KIET IJCE KIET International Journal of Communications &Electronics
Volume. No. 4, Issue No. 2, July-December 2016, ISSN: 2320 - 8996

Image Enhancement using Wavely Transform by Bilinear Method

Khushboo Jindal[#1], Shelly Singla[#2]

[#] *Electronics and Communication Engineering*
Indus Institute of Engineering and Technology, Jind, India
[1]jindal.khushboo@gmail.com
[2]s.singla428@gmail.com

Abstract— **This Image processing for low resolution digital images (e.g. mobile phones with low resolution camera and computed tomography(CT) scan medical images) is very challenging problems. It is because of the errors due to quantization and sampling. Over the last several years; significant improvements have been made in this area; however, it is still very challenging. In particularly, enhancement of such images is very complicated. For zooming, the process of re-sampling is normally employed. Therefore, this paper focuses on investigating the effect of interpolation functions on zooming low resolution images. For this purpose, ideally,an ideal low-pass filter is preferred; however, it is difficult to realize in practice. Therefore, four interpolation functions (nearest neighbor, linear, cubic B-spline and high-resolution cubic spline with edge enhancement (-2≤a≤0)) are investigated inthis paper for the low resolution medical CT scan images. From the results, it is found that cubic B-spline and high-resolution cubic spline have a better frequency response than nearest neighbor and linear interpolation functions. When these functionsare applied for the purpose of enhancement of digital images, the best response was obtained with the high-resolution cubic spline functions; however, at the expense of increase in computation time.**

***Keywords*— super resolution; wavelet transform; stationary and discrete wavelet.**

I. Introduction

Image resolution is always a key feature for all kinds of images. With ever increasing sizes of the displays need for super resolution images has also been increased. This is also impacted by the limited size of the digital image sensor. Though widespread commercial cameras provide very high resolution images, most of the scientific cameras still have the resolution of only 512 X 512. Resolution enhancement is always being associated with the interpolation techniques. Research suggests that interpolation methods increase the intensity of low frequency components. This means interpolated image will have less number of sharp intensity transactions per pixel. A new method for resolution enhancement which preserves high frequency contents of the image is suggested in the paper. Spatial domain techniques lag in extraction and preservation of high frequency components of an image. This suggests that some other technique not involving spatial domain is to be used. So the image needs to be converted to some other domain, processed and then converted back to spatial domain. The domain can be Fourier domain, wavelet domain or any other. Fourier domain is more suitable for spectral filtering. The spectral filtering removes particular frequencies from the image. Wavelet domain separates components of an image in to individual matrices. These matrices then can be processed separately and combined together to get the desired result.

Fast algorithms for implementation of discrete wavelet transform have enhanced the use of wavelet domain for image resolution improvement. Various image processing algorithms can be implemented with discrete wavelet transform(DWT). DWT decomposes image into four sub bands. These sub bands are low-low (LL), low-high (LH), high-low (HL) and high-high (HH). These sub bands are of . half the dimensions of that of image under consideration. Stationary wavelet transform (SWT) is also being used for the image resolution enhancement . SWT also has four sub bands similar to DWT but sub bands in SWT are of same size of that of the image. Here we have proposed a new method for image resolution enhancement which is based on combination of DWT and SWT components and interpolation. Also we have proved that our proposed technique is better compared to previously available techniques for resolution improvements. In section II, a literature review for image resolution enhancement techniques has been given. In section III, the proposed method is described in detail. Results are demonstrated in section IV and concluding remarks are presented in section V.

A. *Flow Chart of the Resolution*

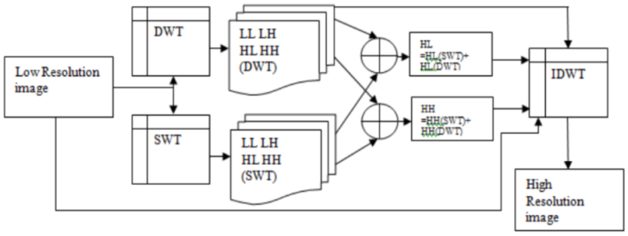


Fig. 1 Flow chart of the resolution enhancement algorithm

B. *Need of Image Resolution Enhancement*

Resolution of an image has been always an important issue in many image and video-processing applications, such as video resolution enhancement, feature extraction, and satellite image resolution enhancement. Interpolation in image processing is a method to increase the number of pixels in a digital image. Interpolation has been widely used in many image processing applications, such as facial reconstruction, multiple description coding, and image resolution enhancement. The interpolation-based image resolution enhancement has been used for a long time and many interpolation techniques have been developed to increase the quality of this task. There are three well-known interpolation techniques, namely, nearest neighbour, bilinear, and bicubic. Bicubic interpolation is more sophisticated than the other two techniques and produces smoother edges. 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) along the rows of the image first, and then the results are composed along the columns. This operation results in four decomposed sub band images referred to low-low (LL) low-high (LH), high-low (HL), and high-high (HH). The frequency components of those sub bands cover the full frequency spectrum of the original image. Image resolution using wavelets is a relatively new subject and recently many new algorithms have been proposed. Carey et al have attempted to estimate the unknown details of wavelet coefficients in an effort to improve the sharpness of the reconstructed images. Their estimation 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 in lower frequency sub bands were used to prepare a model 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 has been also implemented in order to estimate the coefficients. In this paper, we propose a resolution-enhancement technique using interpolated DWT high-frequency sub band images and the input low-resolution image. Inverse DWT (IDWT) has been applied to combine all these images to generate the final resolution-enhanced image. In order to achieve a sharper image, we propose to use an intermediate stage for estimating the high- frequency sub bands by utilizing the difference image obtained by subtracting the input image and its interpolated LL sub band. The proposed technique has been compared with standard interpolation techniques, wavelet zero padding (WZP), where the unknown coefficients in high-frequency sub bands are replaced with zeros, and state-of-art techniques, such as WZP and cycle- spinning (CS), and previously introduced complex wavelet transform (CWT)-based image resolution enhancement. It is necessary to recall that in this paper the resolution enhancement is used as a process that enlarges the given input in the way that the output is sharper. The performance of the proposed technique over performs all available state-of-art methods for image resolution enhancement. The visual and quantitative results are given in the results and discussions section. In all steps of the proposed satellite image resolution enhancement technique, Daubechies wavelet transform as mother wavelet function and bicubic interpolation as interpolation technique have been used.

II. BICUBIC INTERPOLATION METHOD

All In mathematics, bicubic interpolation is an extension of cubic interpolation for interpolating data points on a dimensional regular. The interpolated surface is smoother than corresponding surfaces obtained by bilinear interpolation or nearest-neighbour interpolation. Bicubic interpolation can be accomplished using either Lagrange polynomials, cubic splines, or cubic convolution algorithm. In image processing, bicubic interpolation is often chosen over bilinear interpolation or nearest neighbour in image resampling, when speed is not an issue. In contrast to bilinear interpolation, which only takes 4 pixels (2×2) into account, bicubic interpolation considers 16 pixels (4×4). Images resampled with bicubic interpolation are smoother and have fewer interpolation artifacts.

Cubic Convolution Interpolation determines the grey level value from the weighted average of the 16 closest pixels to the specified input coordinates, and assigns that value to the output coordinates [5]. The image is slightly sharper than that produced by Bilinear Interpolation, and it does not have the disjointed appearance produced by Nearest Neighbour Interpolation.

First, four one-dimension cubic convolutions are performed in one direction (horizontally in this paper) and then one more one-dimension cubic convolution is performed in the perpendicular direction (vertically in this paper). This means that to implement a two-dimension cubic convolution, a one-dimension cubic convolution is all that is needed.

For one-dimension Cubic Convolution Interpolation, the number of grid points needed to evaluate the interpolation function is four, two grid points on either side of the point under consideration.

Cubic convolution is a third degree interpolation algorithm that fairly well approximates the theoretically optimum sinc interpolation function. The kernel is composed of piecewise cubic polynomials defined on subintervals (-2, -1), (-1, 0), (0, 1) and (1, 2). Outside this interval the interpolation kernel is zero. For deriving the cubic convolution kernel, we have to solve 8 linear equations with 7 unknown parameters, so the system has one “free” parameter that may be controlled by the user. The kernel is of form:

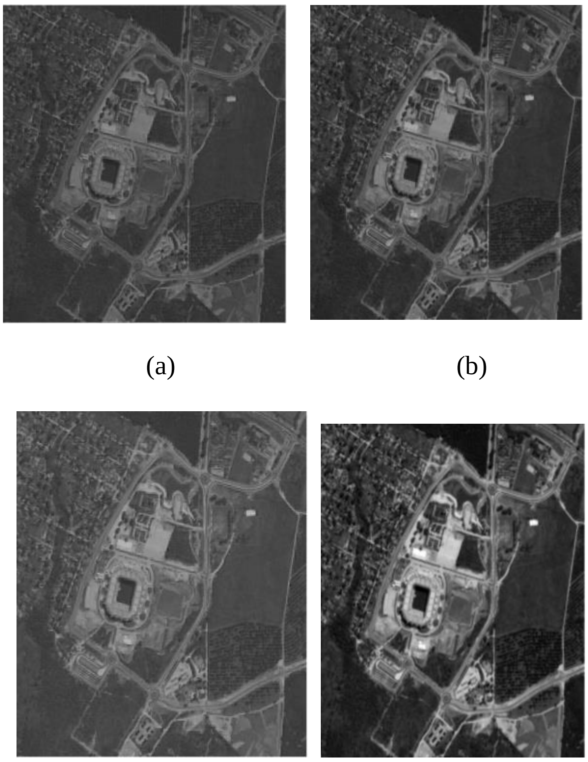
$$h(x) = \begin{cases} (a+2)|x|^3 - (a-3)|x|^3 + 1 & 0 \le |x| < 1 \\ a|x|^3 - 5a|x|^2 - 8a|x| - 4a & 1 \le |x| < 2 \\ 0 & 2 \le |x| \end{cases}$$

The frequency response of the cubic kernel is

$$H(w) = \frac{12}{w^2}\left(\mathrm{sinc}^2\left(\frac{w}{2}\right) - \mathrm{sinc}(w)\right)$$

The performance of interpolation depend upon a. Interpolation gives different result at different values of a. The value of may be 1, 0.7, 0.5.

III. VISUAL RESULT



(a) (b)

(c) (d)

Fig 2. (a) Low Resolution Image 256×256 sat2 image (b) 256×256 to 512×512 Enhanced image using bilinear interpolation (c) 256×256 to 512×512 Enhanced image using bicubic interpolation (d) 256×256 to 512×512 Enhanced image using DWT image enhancement technique.

IV. QUANTITATIVE RESULTS

To show the effectiveness of proposed method quantitative results are also taken in to consideration. Quantitative results are obtain on various test images (baboon, lena) and some satellite images. Quantitative results on 256×256 to 512×512 enhanced images are shown in tables Parameters for comparison are PSNR, MSE, and Entropy.

1) PSNR Results: PSNR is the one of vital parameter in comparison of the two images quantitatively PSNR is measure of peak signal to noise ratio peak signal power is considered as the power of range and noise is considered as the error obtain from subtracting the enhanced image from the base image. A log (base 10) is taken for the ratio of two quantities and multiply by a factor of 10 to calculate db value. Table 6.1 shows comparison of results in terms of PSNR in db formulae for calculation of PSNR is given as

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

R = Range of intensity Levels

2) MSE = Mean Square Error

Method \Image	Lena	Sat image 1	Sat image 2	Sat image 3	Sat image 4
Bicubic	24.13	24.0996	24.0993	24.1004	24.1148

V. CONCLUSION

This paper has proposed a new method for obtaining super resolution images from low resolution images. The proposed method is much better than previous methods. We have also provided subjective and objective comparison of the resultant images. Proposed method involves calculation of DWT sub bands. High frequency sub bands are interpolated to double their size. DWT loses some information in the process of interpolation; it is corrected with the help of SWT. IDWT with original image and high frequency components give super resolution image. We have compared proposed method with state of the art methods. PSNR table shows the superiority of the proposed method.

REFERENCES

[1] Mallat, S., A Wavelet tour of Signal Processing. 2nd ed. 1999: New York: Academic.

[2] Fowler, J.E., The Redundant Discrete Wavelet Transform and Additive Noise. Signal Processing Letters, IEEE, 2005. 12(9): p. 629-632.

[3] 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.

[4] 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.

[5] 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.

[6] 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.

[7] 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.

[8] 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).

[9] 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.