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Image Resolution Enhancement by Wavelet Transform

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***Abstract*— Wavelet transform based images resolution improvement is new technique in which all low and high frequency bands are considered for improvement using interpolation techniques like linear and bicubic which scales image. In previous work only high frequency bands are used for interpolation here differently low pass band is also considered because LL low –low frequency band mainly consist directional information feature .The interpolated frequency sub band coefficients have been corrected by using the frequency sub bands achieved by SWT of the input image. An original image is interpolated with half of the interpolation factor used for interpolation the high frequency sub bands. Afterwards all these images have been combined using IDWT to generate super resolved image. We are interpolating it to achieve high resolution using directional information features of low low band. We are using the input image for the interpolation of low frequency sub band image.**

Index Terms*— DWT, IDWT, Interpolation, Wavelet transform.

I. INTRODUCTION

Image resolution can be measured in various ways. Basically, resolution quantifies how close lines can be to each other and still be visibly resolved. Resolution units can be tied to physical sizes (e.g. lines per mm, lines per inch), to the overall size of a picture (lines per picture height, also known simply as lines, TV lines, or TVL), or to angular subtenant. Line pairs are often used instead of lines; a line pair comprises a dark line and an adjacent light line. A line is either a dark line or a light line. Resolution is the capability of sensor to observe or measure the smallest object clearly with distinct boundaries. There is difference between resolution and pixel. Pixel is actually a unit of digital image. Resolution depends upon the size of pixel. Smaller the size of pixel, higher will be the resolution and more clearly will the object in image. Image having smaller pixel size occupy more size on disk. Over the past several years, the wavelet transform has gained widespread acceptance in signal processing in general and in image compression research in particular. In applications such as still image compression, discrete wavelets transform (DWT) based schemes have outperformed other coding schemes like the ones based on DCT. Since there is no need to divide the input image into non-overlapping 2-D blocks and its basis functions have variable length, wavelet-coding schemes at higher

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II. PROPOSED SCHEME

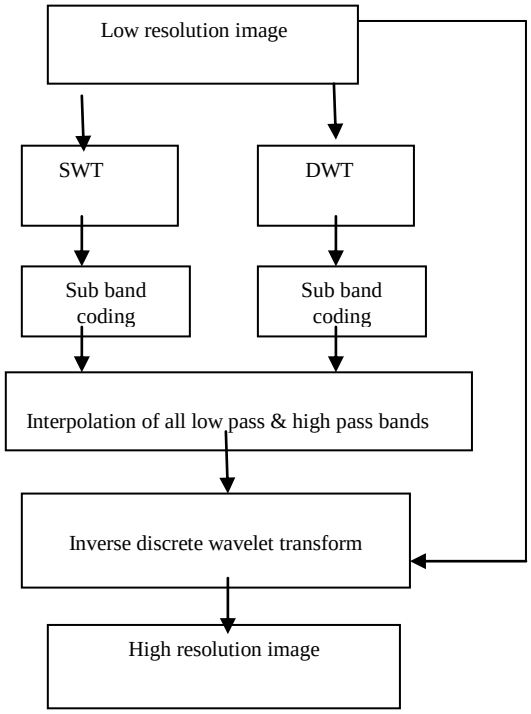

Fig.1: Block diagram of proposed system

Compression ratios avoid blocking artifacts. Because of their inherent multiresolution nature, wavelet-coding schemes are especially suitable for applications where scalability and tolerable degradation are important. A DWT is a wavelet transform for which the wavelets are discretely sampled. The DWT of a signal is calculated by passing it through a series of low and high pass filters to obtain four sub bands Fig. 1 shows block diagram of the proposed system. Low resolution image obtained is passed for wavelet transform like discrete wavelet transform and stationary wavelet transform which will give sub band coding.diffrent bands like LL, LH, HL, HH all bands are interpolated with bicubic and linear interpolation technique to increase resolution with pixel based improvement then estimated bands are passed to inverse discreet wavelet transform for reconstruction of high resolution of image. Discrete wavelet transform gives multi resolution analysis.

2.1Low resolution image

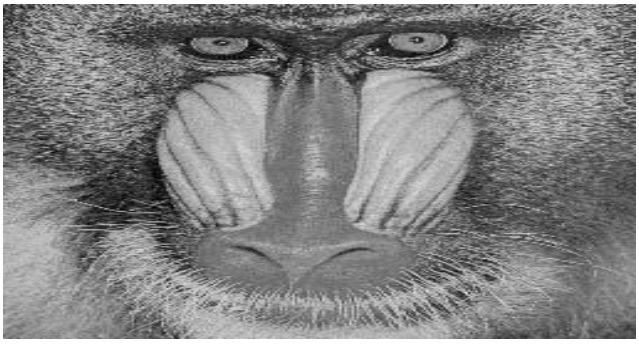

Fig.2 Low Resolution Image

Figure 2 shows the low resolution image whose resolution will be increased with wavelet transform. Using satellite images of low resolution image is captured and passed further for preprocessing.Diffrent cameras can be used to take input images which can be resized after processing for further operations.

2.2 DWT (Discrete Wavelet Transform)

The wavelet transform concentrates the energy of the image signals into a small number of wavelet coefficients. It has good time-frequency localization property the fundamental idea behind wavelets is to analyze signal according to scale. It was developed as an alternative to the short time Fourier to overcome problems related to its frequency and time resolution properties .Wavelet transform decomposes a signal into a set of basic functions. These basic functions are obtained from a mother wavelet by translation and dilation

$$w\varphi(a,b) = \int_{-\infty}^{+\infty} f(x) * \varphi a,b(t)\,dx \quad 1)$$

$$\varphi a,b(t) = \frac{1}{\sqrt{a}}\varphi\left(\frac{t-b}{a}\right) \quad 2)$$

Where a and b are both real numbers which quantify the scaling and translation operations respectively.

$$DWT(x,y) = \begin{cases} dj,k = \sum(x(n)\,h * j(n-2jk) \\ dj,k = \sum(x(n)\,g * j(n-2jk) \end{cases} \quad 3)$$

The coefficients dj , k refer to the detail components in signal x (n) and correspond to the wavelet function, whereas aj, k refer to the approximation components in the signal.

The functions h(n) and g(n) in the equation represent the coefficients of the high-pass and low-pass filters respectively, whilst parameters j and k refer to wavelet scale and translation factors. For the case of images, the one-dimensional (1-D)

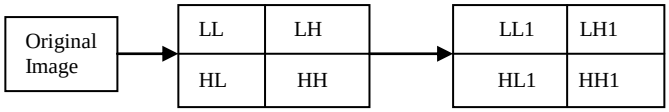

Fig.3 Process of decomposing using DWT of an image

The symbols L and H refer to low-pass and high-pass filter respectively. LL represents the approximation sub-band & LH, HL and HH are the detail sub-bands. LL is the low frequency sub-band gives global description of an image with directional features. Horizontal coefficients (LH) correspond to the low-frequency component in the horizontal direction and high-frequency component in the vertical direction.DWT based wavelet transform gives good multiresolution analysis compared to other wavelet transform.

2.3 Advantage of DWT

The advantage of DWT over DFT and DCT is that DWT performs a multi-resolution analysis of signal with localization in both time and frequency. Also, functions with discontinuities and with sharp spikes require fewer wavelet basis vectors in the wavelet domain than sine-cosine basis vectors to achieve a comparable approximation.DWT gives sub band coding using low pass and high pass filtering. DWT gives multiresolution analysis good compared to other transform like fourier transform which genrally use for staionary signals.

2.4 S*WT*

We know that the classical DWT suffers a drawback: the DWT is not a time- invariant transform. This means that, even with periodic signal extension, the DWT of a translated version of a signal X is not, in general, the translated version of the DWT of X. How to restore the translation invariance, which is a desirable property lost by the classical DWT ?The idea is to average some slightly different DWT, called ε-decimated DWT, to define the stationary wavelet transform (SWT).This property is useful for several applications such as breakdown points detection. The main application of the SWT is de-noising.

2.5 Interpolation Techniques

Interpolation is the process of using known data values to estimate unknown data values. Various interpolation techniques are often used in the atmospheric sciences. One of the simplest methods, linear interpolation, requires knowledge of two points and the constant rate of change between them. With this information, you may interpolate values anywhere between those two points. More sophisticated interpolations are also available in the Data Library. They are often applied to station datasets with irregular spacing between stations. The Cressman and Weaver analysis interpolation techniques are covered in this tutorial section. Both methods are primarily used to estimate equally-spaced latitude /longitude grid data from station data or gridded data with non-constant spacing. bicubic interpolation is an extension of cubic interpolation for interpolating data points on a two dimensional regular grid. In image processing, bicubic interpolation is often chosen over bilinear interpolation or nearest neighbor in image resampling, when speed is not an issue. In contrast to bilinear interpolation, which only takes 4 pixels (2x2) into account, bicubic interpolation considers 16 pixels (4x4). Images resample with bicubic interpolation are smoother and have fewer interpolation artifacts.

2.6 IDWT (Inverse discrete wavelet transform)

After DWT sub band coding LL sub band concentrates the illumination information. That is why only the LL sub band goes through the process, which preserves the high-frequency components (i.e., edges). Hence, after inverse DWT (IDWT), the resultant image will be sharper with good contrast.

III. APPLICATIONS

Resolution has been frequently referred as an important aspect 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 widely used in many image processing applications such as facial reconstruction, multiple description coding, and super resolution.

IV. RESULTS

The proposed technique uses DWT to decompose an image into different sub bands, and then the all frequency sub band images have been interpolated. In previous work only high frequency bands are used for interpolation here differently low pass band is also considered because LL low –low frequency band mainly consist directional information feature .The interpolated frequency sub band coefficients have been corrected by using the frequency sub bands achieved by SWT of the input image. An original image is interpolated with half of the interpolation factor used for interpolation the high frequency sub bands. Afterwards all these images have been combined using IDWT to generate super resolved image.

Techniques/ Images	PSNR (dB)		
	Lena	Baboon	Barbara
Bilinear	29.28	27.71	28.16
Bicubic	31.32	29.68	30.11
WZP	36.48	34.86	35.40
Proposed Technique	36.83	35.03	35.71

Fig 3. Results.

V. CONCLUSIONS

The interpolated frequency sub bands and the SWT frequency sub bands have the same size which means they can be added
with each other. The new corrected frequency sub bands can be interpolated further for higher enlargement. Also it is known that in the wavelet domain, the low resolution image is obtained by low pass filtering of the high resolution image. In other words, low frequency sub band is the low resolution of the original image. But still we are interpolating it to achieve high resolution using directional information features of low low band. We are using the input image for the interpolation of low frequency sub band image. Using input image instead of low frequency sub band increases the quality of the super resolved image.DWT gives better performance compared to discrete cosine transform.

VI. ACKNOWLEDGMENT

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