ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Survey Paper of Discrete Wavelet Transform-Based Satellite Image Resolution Enhancementmethod

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ABSTRACT:

Now a day, Satellite images are being used in many fields of research in the world of the system. In this topic one of the main issues of these types of images is their resolution method. Here, we propose a new satellite image resolution enhancement technique based on the interpolation of the high-frequency subbands obtained by discrete wavelet transform (DWT) and the input image of the system. In this, the proposed resolution enhancementtechnique uses DWT to divides the input image into different subbands of the system. The high-frequency subband images and the input low-resolution image have been interpolated followed by combining all these images to generate a new resolution-enhanced image by using inverse DWT in the system. To achieve a sharper image an intermediate stage for estimating the high-frequency subbands has been proposed in this technique. So, the proposed technique has been tested on satellite benchmark images in this system. Finally, the quantitative and visual results show the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques.

Index Terms :

Discrete wavelet transform (DWT), interpolation, satellite image resolution enhancement, wavelet zero padding(WZP).

Introduction:

Image enhancement is a method of improving the definition of a video picture by a computer program, which reduces the lowest gray values to black and the highest to white, for the pictures from microscopes,surveillance cameras, and scanners. Improvement of the quality of a picture, with the aid of a computer, by giving it higher contrast or making it less blurred or less noisy.

Image enhancement techniques can be divided into two broad categories are Spatial domain methods, which operate directly on pixels and frequency domain methods, which operate on the Fourier transform of an image. 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. 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 decomposed 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. A satellite image resolution enhancement technique is based on the interpolation of the high-frequency subband obtained by discrete wavelet transform (DWT) and the input image. This resolution enhancement technique uses DWT to decompose the input image into different subband. Then, the high-frequency subband images and the input low resolution image have been interpolated, followed by combining all these images to generate a new resolution enhanced image.The resolution of an image has been always an important issue in many image- and video-processing applications,such as video resolution enhancement [1], feature extraction [2], and satellite image resolution enhancement [3].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 [4], multiple description coding [5], and image resolution enhancement [6]–[8].

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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 neighbor, bilinear,andbicubic. Bicubic interpolation is more sophisticated than the other two techniques and produces smoother edges.Wavelets are also playing a significant role in many imageprocessing 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 decomposed along the columns. This operation results in four decomposed subband images referred to low low (LL), low-high (LH), high-low (HL), and high-high (HH).The frequency components of those subbands cover the full frequency spectrum of the original image.

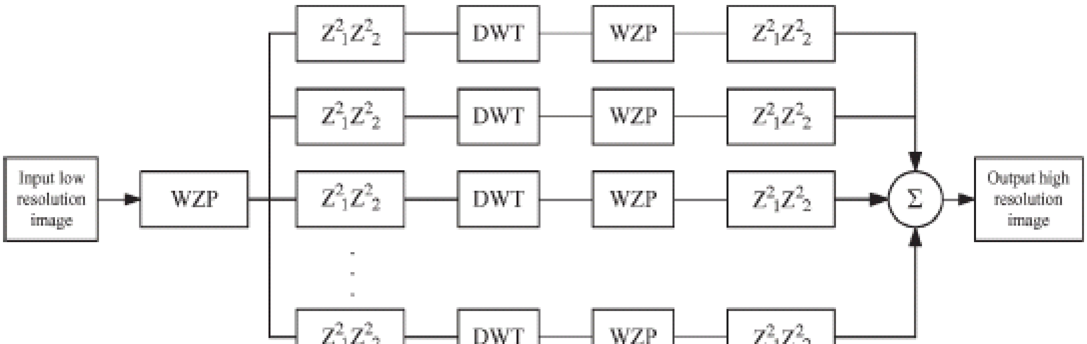

Figure 1. Block diagram of the WZP- and CS-based image resolution enhancement [17].

II. System Description:

II. WAVELET-BASED IMAGE RESOLUTION ENHANCEMENT:

There are several methods which have been used for satellite image resolution enhancement. In this paper, we have used two state-of-art techniques for comparison purposes. The first one is WZP and CS, and the second one is the previously introduced CWT-based image resolution enhancement [3].

A. CS Based Image Resolution Enhancement:

This method adopts the CS methodology in the wavelet domain. The algorithm consists of two main steps as follows:

1) An initial approximation to the unknown high resolution image is generated using wavelet domain zero padding (WZP).

2) The cycle-spinning methodology is adopted to operate the following tasks:

a) A number of low resolution images are generated from the obtained estimated high resolution image in part (1) by spatial shifting, wavelet transforming, and discarding the high frequency subbands.

b) The WZP processing is applied to all those low resolution images yielding N high resolution images.

c) These intermediated high resolution images are realigned and averaged to give the final high resolution reconstructed image.

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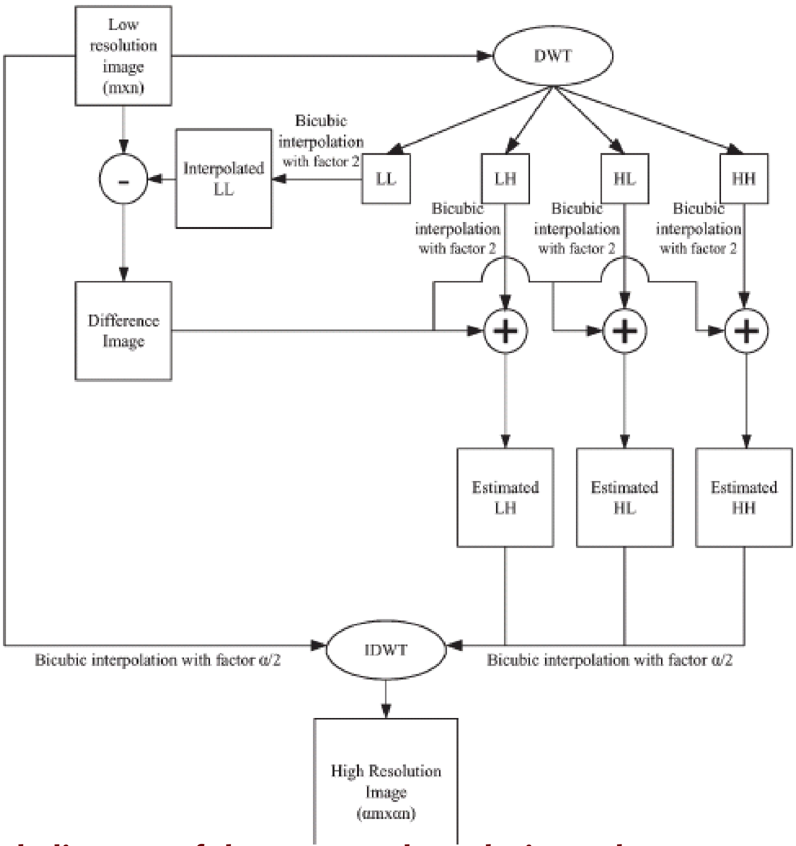

Figure 2. Block diagram of the proposed resolution enhancement algorithm.

The intermediate process of adding the difference image, containing high-frequency components, generates significantly sharper and clearer final image. This sharpness is boosted by the fact that, the interpolation of isolated high-frequency components in HH, HL, and LH will preserve higher-frequency components than interpolating the low-resolution image directly.

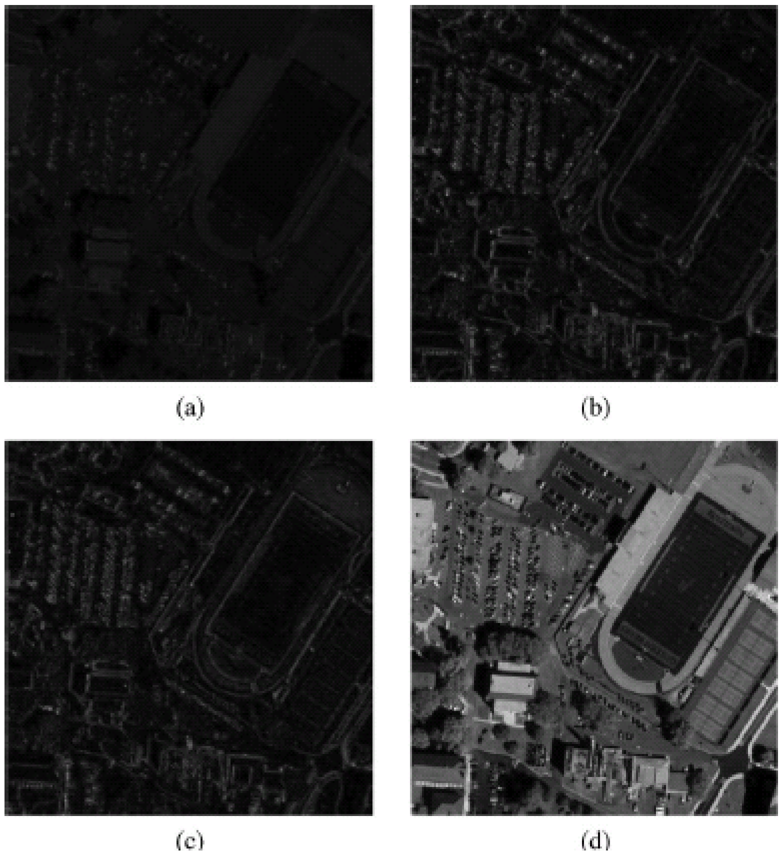

Figure 3.Difference between (d) the original high-resolution satellite image and (a) the proposed enhanced image, (b) the standard bicubic interpolation, and (c) the WZP- and CS-based image resolution enhancement technique.

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III.DWT-BASED RESOLUTION ENHANCEMENT:

As it was mentioned before, 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. Hence, in order to increase the quality of the enhanced image, preserving the edges is essential.

IIIResult analysis:

The proposed technique has been tested on several different satellite images. In order to show the superiority of the proposed method over the conventional and state-of-art techniques from visual point of view are included. In those figures with low-resolution satellite images, the enhanced images by using bicubic interpolation, enhanced images by using WZPand CS-based image resolution enhancement, and also the enhanced images obtained by the proposed technique are shown. It is clear that the resultant image, enhanced by using the proposed technique, is sharper than the other techniques.

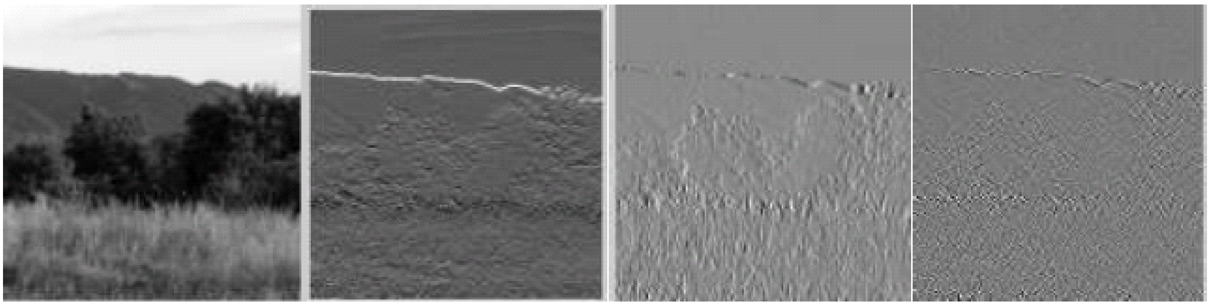


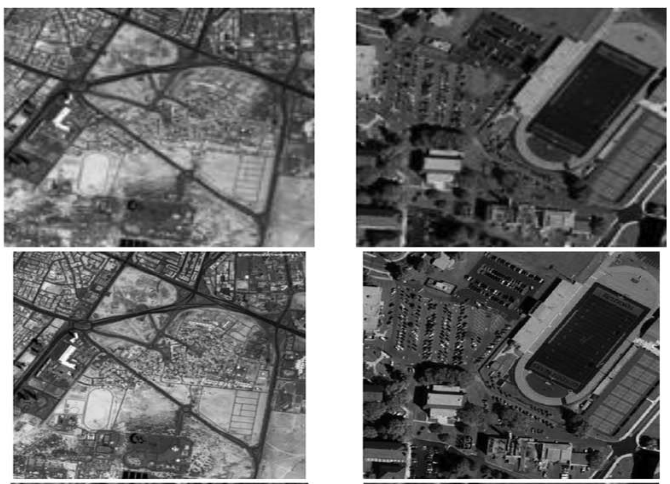
Figure 4. LL, LH, HL, HH subband of input image

Table 1: PSNR, RMSE Results for DWT Method.

Image	RMSE	PSNR
Test Image	3.79	37.8
Moon Image	3.99	38.9
Water Image	4.01	40

(a)

(b)



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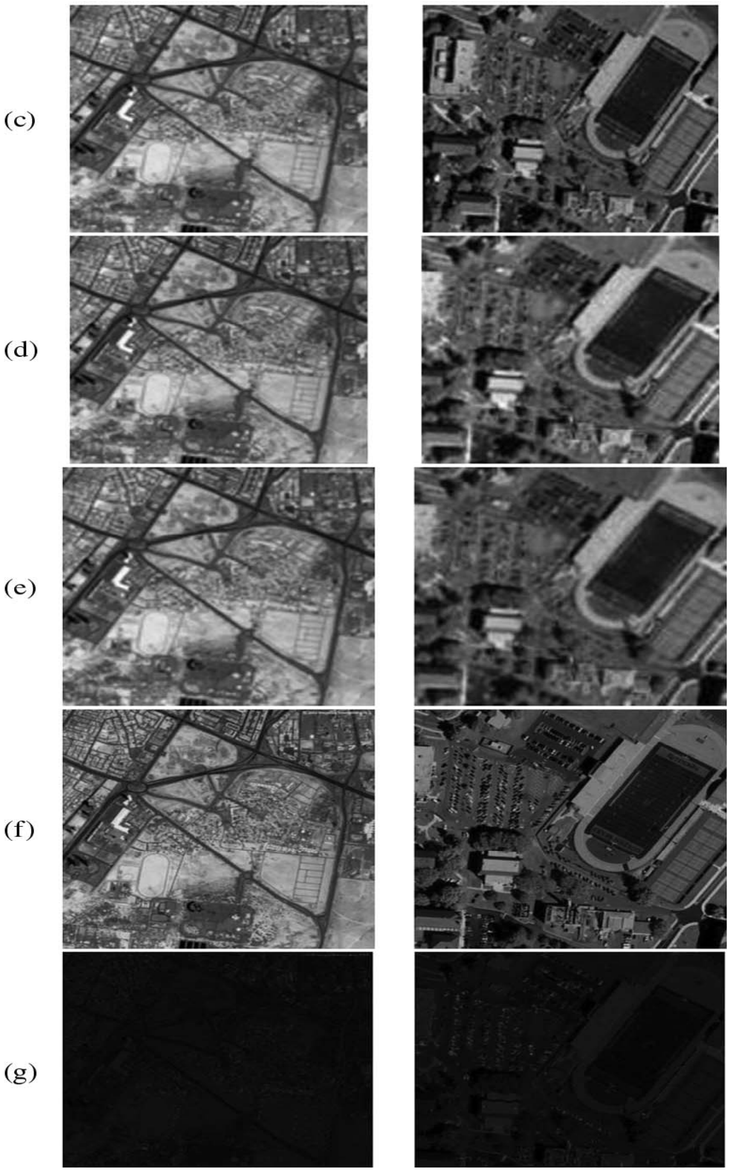

Figure 5. (a) Low-resolution image obtained from downsampling of the highresolution satellite image through 2 cascaded DWT, (b) original high-resolution satellite image, (c) bicubic interpolation-based resolution enhancement,(d) WZP, (e) WZP and CS technique, (f) the proposed image resolution enhancement technique, and (g) the difference between the original highresolution satellite image and the image enhanced by the proposed technique with enlargement from 128 × 128 to 512 × 512.

Acknowledgement:

We especially thanks to our department and our institute for the great support regarding paper and their all views.I really thankful to my all staffs and my guide Mr. who showed me the way of successful journey of publishing paper and project.

Conclusion:

This paper has proposed a new resolution enhancement technique based on the interpolation of the high-frequency subband images obtained by DWT and the input image. The proposed technique has been tested on well-known benchmark images, where their PSNR and RMSE and visual results show the superiority of the proposed technique over the conventional and state-of-art image resolution enhancement techniques.The PSNR improvement of the proposed technique is up to 7.19 dB compared with the standard bicubic interpolation.

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