A Survey on Satellite Images Resolution Enhancement Using Dwt, Dwt-Swt and SVD

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Abstract-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. First image enhancement is done by DWT. The input satellite image is decomposed it into four sub-bands by DWT, then the high frequency sub bands and the input low resolution satellite image have been interpolated to obtain four interpolated images which are later combined after minor alterations to the interpolated input image using IDWT. The Resolution is defined as the smallest number of discriminable detail in an image. There are two types of resolution, grey level resolution and spatial resolution. Gray level resolution enhances the smallest discriminable details in an image, i.e. we can discriminate change in grey level. Images are being processed in order to obtain more enhanced resolution. Second resolution enhancement technique based on high frequency sub-band images obtained by discrete wavelet transform (DWT) of the input image. Input image is interpolated by bicubic interpolation, then DWT is performed on the interpolated input image to obtain HF sub-bands. The high frequency sub-band's edges are enhanced using stationary wavelet (SWT).Brightness is increased by SVD (singular value decomposition). Compression is also done by SVD. This second technique has got better PSNR and RMSE values compared to first enhancement technique.

Keywords-Discrete wavelet transform, Inverse discrete wavelet transform, Stationary wavelet transform, singular value decomposition.

I. INTRODUCTION

Resolution is the limiting factor for the utilization of remote sensing data (satellite imaging, etc.). Spatial and spectral resolutions of satellite images (unprocessed) are related (a high spatial resolution is associated with a low spectral resolution and vice versa) with each other . Therefore, spectral, as well as spatial, resolution enhancement (RE) is desirable. An image is a rectangular grid of pixels. It has a definite height and a definite width counted in pixels. They may be captured by optical devices—such as cameras, mirrors, lenses, telescopes, microscopes, etc. and natural objects and phenomena, such as the human eye or water surfaces. The recent advances in low-cost imaging solutions and increasing storage capacities, there is an increased demand for good image quality in a wide variety of applications involving both image and video processing [1].

In image resolution enhancement by using interpolation the main loss is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. Hasan Demirel and Gholamreza Anberjafri proposed a method, in this method; DWT has been employed in order to preserve the high frequency components of the image. The redundancy and shift invariance of the DWT mean that DWT coefficients are inherently interpolated. One level DWT is used to decompose an input image into different sub-bands [2]. Interpolation in image processing is a well-known method to increase the resolution of digital image. It increases the number of pixels in a digital image. Interpolation method select new pixel from surrounding pixels. Interpolation has been widely used in many image processing applications such as facial reconstruction, multiple-description coding and resolution enhancement [2]. There are many interpolation technique has been developed to increase the quality of this task. Mainly there are three well-known interpolation techniques for image interpolation namely Linear, nearest neighbor and Bicubic. Bicubic is more sophisticated than the other and produces smoother edges [2].

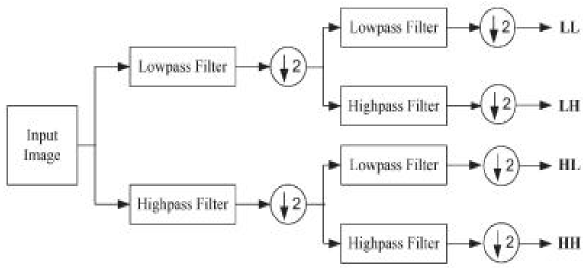

Fig. 1. Block diagram of DWT filter banks of level 1

Relatively new research addition, and recently, many new algorithms and others have estimated at the unknown details of wavelet coefficients in an effort to improve the sharpness of reconstructed images [3].The 1-D DWT can be extended to 2-D transform using separable wavelet filters. With separable filters, applying a 1-D transform to all the rows of the input and then repeating on all of the columns can compute the 2-D transform. When one-level 2-D DWT is applied to an image, four transform coefficient sets are created. The four sets are LL, HL, LH, and HH, where the first letter corresponds to applying either a low pass or high pass filter to the rows, and the second letter refers to the filter applied to the columns as shown in fig.1.

Low pass filtered signal contains information about slow changing component of the signal, looking very similar to the original signal. High pass filtered signal contains information about fast changing component of the signal. In most cases high pass component is not so rich with data relatively new research addition, and recently, many new algorithms and others have estimated at the unknown details of wavelet coefficients in an effort to improve the sharpness of reconstructed images [3].

II. LITERATURE SURVEY

Image interpolations based resolution enhancement increases the number of pixels in the image, there are three main techniques i.e. nearest neighbor interpolation, bilinear interpolation and bi-cubic interpolation. The application of these methods results in the softening of edges, creating a blurring effect on the image. The Discrete Wavelet Transform (DWT) based resolution enhancement is a relatively new concept, but it is able to address the problem of blurring. By applying DWT, the low resolution input satellite image is decomposed into four sub-bands, three high frequency sub-bands (LH, HL and HH) and the other low frequency sub-band (LL) which is a low resolution approximation of the input image but all the four sub-bands obtained are of half the size of that of the input image.

In this resolution enhancement technique shown in fig.2, after applying DWT on the input image using HAAR wavelet function, the high frequency sub-bands i.e. LH, HL and HH are interpolated by a factor of 4 using bicubic interpolation. Haar wavelet is used because it involves less computation. Then the LL sub band is discarded as it contains less information as compared to the input image. After that, the interpolation of input image is done by a factor of 2 using bicubic interpolation to match its scale with other three high frequency sub-bands [11].

Note that, DWT is shift variant, which causes artifacts in the RE image, and has a lack of directionality; however, DT-CWT is almost shift and rotation invariant [13] .

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. In this paper, DWT has been employed in order to preserve the high-frequency components of the image. DWT separates 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.

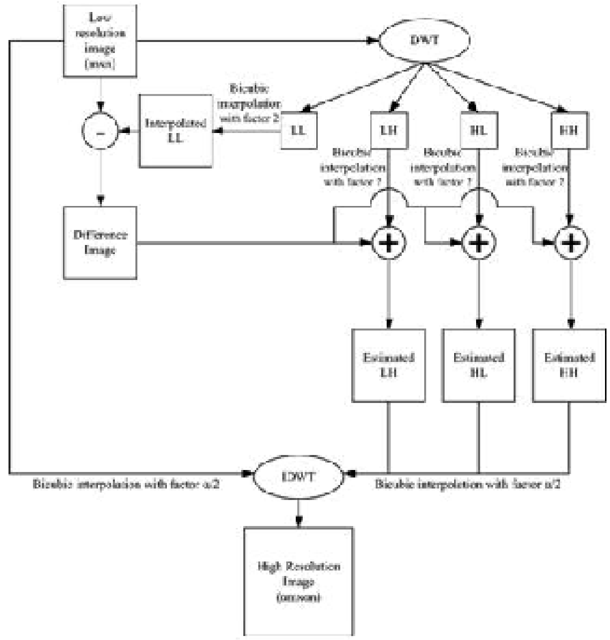

Fig. 2. Block diagram of DWT filter banks of level 2

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 bands, as shown in Fig. 3. 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 [12].

In recent years there is increased demand for better quality images in various applications such as biomedical imaging, surveillance and video enhancement. Image enhancement is also widely useful for satellite image applications which include mine detection, urban planning, military planning, intelligence and disaster monitoring/evaluation. Image resolution and contrast are the two major issues of images in these fields. Images are processed in order to enhance the quality of the digital images.

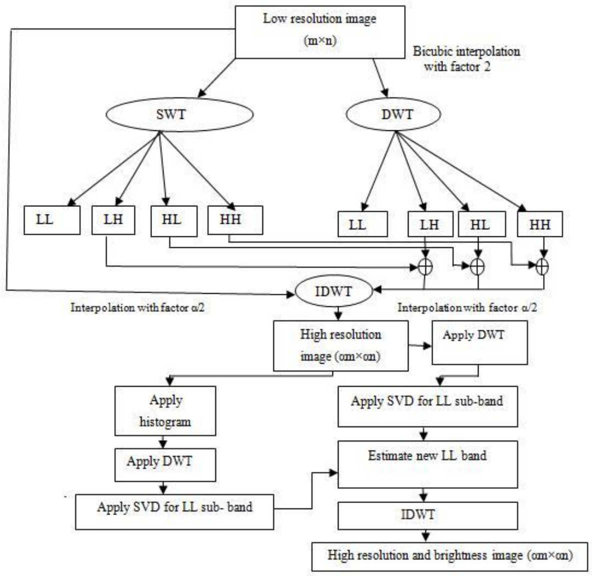

Fig. 3. Block diagram of enhancement technique using DWT, SWT and SVD

III. RESULTS

Fig.4. Low resolution satellite image   Fig.5. Resolution enhanced image by DWT

Fig.6.Resolution enhanced image by DWT-SWT

TABLE I: Enhancement using DWT AND DWT-SWT techniques

Table Head	**COMPARISON OF ALGORITHMS**		
	ALGORITHM	***PSNR***	***RMSE***
1	DWT	46.6367	1.1924
2	DWT-SWT & SVD	48.4069	0.9432

IV.CONCLUSION

Satellite image resolution technique is based on DWT, SWT & SVD is tested. Here DWT is used to enhance the high frequency sub bands.SWT is used to enhance the edge.DWT and SWT is used to enhance the brightness. This enhancement technique has better PSNR and RMSE values compared to DWT technique.

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