Satellite Image enhancement using Combination of Transform Techniques and Interpolation Methods

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Abstract: Satellite images are used in many fields of research and enhancement of these images is an important process. In this paper we discuss the different types of transform techniques used for image enhancement. The edges of an image can be improved by using an effective transform technique and the resolution can be improved by using interpolation technique. The combination of transform techniques and interpolation methods helps to produce an overall enhanced image. The different transform techniques discussed in this paper are DWT, CWT, SWT and Curvelet Transform.

Keywords: DWT,CWT,SWT,Curvelet Transform**.**

1. Introduction

Image enhancement is a very important process in every image processing applications. The satellite, medical images are needed to be enhanced both in terms of edges and resolution so that the enhanced image looks better in terms of clarity. Image enhancement is done using a combination of transform technique and interpolation methods. Edges in an image can be improved by using transform techniques .Wavelet transform techniques are used effectively for edge improvement, but as it is not proper to the image with directional element, we use Curvelet transform for edge improvement. Image resolution is also an important parameter for image enhancement,this can be done by using

interpolation. Interpolation is a method of increasing the number of pixels in an image. The various interpolation techniques used are Nearest Neighbour, Bilinear, Bicubic and curvature interpolation.

The paper is organized as follows: section 2 describes about the image enhancement using discrete wavelet transform. Section 3 describes image enhancement using stationary wavelet section 4 describes about complex wavelet transform and finally section 5 describes proposed method using a combination of curvelet transform and cubic based interpolation for image enhancement.

2. Image enhancement by using Discrete Wavelet Transform(DWT)

Image Resolution enhancement using DWT [1] is a very popular technique .Image resolution is enhanced by using interpolation

technique. Bicubic interpolation is used in this method to increase the number of pixels in the image. The loss occurred due to smoothing caused by interpolation of high frequency components are avoided by using the discrete wavelet transform by which the edges are enhanced. Wavelet plays a very important role in many image processing applications. The 2D wavelet decomposition of image results in four decomposed sub band images referred as low-low (LL),low-high(LH),high low(HL) and High-high(HH).Fig.1 Shows the block diagram of DWT filter bank.
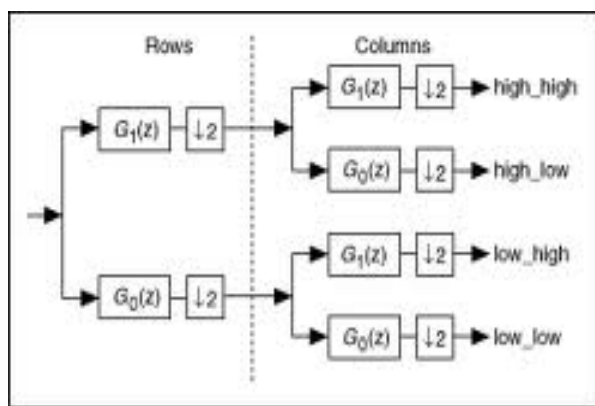

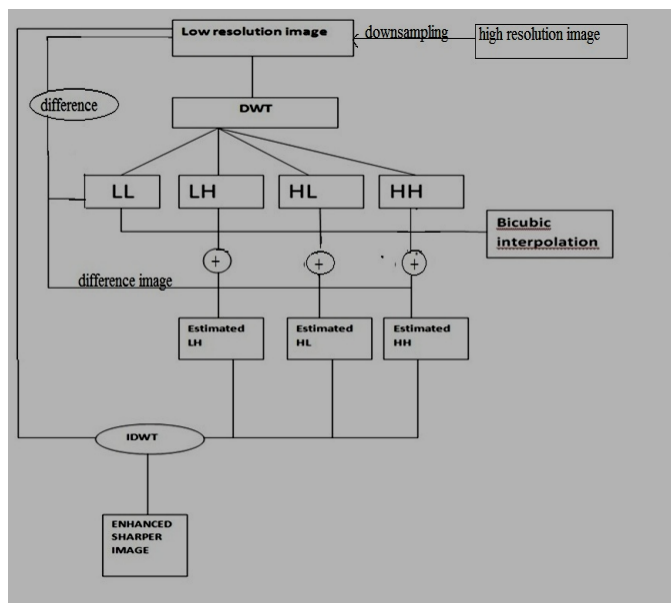**Fig.1 Block Diagram of DWT Filter bank**

Fig.2 DWT Based method of Image enhancement

From the fig.2 the high frequency subband images and the input low resolution images have been interpolated to generate a new resolution enhanced image. Although this method gives a resolution enhanced image, the wavelet based approach need many wavelet coefficients to accounts for edges. (i.e) singularities along lines or curves and also it lacks from directional selectivity and translational invariance. So this is improved by using the dual tree complex wavelet transform and stationary wavelet transform. There are also other directional wavelets like steerable wavelets, Gabor wavelets, wedgelets, Beamlets, bandlets, contourlets, shearlets, wave atoms, platelets etc.

3. Image Enhancement using Stationary Wavelet Transform

The stationary wavelet transform is a wavelet transform algorithm designed to overcome the lack of translational invariance[6] of discrete wavelet transform. It is similar to DWT but it does not use downsampling hence the subbands will have the same size as input image [2]. Downsampling in each of the sub-bands of DWT cause information loss that's the reason why SWT is employed. Image produced at the output will be of sharper high resolution image.

4. Image Enhancement using Complex Wavelet Transform (CWT)

Complex wavelet transform based approach of image enhancement is one of the recent approaches used in image processing and also an improvement technique of discrete wavelet transform. The lack of poor directionality of DWT is improved in CWT.Resolution enhancement is achieved by using directional selectivity provided by CWT. The high frequency subband in 6 different directions contributes to the sharpness of high frequency details such as edges. Dual tree complex wavelet transform (DT-CWT) [3] is used to decompose an image into different subbands. One level

CWT of an image produces 2 complex valued low frequency images and 6 complex valued high frequency images. The high frequency subband images are the results of directional selective filters.They show peak magnitude responses in the presence of image features oriented at $+75^0,+45^0,+15^0,-15^0,-45^0,-75^0$. The loss in the edges of the image are improved by using CWT.The diagram below shows the image enhancement method using DT-CWT. Interpolation is applied to the high frequency subband images.The advantages of using DT-CWT are high directional selectivity when compared to DWT. It also has limited redundancy, shift invariant.

It is difficult to design complex wavelets with perfect reconstruction properties and good filter characteristics [4]. DT-CWT added perfect reconstruction to other attractive properties of complex wavelet including shift invariance, six directional selectivities, limited redundancy and efficient computation.Fig.3 shows the DT-CWT based method of image enhancement.
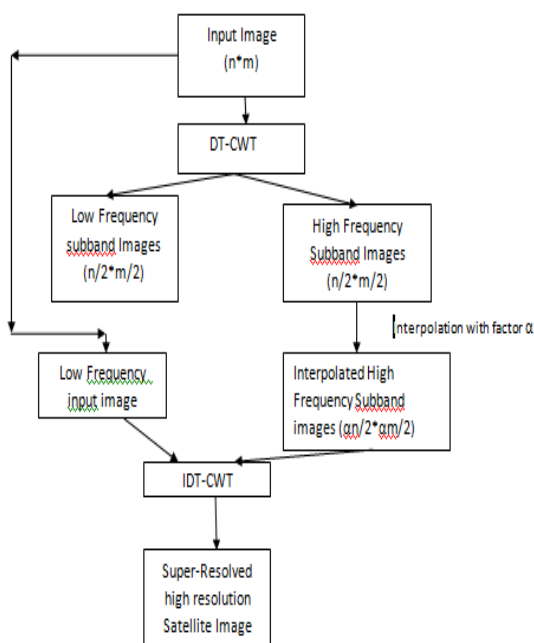

Fig.3 DT-CWT based method of Image Enhancement

5. Proposed Methodology

In the proposed method of image enhancement, the input image which contains some amount of noise can be removed by passing it through a suitable noise removal filter. Now curvelet transform is applied to the filtered image. The purpose of applying the curvelet transform is to improve the edges of the image [4]. The edge plays an important role in identification of image. The wavelet based approach of edge enhancement is not proper to the image with directional element whereas the curvelet based approach is high sensitive to directional image and edge, and the advantage of curvelet is that it handles the curve discontinuities very well. The various steps performed in curvelet transform are subband decomposition, smooth partitioning, renormalization and ridgelet analysis.After applying the curvelet transform then each subband cooeficients are enhanced. The cubic interpolation technique is applied to the image which enhances the resolution of the image. Finally inverse curvelet transform is applied to the coefficients. We get the final image enhanced in terms of noise, edge and resolution.

6. Conclusion

This paper gives a brief review of the image enhancement methods which uses a combination of transform techniques and interpolation. The proposed method enhances the image by reducing the noise, improving the edges and increasing the resolution. The performance of every technique can be measured by the values of PSNR and RMSE.

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