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Discrete Curve let and Morphological Based Adaptive Satellite Image Enhancement

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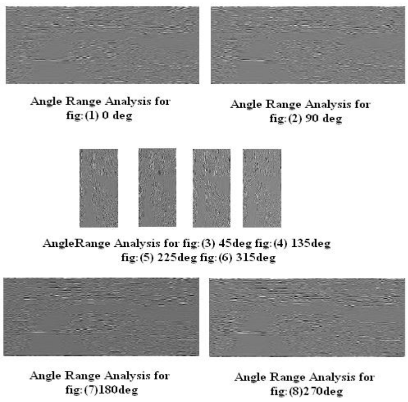
Abstract - Satellite colour images are being used in many fields of research. One of the major issues of these types of colour images is their poor perception. In this letter a new method to enhance the satellite image which using the concept of curve lets and multi structure decomposition. The proposed enhancement technique uses FDCT (Fast Discrete Curve lets) to decomposed input image into different sub bands. Multi Structure (Morphological) decomposition is a Powerful theoretical tool, which is used in nonlinear image analysis .Detecting the positions of the edges through threshold decomposition and these edges are sharpened by using morphological filters. This method will give better qualitative and quantitative results.

Keywords: - Fast Discrete Curve-Let Transform (FDCT), Singular Valued Decomposition (SVD), Morphological Process (Multi-Structure Elem-ent), Satellite Image Enhancement Validation Analysis

I. INTRODUCTION

Pictures are the most common and convenient means of conveying or transmitting information. A picture is worth a thousand words. Pictures concisely convey information about positions, sizes and inter-relationships between objects. They portray spatial information that we can recognize as objects Satellite Image Contrast Enhancement is the technique which is most widely required in the field of image processing to improve quality of the feature [1]. In general, the popular edge enhancement filtering is carried out with the help of traditional filters [2, 3 and 4]. But these filters do have some problems, especially while enhancing edges sharpened for image. The effort on edge enhancement has been focused mostly on improving the visual perception of images that are not clarity because of so many sub bands. Noise removal and preservation of useful information are important aspects of image enhancement. A wide variety of methods have been proposed to solve the edge preserving and noise removal problem for more improvement. Curve Lets are also playing a most role in many image-processing applications. The Curve Let decomposition of an image is performed by applying their performance was very slow; hence, researchers developed a new version which is easier to use and understand. In this new method, the use of the ridge let transform as a pre-processing step of curve let was discarded, thus reducing the amount of redundancy in the transform and increasing the speed considerably The first part of the tutorial reviews the motivation of " Why Curve let Proposed " and briefly reminds the history of tiling in time frequency space. Followed, the curve let transform structure is shown. The curve let transform can be decomposed with four steps: (1) Sub band Decomposition (2) Smooth Partitioning (3) Renormalization (4) Ridge let Analysis. By inversing the step sequence with mathematic revising, it is able to reconstruct the original signal which is called inverse curve let transform. There are some simulation experiments be shown for those three application respectively with comparison of wavelet transform and curve let transform. As the curve let transform is not a fully mature technology because it is just proposed in a decade, in the fifth section, I conclude some future work for nowadays curve let: (1) Reducing complexity; (2) Better thresholding function. In our project, the enhancement is applied through a SVD process of multi structure decomposition.



Fig; 1: Block Diagram: Fast Discrete Curve let Transform

This has two advantages: it reduces the edge detection to a simple binary process of each and every angle; and it makes the estimation of edge direction straight and cross condition also. Edge detection and direction estimation may be carried out by identifying simple patterns, which are closely related to the Prewitt operators [6]. These detected edges were then sharpened by using some morphological filters [9]. Binary morphological operations of dilation and erosion are used to increase the contrast in the region and direction of the detected edges with the aid of a flat structuring element. A summation is applied over all levels in order to reconstruct the sharpened image.

II. IMAGE ENHANCEMENT

Image enhancement techniques improve the quality of an image as perceived by a human. These techniques are most useful because many satellite images when examined on a colour display give inadequate information for image interpretation. There is no conscious effort to improve the fidelity of the image with regard to some ideal form of the image. There exists a wide variety of techniques for improving image quality. The contrast stretch, density slicing, edge enhancement, and spatial filtering are the more commonly used techniques. Image enhancement is attempted after the image is corrected for geometric and radiometric distortions. Image enhancement methods are applied separately to each band of a multispectral image. Contrast generally refers to the difference in luminance or grey level values in an image and is an important characteristic. It can be defined as the ratio of the maximum intensity to the minimum intensity over an image. Contrast ratio has a strong bearing on the resolving power and delectability of an image. Larger this ratio, more easy it is to interpret the image. Satellite images lack adequate contrast and require contrast improvement.

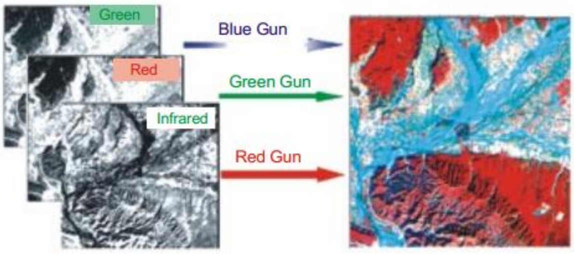
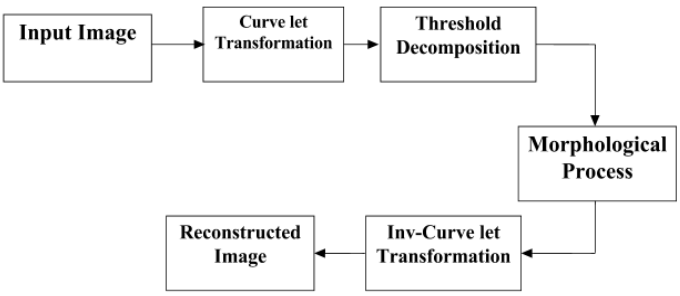


Fig: 2 Plane Separation Process on Input Image

A colour infrared composite 'standard false colour composite' is displayed by placing the infrared, red, and green in the red, green and blue frame buffer memory (Fig. 3). In this healthy vegetation shows up in shades of red because vegetation absorbs most of green and red energy but reflects approximately half of incident Infrared energy. Urban areas reflect equal portions of NIR, R & G, and therefore they appear as steel grey. While displaying the different bands of a multispectral data set, images obtained in different bands is displayed in image planes (other than their own) the colour composite is regarded as False Colour Composite (FCC). High spectral resolution is important when producing colour components. For a true colour composite an image data used in red, green and blue spectral region must be assigned bits of red, green and blue image processor frame buffer memory. Curve lets implementations are based on the original construction which uses a pre-processing step involving a special partitioning of phase-space followed by the ridge let transform which is applied to blocks of data that are well localized in space and frequency. In the last two or three years, however, curve lets have actually been redesigned in an effort to make them easier to use and understand. As a result, the new construction is considerably simpler and totally transparent. Moreover, this process is very time consuming, which makes it less feasible for texture features analysis in a large database Fast discrete curve let transform based on the wrapping of Fourier samples has less computational complexity as it uses fast Fourier transform instead of complex ridge let transform. In this approach, a tight frame has been introduced as the curve let support to reduce the data redundancy in the frequency domain.



Fig; 3: Block Diagram: Image Contrast Enhancement Using FDCT

To achieve higher level of efficiency, curve let transform is usually implemented in the frequency domain. That is, both the curve let and the image are transformed and are then multiplied in the Fourier frequency domain. The product is then inverse Fourier transformed to obtain the curve let coefficients. The process can be described as

Curve let transform = IFFT [FFT(Curve let) × FFT(Image)] and the product from the multiplication is a wedge .The trapezoidal wedge in the spectral domain is not suitable for use with the inverse Fourier transform which is the next step in collecting the curve let coefficients using IFFT.

The wedge data cannot be accommodated directly into a rectangle of size 2 *j* ×2 *j* / 2. To overcome this problem, Candies et al. have formulated a wedge wrapping procedure [18] where a parallelogram with sides 2 *j* and 2 *j* / 2 is chosen as a support to the wedge data. The wrapping is done by periodic tiling of the spectrum inside the wedge and then collecting the rectangular coefficient area in the centre.

III. SINGULAR VALUED DECOMPOSITION (SVD)

SVD methods deal with solving difficult linear-least squares problems such as the terms in documents case and here colours in images. They are based on the following theorem of Linear Algebra. Each image can be represented by a matrix which contains the pixel intensity values. In general, for any image matrix *A*, the SVD can be defined as:

$$A = U\sum V$$

Where *U* and *V* are orthogonal square matrices and *ΣA* matrix contains the sorted singular values on its main diagonal. *ΣA* contains the intensity information of the given image which means that the maximum singular value of *ΣA* contributes more than the other singular values.

Morphology Multi Structuring Element:-

Morphology is a technique of image processing based on shapes. The value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, you can construct a morphological operation that is sensitive to specific shapes in the input image. In mathematical morphology, a **structuring element** is a shape, used to probe or interact with a given image, with the purpose of drawing conclusions on how this shape fits or misses the shapes in the image. It is typically used in morphological operations, such as dilation, erosion, opening, and closing, as well as the hit-or-miss transform.

Shape: - For example. can be a "ball" or a line; convex or a ring, etc. By choosing a particular see. One sets a way of differentiating some objects (or parts of objects) from others, according to their shape or spatial orientation.

Size;-. For example, one can be a 3 X 3 square or a 21 X 21 square. Setting the size of the structuring element is similar to setting the observation scale, and setting the criterion to differentiate image objects or features according to size.

<u>Dilation</u>

The value of the output pixel is the **maximum value** of all the pixels in the input pixel's neighbourhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

<u>Erosion</u>

The value of the output pixel is the **minimum value** of all the pixels in the input pixel's neighbourhood. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0.

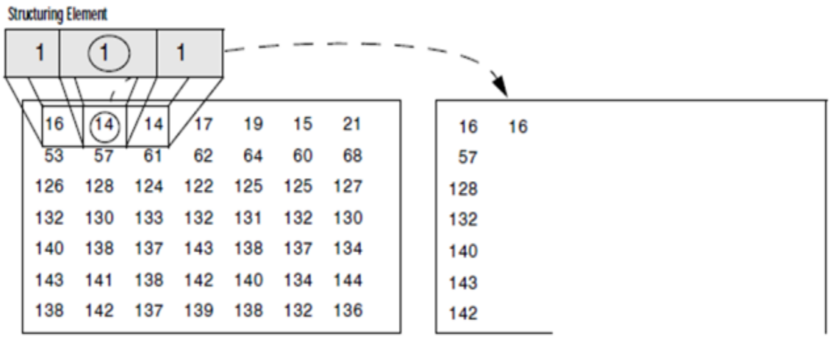


Fig:4 (a) Input Image Fig (b) Multi-Structure Element Image

After Morphological Process is used to sharpen these detected edges. Image enhancement techniques are used to improve an image, where "improve" is sometimes defined objectively (e.g., increase the signal-to-noise ratio), and sometimes subjectively (e.g., make certain features easier to see by modifying the colours or intensities). Peak signal to noise ratio (PSNR) and root mean square error (RMSE) have been implemented in order to obtain quality results. PSNR can be obtained by using the following formula:

$$\mathbf{PSNR = 10\ log10[(255X255)/RMSE]}$$

RMSE is representing input image I1 and proposed enhanced image I2 which can be obtained by the following formula:

MSE= {∑∑ [K (i, j)-P (i, j)] ^2} / (MXN)

In Root Mean Square Error

RMSE=√ ({∑∑ [K (i, j)-P (i, j)] ^2} / (MXN))

IV. RESULT ANALYSIS

The results for the enhancement of satellite images are given. The images tested in the proposed method were performed shown in figure (e) which was express in the numerical form of satellite image. The result image can be evaluated withthree characteristics, edges, distortion and sharpness. According to the distortion evaluation, adjusting errors are required, by computing the Mean Square Error (MSE). Mean square error has been the performance metric in lost performance compared with Wavelet Enhancement. Peak Signal to Noise Ratio (PSNR) adjusts the quality of the image which the higher the PSNR refers to the better quality for Wavelet Enhancement image. Quantity is high in proposed image enhancement techniques Fig.5.1 (a), 5.2 (a) and 5.2(a) are original images

Fig: 5.1 (a) Fig: 5.1 (b) Fig: 5.1 (c) Fig: 5.1 (d) Fig: 5.1 (e)

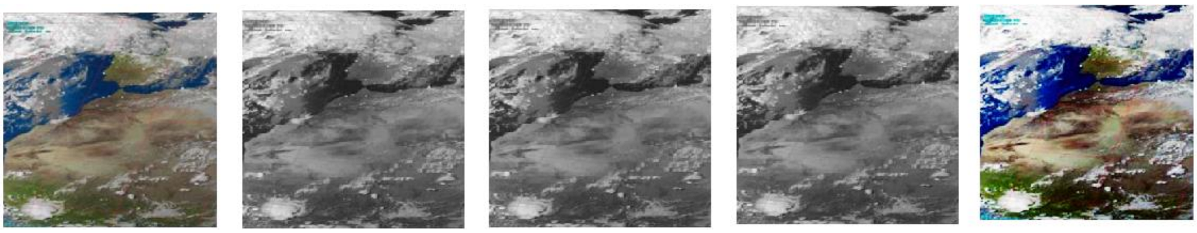


Fig: 5.2 (a) Fig: 5.2 (b) Fig: 5.2 (c) Fig: 5.2 (d) Fig: 5.2 (e)

Fig: 5.3 (a) Fig: 5.3 (b) Fig: 5.3 (c) Fig: 5.3 (d) Fig: 5.3 (e)

Fig: 5: Satellite Image Contrast Enhancement Using Curve let with Multi Structure Element

Images	image1	image2	image3	image4
FDCT	8.9955	9.7926	5.1837	7.6646
DWT	11.4216	12.4211	7.216	9.6646

Tabulation: 1 RMSE Comparison between FDCT vs. DWT process in Satellite Image Enhancement

Images	image1	image2	image3	image4
FDCT	36.5906	38.2218	40.9844	39.2859
DWT	30.1459	34.7694	36.2052	35.2859

Tabulation: 1 PSNR Comparison between FDCT vs. DWT process in Satellite Image Enhancement

Fig: 5.1(b), 5.2(b), 5.3(b) all is RED Plane Images. Fig: 5.1(c), 5.2(c), 5.3(c) all is GREEN Plane Images. Fig: 5.1(d), 5.2(d), 5.3(d) all are BLUE Plane Images. After using Satellite image enhancement using FDCT and Multi-Structure Element driven morphological filter. The proposed method gives better qualitative and quantitative results .as shown Fig.5.1 (e), 5.2 (e), and 5.3 (e) are enhanced images.

V. CONCLUSION

In Our Project the shape detected guided wrapping and smoothing filters succeeded in enhancing low contrast satellite images. This was done by accurately detecting the positions of the edges through SVD decomposition. The detected edges were then sharpened by applying smoothing and wrapping filter. By utilizing the multi-structure element edges, the scheme was capable to effectively sharpening and detecting fine details. The visual examples shown above, have demonstrated that the FDCT (Fast Discrete Curve let Transform) method was significantly better than many other well-known sharpener-type filters in respect of edge and fine detail restoration The PSNR improvement compared with DWT, FDCT technique is high.

VI. FUTURE SCOPE

This resolution enhancement can further improve with Lenclos based up-sampling and Gabor filtering for texture characterization. Up-sampling reduces the distortion of detailed information and Gabor provides detail, structure components at different orientations using Satellite Images.

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2. PGK.Sirisha,AssociateProfessor,CSE in sri mittapalli institute of technology for women. Her research area includes Image Processing.

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