Image Resolution Improvement By Using DWT & SWT Transform

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ABSTRACT

In this proposed method an image resolution enhancement technique based on interpolation of the high frequency subband images obtained by discrete wavelet transform (DWT) and the input image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform(SWT). In DWT is applied in order to decompose an input image into different subbands. Then the high frequency subbands as well as the input image are interpolated. The estimated high frequency subbands are being modified using high frequency subbands obtained through SWT.Then all these subbands are combined to generate a new high resolution image using inverse DWT (IDWT). The quantitative and visual results are showing the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques

Keyword: - *DWT, IDWT, Interpolation, SWT,Bicubic,Bilinear*

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1. INTRODUCTION

Resolution has been frequently referred as an important property of an image. Images are being processed in order to obtain more enhanced resolution. One of the commonly used techniques for image resolution enhancement is Interpolation. Interpolation has been mostly used in many image processing applications such as facial reconstruction, multiple description coding, and super resolution. There are three well known interpolation techniques, namely nearest neighbor interpolation, bicubic interpolation, and bilinear interpolation. Image resolution enhancement in the wavelet domain is a relatively new research topic and recently many new algorithms have been proposed. Discrete wavelet transform (DWT) is one of the recent wavelet transforms used in image processing. DWT decomposes an image into different subband images, namely low-low (LL), lowhigh (LH), high-low (HL), and high-high (HH). Another recent wavelet transform which has been used in several image processing applications is stationary wavelet transform (SWT). In short, SWT is similar to DWT but it does not use down-sampling, hence the subbands will have the same size as the input image

2. PROPOSED SCHEME

In image resolution enhancement by interpolation the main loss is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. In order to improve the quality of the super resolved image, preserving the edges is essential. In this work, DWT has been employed in order to preserve the high frequency components of the image. The redundancy and shift invariance of the DWT means that DWT coefficients are inherently interpolable.

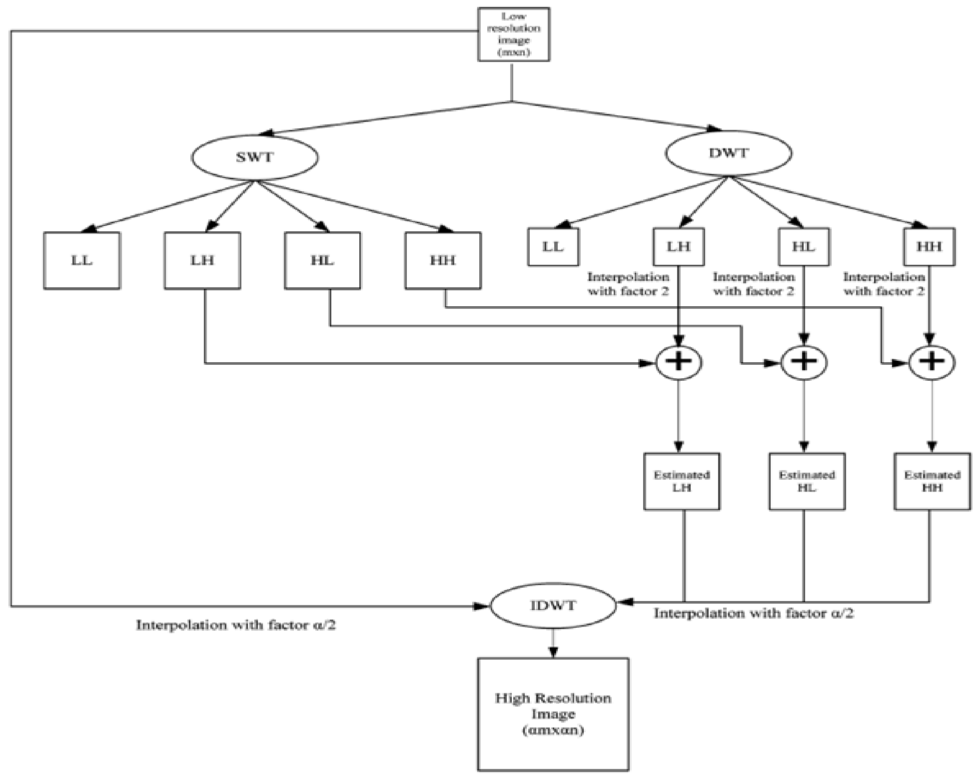

Fig.1 Block Diagram of Proposed System

In this proposed method, one level DWT (with Daubechies 9/7 as wavelet function) is used to decompose an input image into different subband images and also use Haar wavelet transform. Three high frequency subbands (LH, HL, and HH) contain the high frequency components of the input image. In the proposed technique, bicubic interpolation with enlargement factor of 2 is applied to high frequency subband images. Downsampling in each of the DWT subbands causes information loss in the respective subbands. That is why SWT is employed to minimize this loss. 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, the low resolution image is obtained by lowpass filtering of the high 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, we are using the input image for the interpolation of low frequency subband image. Using input image instead of low frequency subband increases the quality of the super resolved image. Figure 1 shows the block diagram of the proposed image resolution enhancement technique. By interpolating input image by , 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.[1]

2.1 DWT-Based Resolution Enhancement

Resolution is an important feature in satellite imaging, which makes the resolution enhancement of such images to be of 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[5]. Hence, in order to increase the quality of the enhanced image, preserving the edges is essential. DWT has been employed in order to preserve the high-frequency components of the image. DWT separate the image into different sub band images, namely, LL, LH, HL, and HH. High frequency sub bands contain the high-frequency component 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 image. 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. In other words, low-frequency sub band images are the low resolution of the original image. Therefore, instead of using low-frequency sub band images, which contains less information than the original input image, we are using this input image through the interpolation process. Hence, the input low-resolution image is interpolated with the half of the interpolation factor, alpha/2, used to interpolate the high-frequency sub band.In order to preserve more edge information, i.e., obtaining a sharper enhanced image, we have proposed an intermediate stage in high-frequency sub band interpolation process.

2.2 SWT-Based Resolution Enhancement

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

3. QUANTITATIVE ANALYSIS

To evaluate the performance of each algorithm different metrics such as Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Root Mean Square Error (RMSE) has been calculated

3.1 PSNR

Peak signal-to-noise ratio (PSNR) and root mean square error (RMSE) have been implemented in order to obtain some quantitative results for comparison. PSNR can be obtained by using the following formula,where R is the maximum uctuation in the input image (255 in here as the images are represented by 8 bit, i.e., 8-bit grayscale representation have been usedradiometric resolution is 8 bit)

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

3.2 MSE

MSE is representing the MSE between the given input image Iin and the original image Iorg which can be obtained by the following formula,where M and N are the size of the images

$$MSE = \frac{\sum_{i,j}\left(I_{in}(i,j) - I_{org}(i,j)\right)^2}{M \times N}$$

3.3 RMSE

RMSE is the square root of MSE, hence it can be calculated by the following

$$RMSE = \sqrt{\frac{\sum_{i,j}\left(I_{in}(i,j) - I_{org}(i,j)\right)^2}{M \times N}}.$$

3.1 ENTROPY

- Entropy:

$$H = -\sum_{i=1}^{n} p(x_i)\log_b(x_i)$$

4. RESULTS

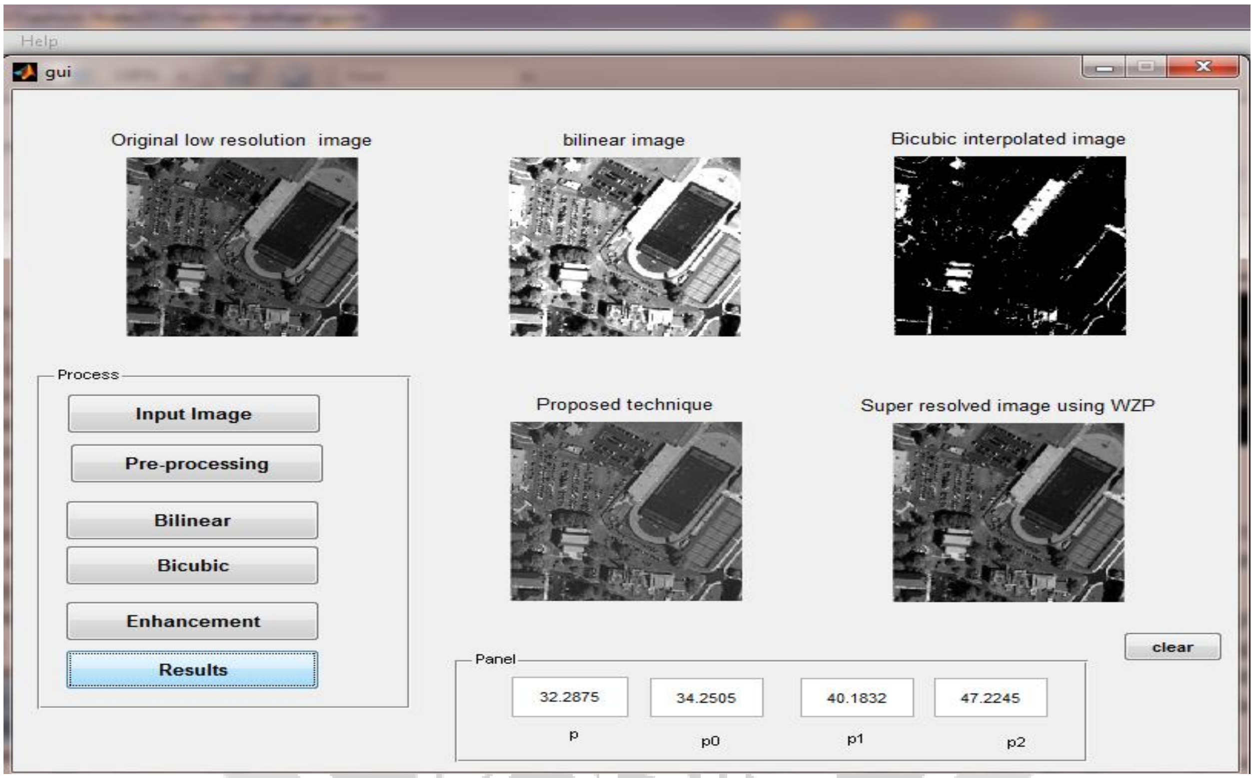

Fig.2 Output Window For Map Image

Technique	ENTROPY	RMSE	PSNR
Original	7.2027	----	----
Bilinear	1.0287	0.3881	32.2875
Bicubic	0.6634	0.6197	34.2505
Proposed Method	6.1850	0.2032	40.1832
Super resolved using WZP	**7.4295**	**0.0695**	**47.2245**

Table 1. Results for MAP image

5. CONCLUSIONS

This work proposed an image resolution enhancement technique based on the interpolation of the high frequency subbands obtained by DWT, correcting the high frequency subband estimation by using SWT high frequency sub-bands, and the input image. The proposed technique uses DWT to decompose an image into different subbands, and then the high frequency subband images have been interpolated. The interpolated high frequency subband coefficients have been corrected by using the high frequency subbands achieved by SWT of the input image. An original image is interpolated with half of the interpolation factor used for interpolation of the high frequency subbands. Afterwards all these images have been combined using IDWT to generate a super resolved image. The proposed technique has been tested on well-known benchmark images, where their PSNR and visual results show the superiority of proposed technique over the conventional and state-of-art image resolution enhancement techniques.

5.1 Advantages

1. Proposed method of image enhancement is used to enhance the images by using different interpolation techniques-Bilinear,Bicubic,WZP.
2. The image enhancement based on SWT and DWT transform is the most beneficial technique of image enhancement.
3. Multiscale wavelet decomposition is greatly effective for image enhancement.
4. Allows good localization both in time domain and frequency domain.
5. Reduces computation time
6. Reduces resource requirement
7. Multiresolution analysis.
8. DWT can be implemented in hardware.
9. Perform well in high compression ratio.

5.2 Applications

1. Medical Imaging
2. Forensic Science
3. Remote Sensing
4. Surveillance
5. Child base Detection
6. Homeland Defence
7. Access Control
8. Financial Services
9. Immigration

5.3 Future Scope

1. For the enhancement of different test images,Multilevel DiscreteWavelet Transform can be used.
2. The proposed method of image enhancement designed here give better results in the various test cases and can be further explored to all the types of images by using different interpolation techniques.
3. Low resolution satellite image enhancement can be extended further using Different wavelet transform and interpolation method.
4. The choice of an optimum wavelet transform depends mainly on types of images to be enhanced.

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