLATION: Bilinear interpolation considers the closest 2x2 neighborhood of known pixel values surrounding the unknown pixel. It then takes a weighted average of these 4 pixels to arrive at its final interpolated value. This results in much smoother looking images than nearest neighbor.

BICUBIC INTERPOLATION: Bicubic goes one step beyond bilinear by considering the closest 4x4 neighborhood of known pixels — for a total of 16 pixels. Since these are at various distances from the unknown pixel, closer pixels are given a higher weighting in the calculation. Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality.

Wavelets are also playing a significant role in many image processing applications. The 2-D wavelet decomposition of an image is performed by applying the 1-D discrete wavelet transform (DWT)[3][4] along the rows of the image first, and then finally, corrected interpolated high frequency sub bands and interpolated input image are combined with the help of inverse DWT (IDWT) to achieve a high resolution output image. The results are decomposed into columns. This operation results in four decomposed sub band images called low low(LL), low-high (LH), high-low (HL), and high-high (HH).The frequency components of these sub bands cover the full frequency spectrum of the original image. Image resolution enhancement[5] using wavelets is a relatively a new subject and recently many new algorithms have been proposed. Their task was carried out by investigating the evolution of wavelet transform extreme among the same type of sub bands. Edges identified by an edge detection algorithm[6] in lower frequency sub bands were used to prepare a model used for estimating edges in higher frequency sub bands and only the coefficients with significant values were estimated as the evolution of the wavelet coefficients. In many researches, hidden Markov model has been also implemented in order to estimate the coefficients.

In this paper we propose an image resolution enhancement technique which generates sharper high resolution images. The proposed technique uses Discrete Wave Transform(DWT) to decompose a low resolution image into three high frequency sub-bands. Then these sub-band images have been interpolated with the help of bi-cubic interpolation. The high frequency sub-bands obtained by SWT of the input image are converted into the interpolated high frequency sub-bands. This helps in correcting the estimated coefficients. In addition the input image is also interpolated separately. Finally, corrected interpolated high frequency sub-bands and interpolated input image are combined by using a method called inverse DWT (IDWT) to achieve a high resolution output image. To achieve sharper images, we propose to use an intermediate stage to estimate the high frequency sub bands by utilizing the difference image obtained by subtracting the input image and its interpolated LL sub band. In all steps of the proposed satellite image resolution enhancement technique, Daubechies wavelet transform as mother wavelet function and bi-cubic interpolation as interpolation technique have been used.

II. EXISTING SYSTEM

The main loss in image resolution enhancement by using interpolation is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. Edges plays very important role in image. To increase the quality of the super resolved image, it is essential to preserve all the edges in image. In [5] work, DWT has been employed in order to preserve the high frequency components of the image(i.e. edges). The redundancy and shift invariance of the DWT mean that DWT coefficients are inherently interpolable. In this correspondence, one level DWT (with Daubechies 9/7 as wavelet function) is used to decompose an input image into different subband images. Three high frequency subbands (LH, HL, and HH) contain the high frequency components of the input image(i.e. edges). In this technique, bicubic interpolation with enlargement factor of 2 is applied to high frequency subband images. Information loss occur due to downsampling in each of the DWT subbands caused in therespective subbands. That is why SWT (Stationary Wavelet Transform) is used to minimize this loss.

The SWT is an inherently redundant scheme as the output of each level of SWT contains the same number of samples as the input – so for a decomposition of N levels there is a redundancy of N in the wavelet coefficients. The interpolated high frequency subbands and the SWT high frequency subbands have the same size which means they can be added with each other. The new corrected high frequency subbands can be interpolated further for higher enlargement. Also it is known that in the wavelet domain, lowpass filtering of the high resolution image produce the low resolution image. In other words, low frequency subband is the low resolution of the original image. Therefore, instead of using low frequency subband, which contains less information than the original high resolution image, Hasan Demirel and Gholamreza Anbarjafari [5] are using the input image for the interpolation of low frequency subband image. The quality of the super resolved image increases using input image instead of low frequency subband. Figure 1 illustrates the block diagram of the used image resolution enhancement technique.

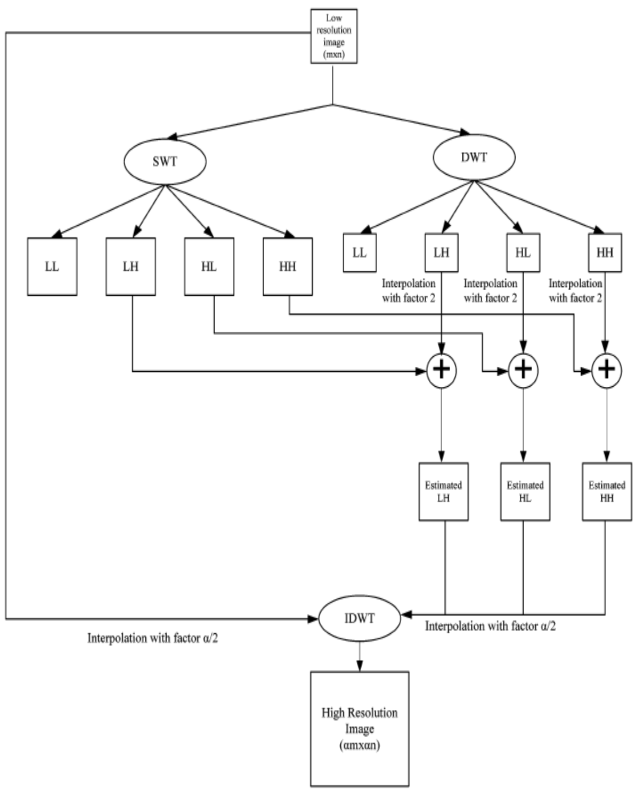


Figure 1. Block diagram of image resolution enhancement method using SWT and DWT

By interpolating input image by 3, and high frequency subbands by 2 and in the intermediate and final interpolation stages respectively, and then by applying IDWT, as illustrated in Figure 1, the output image will contain sharper edges than the interpolated image obtained by interpolation of the input image directly. This is due to the fact that, the interpolation of isolated high frequency components in high frequency subbands and using the corrections obtained by adding high frequency subbands of SWT of the input image, will preserve more high frequency components after the interpolation than interpolating input image directly.

III. PROPOSED SYSTEM

Resolution[7] is an important feature in satellite imaging, which makes the resolution enhancement of such images is a vital importance as increasing the resolution of these images will directly affect the performance of the system using these images as input. The main loss of an image after being resolution enhanced by applying interpolation is on its high-frequency components, which is due to the smoothing caused by interpolation method. Thus, in order to increase the quality of the enhanced image, preserving the edges is essential. In this paper, DWT has been used in order to preserve the high-frequency components of the image. DWT separates the image into several sub band images, namely, LL, LH, HL, and HH. A high-frequency sub band contains the high frequency components of the image. The interpolation can be applied to these four sub band images. In the wavelet domain, the low-resolution image is obtained by low-pass filtering of the high-resolution images. The low resolution image (LL sub band), without quantization (i.e., with double-precision pixel values) is used as the input for the proposed resolution enhancement process.

The input low-resolution image is interpolated with the half of the interpolation factor, α/2, used to interpolate the high-frequency sub bands, as shown in Fig. 2. In order to get more edge information, i.e., obtaining a sharper enhanced image, we have proposed an intermediate stage in high frequency sub band interpolation process. As shown in Fig.2, the low-resolution input satellite image and the interpolated LL image with factor 2 are highly correlated. The difference between the LL sub band image and the low-resolution input image are obtained in their high-frequency components. Hence, this difference image can be use in the intermediate process to correct the estimated high-frequency components. This estimation is performed by interpolating the high-frequency sub bands by factor 2 and then including the difference image (which is high-frequency components on low-resolution input image)into the estimated high-frequency images, followed by another interpolation with factor α/2 in order to reach the required size for IDWT process. The intermediate process of adding the difference image, containing high-frequency components.

IV. CONCLUSIONS

This work proposed an image resolution enhancement technique based on the interpolation method of the high frequency subbands obtained by DWT. This paper has proposed a new resolution enhancement technique based on the interpolation method of the high-frequency sub band images obtained by DWT and the input image. The PSNR improvement of the proposed technique will be increased as compared with the standard bi-cubic interpolation. An original image is interpolated with the half of the interpolation factor used for interpolation the high frequency sub bands. Afterwards all these images have been combined using IDWT method to generate a super resolved imaged.

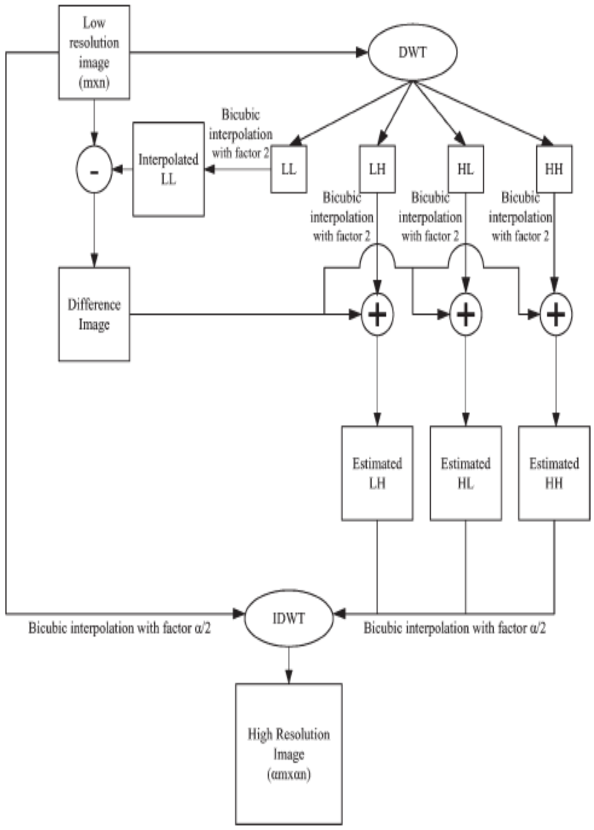
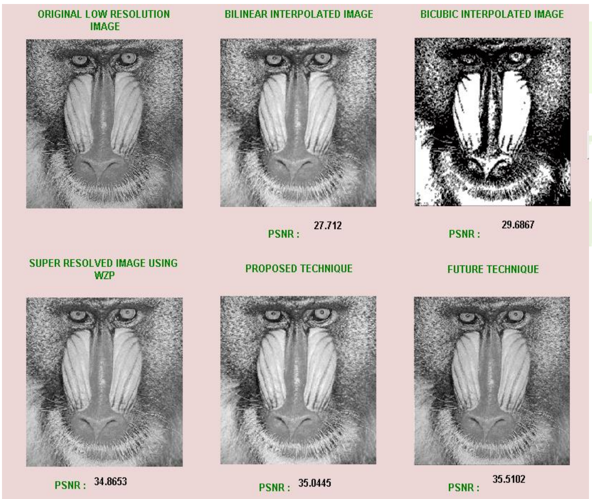


Figure 2. Proposed Method

V.RESULTS



PSNR of different image resolution techniques

Techniques/images	PSNR(db) Lena
Bilinear	26.34
Bicubic	26.84
WZP	28.84
RPII	28.81
NEDI	28.81
HMM	28.86
HMM-SR	28.88
WZP-CS	29.27
WZP-CS-ER	29.36
DWT SR	34.79
CWT SR	33.74
SWT SR	32.01

Proposed technique using MRT	36.87
using DWT&IDWT (extension)	37.19

PSNR (db) values for different resolution Enhancement techniques from 128x128 to 512x512

REFERENCES

[1] A. Goshtasby, D.A. Turner and L.A. Ackerman, "Matching of Tomographic Slices for Interpolation," IEEE Transactions on Medical Imaging, vol. 11, pp. 507–516, December, 1992.

[2] G.J. Grevera and J.K. Udupa, "Shape-Based Interpolation of Multidimensional Grey-Level Images," IEEE Transactions on Medical Imaging, vol. 15, pp. 881–892, December, 1996.

[3] S. Mallat, *A Wavelet Tour of Signal Processing*, 2nd ed. New York: Academic, 1999.

[4] Chiang, J.-S.; Hsia, C.-H. & Chen, H.-J. (2005). 2-D discrete wavelet transform with efficient parallel scheme, International Conference on Imaging Science, Systems, and Technology: Computer Graphics, (June 2005), pp. 193-197.

[5] Hasan. Demirel and Gholamreza. Anbarjafari, —IMAGE Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition,IEEE IMAGE PROCESSING, VOL. 20, NO. 5, MAY 2011.

[6] P.J. Beek, P. J. L. Van, "Edge-Based Image Representation and Coding", Ph.D. Thesis, Delft Uni. of Technology, 1995.

[7] http://en.wikipedia.org/wiki/Image_resolution

V.Venkatlaksmi received her B.Tech degree in Electronics & communication from Acharya Nagarjuna University in 2007, M.Tech Degree from JNTU Kakinada in 2012. She is currently working as Assistant Professor, Dept. of ECE Geethanjali College of Engineering and Technology Autonomous, Secunderabad-501301, T.S. India. her areas of interest Image processing.

B.Ramu , received his B.Tech degree in Electronics & communication from JNT University in 2010, M.Tech Degree from JNT University in 2012. He is currently working as Assistant Professor, Dept. of ECE Geethanjali College of Engineering and Technology Autonomous, Secunderabad-501301, T.S. India. His areas of interest Image and video processing

M,Uma rani She is working as Assistant Professor, Dept. of ECE Geethanjali College of Engineering and Technology Autonomous, Secunderabad-501301, T.S. India. her areas of interest Image processing.