International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 04, April 2017
www.ijates.com
ijates
ISSN 2348 - 7550

ENHANCEMENT OF LOW RESOLUTION IRIS IMAGES USING WAVELET TRANSFORM

Miss Pallavi D. Sawant [1], Mrs. Prof. H. H. Kulkarni [2]

[1]PG Student, [2]Assistant Professor, G. E. S. R. H. Sapat College of Engineering,
Savitribai Phule Pune University, Nashik, Maharashtra, (India)

ABSTRACT

The aim of image resolution enhancement is to process a given input low resolution image to make the result more desirable than the original image for a given specific application. There are various image processing application which requires high resolution images for processing and analysis. One of the commonly used techniques for image resolution enhancement is Interpolation. Interpolation technique has been widely used in many image processing applications such as facial reconstruction, in medical field, multiple descriptions coding, and super resolution. Discrete wavelet transform is used to decompose low resolution image and stationary wavelet transform is used to preserve edges. Iris recognition is widely used in safety certification. In large scenes or long distance conditions, the iris images may has low resolution. Lack of information in these iris images or videos affects the performance of the iris recognition greatly. In this paper, scheme of super resolution is used to reconstruct high resolution images from low resolution iris image sequences.

Keywords- Image resolution enhancement, Interpolation, Discrete wavelet transform, stationary wavelet transform, Iris recognition.

I. INTRODUCTION

Digital imaging systems have a variety of applications for commercial, medical and recreational purposes. In these applications, a high quality image is required to allow human interpretation or machine perception. However, sometimes the spatial resolution of image is limited by technical considerations of the imaging system in which the image is captured. Therefore signal processing techniques are used to create a higher resolution image that will allow for better identification and interpretation of details. The aim of single image super resolution is to create a high resolution image from a single instance of a low resolution image of the original scene.

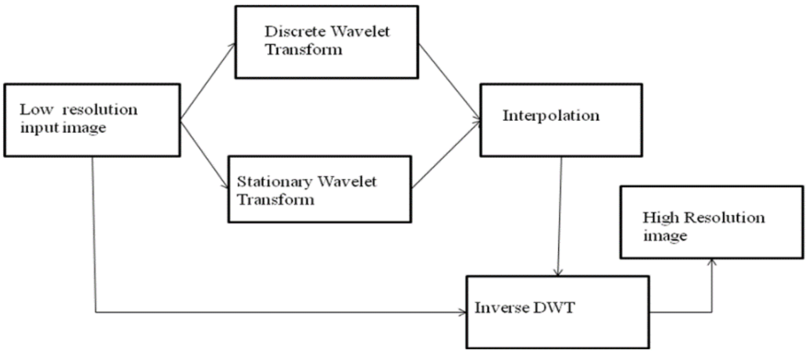

Fig.1 Block Diagram of Image Resolution enhancement Technique [27]

Resolution has been often referred as an important aspect of an image. Images are being processed in order to obtain more improved resolution. Fig. 1 shows Block Diagram of Image Resolution enhancement Technique [27]. The technique us DWT and SWT for decomposing low resolution image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform SWT and DWT is applied in order to decompose an input image into different sub bands**.** Next step is to use Interpolation technique. Interpolation is one of the commonly used techniques for image resolution enhancement. There are conventional interpolation techniques, namely bilinear interpolation, and bi-cubic interpolation.

II. LITERATURE SURVEY

Y. Piao et al. [5] proposed Image resolution enhancement utilizing inter-sub-band correlation in wavelet domain. A new resolution enhancement method utilizing inter-sub-band correlation in which the sampling phase in DWT in the higher level. The proposed method utilized the correlation of sub bands with different sampling phases in discrete wavelet transform. The high frequency bands were estimated with filters which are designed in the lower level under the assumption that filters connecting two bands are similar in different levels. The experimental results demonstrated and shows that proposed method outperformed the competing methods by as much as 0.36 dB. Moreover, filters estimated in various test images showed similar characteristics.

C.B. Atkins et al. [6] proposed optimal image scaling using pixel classification. A new approach is introduced to optimal image scaling called resolution synthesis (RS). In resolution synthesis, the pixel interpolated is first classified in the context of a window of neighbouring pixels; and the corresponding high resolution pixels are obtained by filtering with coefficients that depend upon the classification.

W.K. Carley et al. [7] proposed the regularity of edges by measuring the decay of wavelet transform coefficients across scales and gives the underlying regularity by extrapolating a new sub-band to be used in image re-synthesis. The algorithm which produces visibly sharp edges than that of traditional techniques. It gives an average peak signal to noise ratio (PSNR) improvement of 2.5 dB over bilinear interpolation and bi-cubic interpolation techniques.

Yi Wan et al. [25] has described enhanced Histogram equalization in wavelet domain to enhance an image is very important task such as image enhancement and normalization. Presented a wavelet based method that simultaneously achieves the exact specification of histogram and good image enhancement performance. It does so through a carefully designed strict ordering of pixel process, for the image enhancement purpose the wavelet coefficient are fine tuned. Compared to previous work, this approach takes into account not only local mean intensity values, but also local edge information. Other advantages include fast pixel ordering, better image enhancement performance and good statistical models. Experimental results and comparison with state-of-the-art methods are presented.

Ercelebi, E. et al. [26] proposed method utilizes the multi-scale characteristics of the wavelet transform and local statistics of each sub ands. By using this proposed method transformation of an image take place into the wavelet domain using lifting based wavelet filter and applies a wiener filter in the wavelet domain and finally transform the result into the spatial domain. When the peak to signal ratio (PSNR) is low, image is transforming into the lifting based wavelet domain and then applying the wiener filter in the wavelet domain produce better result than directly applying wiener filter in spatial domain.

III. SYSTEM IMPLEMENTATION

Image resolution enhancement in the wavelet domain is a new research topic and recently many new algorithms are proposed. Fig 2 shows structure of wavelet decomposition. Discrete wavelet transform i.e. DWT is one of the recent wavelet transforms used in image processing. DWT decomposes an original low resolution image into different sub-band images, namely low-low (LL), high-low (HL), low-high (LH), and high-high (HH) [27]. Another wavelet transform which has been used in various image processing applications is stationary wavelet transform (SWT). In short, SWT is somewhat similar to DWT but it does not use down-sampling. Fig 3 shows Structure of DWT decomposition while Fig. 4 shows Structure of SWT decomposition.

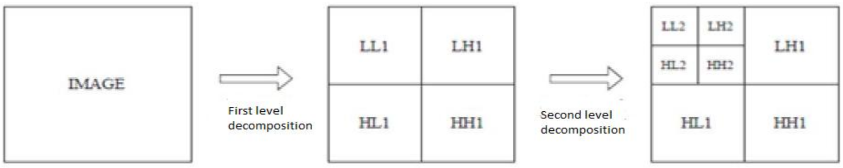

Fig.2 Structure of Wavelet Decomposition [27]

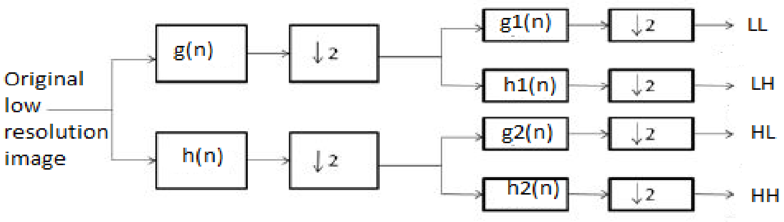

Fig.3 Structure of DWT Decomposition

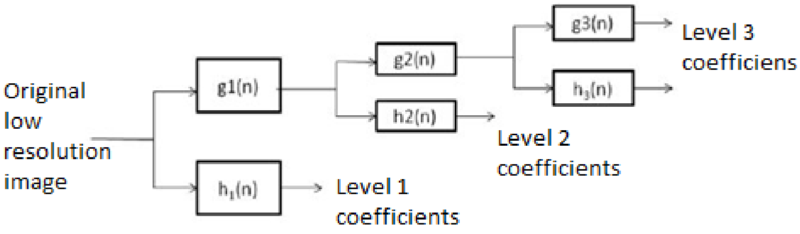

Fig.4 Structure of SWT Decomposition [27]

In this work, an image resolution enhancement technique is proposed which generates sharp high resolution image. The technique utilizes DWT to decompose a low resolution image into different sub-bands [27]. Then the three high frequency sub-band images are then interpolated. Then interpolation with enlargement factor of 2 is applied to high frequency sub band images. Down sampling in each step of the DWT sub bands causes information loss in the respective sub bands. That is why SWT is employed to minimize this loss.

The interpolated high frequency sub bands and the SWT high frequency sub bands have the same size so that they can be added with each other. The new corrected high frequency sub bands can be interpolated further for higher enlargement. The low frequency sub band is the low resolution of the original image. Therefore, instead of using low frequency sub band, which contains less information than the original high resolution image, the input image for the interpolation of low frequency sub band image is used. Using input image instead of low frequency sub band increases the quality of the super resolved image. Fig. 5 illustrates the detail Block Diagram of Image Super resolution using wavelet analysis [1]. Finally, improved interpolated high frequency sub-bands and interpolated input image are combined using inverse DWT (IDWT) to get a high resolution output image. The conventional techniques used for Interpolation are the following.

A. Bilinear Interpolation

Bilinear interpolation [28], [29] 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.

B. Bicubic Interpolation

Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality. Bicubic [28] goes one step beyond bilinear by considering the closest 4x4 neighborhood of 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.

C. Wavelet Zero Padding (WZP)

It is one of the methods for image resolution enhancement. It assumes that the signal is zero outside the original support. Zero padding is used in spectral analysis with transforms to improve the accuracy of the reported amplitudes, not to increase frequency resolution. Without using zero- padding, input frequencies will be attenuated in the output. Zero padding in the time domain is equivalent to the optimal interpolation in the frequency domain, which can restores the correct amplitudes. Since the wavelet transform is defined for infinite length signals, finite length signals are extended before they can be transformed. Zero padding technique shifts the inter sample spacing in frequency of the array that represents the result.

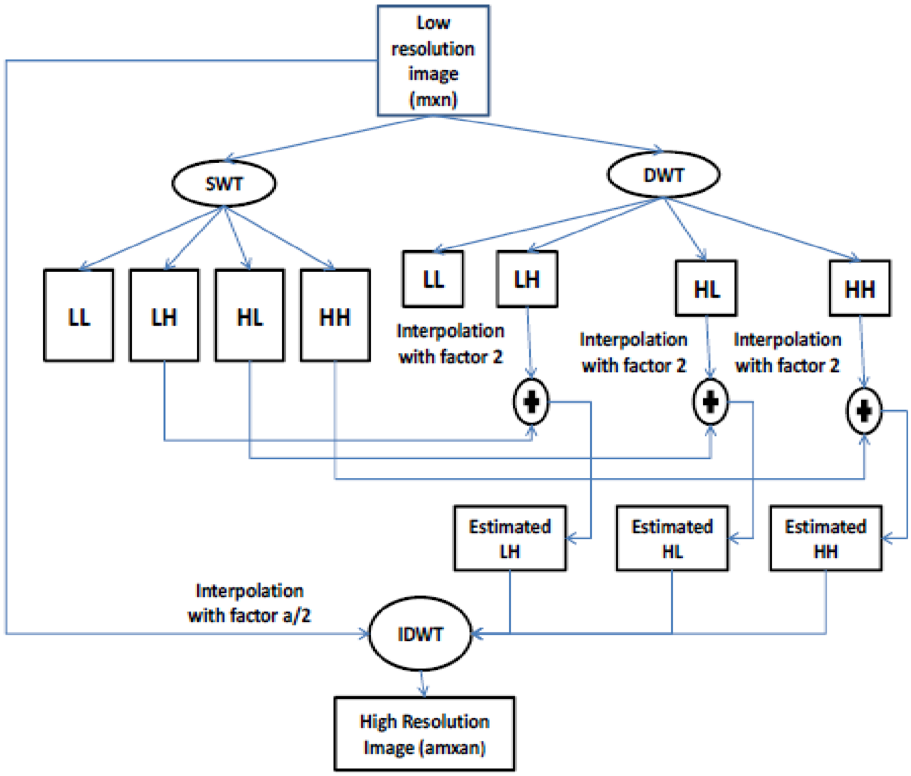

Fig.5 Detailed Block Diagram of Image Super resolution using wavelet analysis [1]

IV. IMPLEMENTATION AND RESULTS

For the reason of measuring the performance characteristics of the techniques some parameters are used namely PSNR and MEAN.

Peak Signal to Noise Ratio-

Peak signal-to-noise ratio i.e. PSNR is the ratio between the maximum possible power of a signal and the power of noise corrupted that affects the fidelity of its representation. Peak signal-to-noise ratio (PSNR) and mean square error (MSE) have been used in order to obtain some quantitative results for comparison. The MSE and PSNR are the two error metrics used to compare image compression quality. The lower the value of Mean square error, the lower the error.

PSNR can be obtained by using the following formula:

$$\text{PSNR (dB)} = 10 \log 10 \quad (255^2/\text{MSE})$$

MSE is defined as,

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}.\sum_{y=1}^{N}(f(x,y) - f^{\wedge}(x,y))$$

MEAN-

The Mean computes the mean of each row or column of the input, along vectors of a specified dimension of the given input, or of the entire input. The Mean block can also track the value of mean in a sequence of inputs over a period of time. To track the mean value in a sequence of inputs, select the Running mean check box. When the Running mean check box is not selected then the block computes the mean value in each row or column of the input, along vectors of a specified dimension of the given input, or of the entire input at each individual sample time. Each element in the output array is the mean value of the corresponding column, row, vector, or entire input.

The enhanced Iris image using low resolution image is enhanced by utilizing the bilinear interpolation, bicubic interpolation, WZP and Image Resolution enhancement Technique. The techniques are tested on iris image dataset from Computer Vision Laboratory, Department of Automation and Computer-aided Engineering, The Chinese University of Hong Kong. Table I compares the parameters i.e. PSNR AND Mean of the different techniques i.e. bilinear, bi-cubic, WZP.

Table1: Result of PSNR and MEAN using Different techniques.

Techniques/Parameters	**Peak signal to noise ratio (PSNR) in dB**	**MEAN**
Bilinear Interpolation	24.540961	1.636161
Bi-cubic Interpolation	26.559624	0.010467
Wavelet zero padding (WZP)	32.438639	0.364014
Image Resolution enhancement Technique	32.436787	0.363796

V. CONCLUSION

This work proposed an Iris low resolution image enhancement technique based on the interpolation of the high frequency sub-bands obtained by DWT and SWT. The technique uses DWT to decompose an image into different sub-bands, and then the high frequency sub-band images have been interpolated. The Interpolation techniques like Bilinear, Bicubic, WZP and Image resolution enhancement technique is used. The techniques has been tested for their PSNR and mean on well-known benchmark images.

VI. ACKNOWLEDGEMENTS

The authors are thankful to Prof. S. P. Agnihotri-HOD, Dr. P. C. Kulkarni-Principal, Mr. P. M. Deshpande-Project Director, Sir M. S. Gosavi-Director, G. E. S. R. H. Sapat College of Engineering, Nashik, Maharashtra, India.

REFERENCES

[1] Hasan. Demirel, Gholamreza. Anbarjafari, “Image Resolution Enhancement by using Discrete and Stationary Wavelet Decompositon”, IEEE image processing, vol. 20, NO. 5, MAY 2011.

[2] L.Yi-bo, X. Hong, Z. Sen-yue, “The wrinkle generation method for facial reconstruction based on extraction of partition wrinkle line features and fractal interpolation”, in Proc. 4th Int. Conf. Image Graph., Aug. 22–24, 2007, pp. 933–937.

[3] Y. Rener, J. Wei,C. Ken, “Downsample-based multiple description coding and post- processing of decoding”, in Proc. 27th Chinese Control Conf., Jul. 16–18, 2008, pp. 253– 256.

[4] H. Demirel, G. Anbarjafari, S. Izadpanahi, “Improved motion based localized super resolution technique using discrete wavelet transform for low resolution video enhancement”, in Proc. 17th Eur. Signal Process. Conf., Glasgow, Scotland, Aug. 2009, pp. 1097

[5] Y. Piao, I. Shin, H. W. Park, “Image resolution enhancement using inter sub band correlation in wavelet domain”, IEEE Proc. Int. Conf. Image Process., 2007, vol. 1, pp. I- 445–448.

[6] C. B. Atkins, C. A. Bouman, J. P. Allebach, “Optimal image scaling using pixel classification,” in Proc. Int. Conf. Image Process., Oct. 7–10, 2001, vol. 3, pp. 864–867.

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

[8] H. Demirel, 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.

[9] S. Mallat, “A Wavelet Tour of Signal Processing”, 2nd edition. New York: Academic, 1999.

[10] X. Li and M. T. Orchard, “New edge-directed interpolation”, IEEE Trans. Image Process, vol. 10, no. 10, pp. 1521–1527, Oct. 2001.

[11] K. Kinebuchi, D. D. Muresan, R. G. Baraniuk, “Wavelet base statistical signal processing using hidden Markov models”, in Proc. Int. Conf. Acoust., Speech, Signal Process., 2001, vol. 3.

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

[13] A. Temizel, T. Vlachos, “Wavelet domain image resolution enhancement using cycle-spinning”, Electron. Lett., vol. 41, no. 3, pp. 119–121, Feb. 3, 2005.

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

[15] G. Anbarjafari, H. Demirel, “Image super resolution based on interpolation of wavelet domain high frequency sub bands and the spatial domain input image,” ETRI J., vol. 32, no. 3, pp. 390–394, Jun. 2010.

[16] A. Temizel, “Image resolution enhancement using wavelet domain hidden Markov tree and coefficient sign estimation”, in Proc. Int. Conf. Image Process., 2007, vol. 5, pp. V- 381–384.

[17] Chang S.G., Cvetkovic Z., Vetterli M., “Resolution enhancement of images using wavelet transform extrema extrapolation”, Proc.ICASSP‘95, vol. 4, pp.2379-2382, May 1995.

[18] Carey W.K., Chuang D.B., Hemami S.S., “Regularity- Preserving Image Interpolation”, IEEE Trans. Image Proc., vol.8, no.9, pp.1295- 1297, Sep. 1999.

[19] Shapiro J.M., “Embedded Image Coding Using Zero trees of Wavelet Coefficients”, IEEE Trans. Signal Proc., vol.41, no.12, pp. 3445-3462, Dec. 1993.

[20] A., Pearlman W.A., “A New Fast and Efficient Image Codec Based on Set Partitioning in Hierarchical Trees”, IEEE Trans. Circ. & Syst., vol.6, pp.243-250, June 1996.

[21] Kinebuchi K., Muresan D.D., Parks T.W., “Image Interpolation Using Wavelet-Based Hidden Markov Trees”, Proc. ICASSP ‘01, vol. 3, pp. 7-11, May 2001.

[22] Crouse M.S., Nowak R.D.,Baraniuk R.G., "Wavelet-Based Statistical Signal Processing Using Hidden Markov Models", IEEE Trans. Signal Proc., vol.46, no.4, pp.886–902, Apr. 1998.

[23] Zhao S., Han H., Peng S., "Wavelet Domain HMT-Based Image Superres", Proc. ICIP '03, vol. 2, pp. 933-936, Sep. 2003.

[24] Woo D.H., Eom I.K., Kim Y.S., "Image Interpolation based on inter-scale dependency in wavelet domain", Proc. ICIP '04, vol. 3, 1687-1690, Oct. 2004.

[25] Yi Wan and Dongbin Shi, "Joint Exact Histogram Specification and Image Enhancement through the wavelet Transform", IEEE Trans. Image Process, Vol.16,No.9, Sept 2007, 2245.

[26] Ercelebi, E., Koc. S, "Lifting based wavelet domain adaptive Wiener filter for image enhancement", IEEE Proc. Vision Image and Signal Processing 153, 3-36,2006.

[27] Pravinkumar Rathod, Mrs. A. V. Kulkarni, "Image Resolution Enhancement by Discrete and Stationary Wavelet Decomposition using Bicubic Interpolation", International Journal of Engineering Research & Technology (IJERT),Vol. 2 Issue 11, November – 2013, ISSN: 2278-0181.

Books

[28] Digital Image Processing Using MATLAB (Second Edition) by Rafel C. Gonzalez and Richard E. woods and Steven L. Eddins.

[29] Digital Image Processing by S. Sridhar, OXFORD Publications.