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Noisy Satellite Image Contrast Enhancement Using Median Filter, DWT–SVD And MMBEBHE Based Method

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Abstract
Satellite image is utilized as a part of numerous applications, for example, geo sciences studies, astronomy and geological data frameworks. The most essential quality considers images originated from its determination. The satellite image improvement method utilizing Discrete Wavelet Transform and Singular Value Decomposition. This Techniques breaks down the information image into four frequency sub band by utilizing Discrete Wavelet Transform and furthermore ascertain the Singular Value Matrix of the Low-Low Sub band images and adjust the improved images through Inverse Discrete Wavelet Transform. In this work we have developed an improved version of this method. The conventional method uses global histogram equalization (GHE) in its processing. In the improved method we have applied median filter for noise removal also we have replaced GHE with minimum mean brightness error bi-histogram equalization method. Experimental results show that the improved method works better than the conventional DWT-SVD-GHE based method.
Keywords:- *histogram equalization, contrast enhancement, brightness preservation, singular value decomposition, discrete wavelet transform.*

1- INTRODUCTION

The aim of this work is to improve the contrast of the satellite image utilizing Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD). The image upgrade is a procedure of enhance the nature of a image. A standout amongst the most imperative quality figures satellite images originates from its contrast.

Contrast enhancement is a standout amongst the most vital issue in image preparing. Contrast is created by the distinction in luminance reflected from two adjoining surfaces. contrast is the distinction in the shading and shine of the image [1]. On the off chance that the contrast of a image is exceedingly focused on a specific range, the data might be lost in those territories which are unreasonably and consistently thought.

The fundamental issue is to advance the contrast of a image to speak to all the data in the information image. There are a few strategies, for example, Generalized Histogram Equalization (GHE) and Singular Value Decomposition (SVE). As the rising interest for great remote detecting images, differentiate improvement procedures are having better visual recognition and shading proliferation Histogram Equalization (HE) is the to upgrade the difference. It is a bit much that contrast will dependably increment in this. There might be a few cases were histogram balance can be more awful. To conquer this issue these issue, bi-histogram evening out (BHE) and dualistic sub image HE strategies have been proposed by utilizing decay of two histograms. For assist changes, the Recursive Mean-Separate Histogram Equalization (RMSHE) technique iteratively plays out the BHE and delivers independently leveled sub histograms.

There are number of global histogram equalization (GHE) based methods developed so far for image contrast enhancement [2]-[14]. These methods can be systematically studied at [15]. In this work we have developed an improved version of this method. The conventional method uses global histogram equalization (GHE) in its processing. In the improved method we have replaced GHE with minimum mean brightness error bi-histogram equalization method. Experimental results shows that the improved method works better than the conventional DWT-SVD-GHE based methods.

2- FEW BASIC CONCEPTS

A- Discrete Wavelet Transform (DWT)

A Discrete Wavelet Transform is a wavelet change which utilizes wavelet coefficients. The DWT strategy which catches both frequency and area data of a image. Determination is a critical element in satellite imaging. The remote detecting images have high frequency substance and also low frequency substance. What's more, the image may have losing of high frequency substance. In this way, the DWT procedure for determination to keep up the high frequency parts of the satellite images [16]. The satellite info image should be isolated into four sub groups. They are Low-Low (LL), Low-High (LH), High-Low (HL), and High-High (HH). At that point the high frequency sub groups are evaluated. The high frequency sub band images and the low determination input images are added and utilizing backwards DWT we can get a determination upgraded image [17]. The addition procedure is utilized to save high frequency substance of the image. The DWT system is primarily used to create the sharper improved image. Fig. 2 shows and example of decomposition of an image into its four frequency sub-bands using DWT.

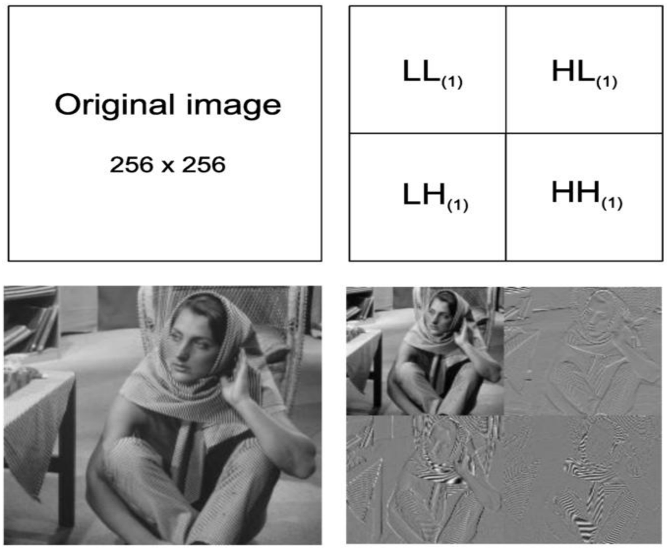

Fig. 1 decomposition of an image into four frequency sub-bands using DWT.

B- Singular Value Decomposition (SVD)

SVD technique is based on a theorem from linear algebra which says that a rectangular matrix A, that can be broken down into the product of three matrices, as follows: (i) an orthogonal matrix U, (ii) a diagonal matrix Σ and (iii) the transpose of an orthogonal matrix V. The singular value decomposition is a factorization of a real or complex matrix. SVD of an image can be interpreted as a matrix is written as follows:

$$A = U.\Sigma.V \qquad (1)$$

Where U and V are orthogonal square matrices and Σ matrix contains singular values on its main diagonal. The intensity information of input image and any change on the singular values are represented at the singular value matrix which will change the intensity of the input image. The main advantage of using SVD for image equalization, Σ has the intensity information of the image.

C-Minimum Mean Brightness Error BI-Histogram Equalization Method (MMBEBHE)

MMBEBHE [6] is the extension of BBHE [5]. MMBEBHE is a technique that isolates the input image histogram in light of limit estimation of information image which limits absolute mean brightness error in the handled image.

The accompanying 3 stages are performed while performing MMBEBHE:

1: Firstly, for every limit level, estimation of AMBE is done.

2: Therefore, figuring of least edge level Xt is finished by this technique which prompts minimum MBE.

3: Finally, base Xd on Xt of step 2 MMBEBHE separates the input histogram and after then apply histogram equalization on each of sub histogram freely.

3- THE DWT-SVD-GHE BASED METHOD

As shown in Fig. 2 the overall processing of method of [17] can be understood from the following simple steps.

1. The input image I is enhanced using global histogram equalization (GHE). Let this enhanced image is I'.
2. Now the discrete wavelet transform DWT is separately applied to I and I' respectively

and these images are converted into four frequency sub-bands.

3. LL part of each image I and I' is taken and singular value decomposition method is applied on it.
4. Now on the basis of singular value decomposition value of ξ is calculated.
5. After that the new enhanced image is reconstructed by using value of ξ and LL frequency sub-band of image I.

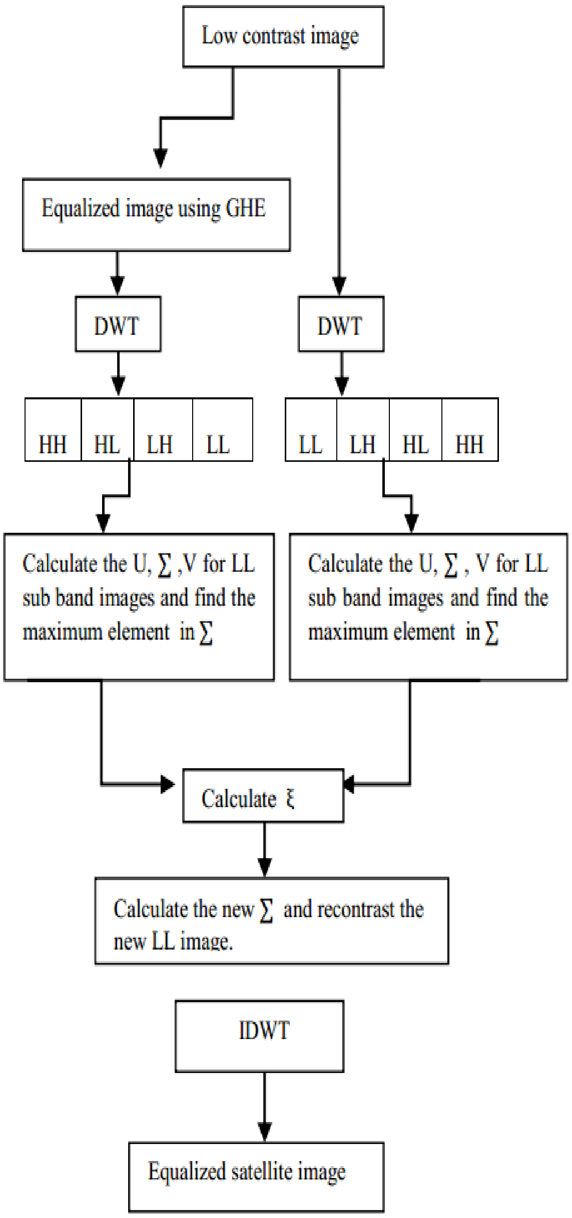

Fig. 2 The DWT-SVD-GHE based method (Fig source [17]).

4- THE PROPOSED METHOD

As said earlier the proposed method is just an improvement of the conventional DWT-SVD-GHE based method and the proposed method is using concept of applying de-noising filter at very beginning of the processing from the work of [18]. The DWT-SVD-GHE method does not use any method to remove noise from the input image also the GHE method suffers from the mean shift problem. Now we will show the mean shift problem.

Mean brightness of GH Equalized image is calculate as: It is assumed theoretically that for an image having gray levels in the range $\{X_0, X_1, \ldots X_{L-1}\}$. The GH equalized image (y) will have uniform histogram i.e.:

$$pdf(y) = \frac{1}{(X_{L-1} - X_0)} \quad (2)$$

Now mean brightness of histogram equlized image is given as:

$$E(Y) = \int_{X_0}^{X_{L-1}} y.pdf(y)dy \quad (3)$$

$$E(Y) = \int_{X_0}^{X_{L-1}} \frac{y}{(X_{L-1} - X_0)} dy \quad (4)$$

$$E(Y) = \frac{(X_0 + X_{L-1})}{2} \quad (5)$$

It is clear that mean brightness of GH equalized image is middle gray level. Means the GHE method shifts mean brightness of input image to middle gray level. This problem is called as the mean shift problem.

To solve the problems of GHE method a number of methods have been proposed. One such method is MMBEBHE [6]. This method leads to minimum brightness change in between input and processed image. Hence in the proposed work we are using the MMBEBHE method instead of GHE. Now the flow chart of proposed method can be understood from the Fig. 3.

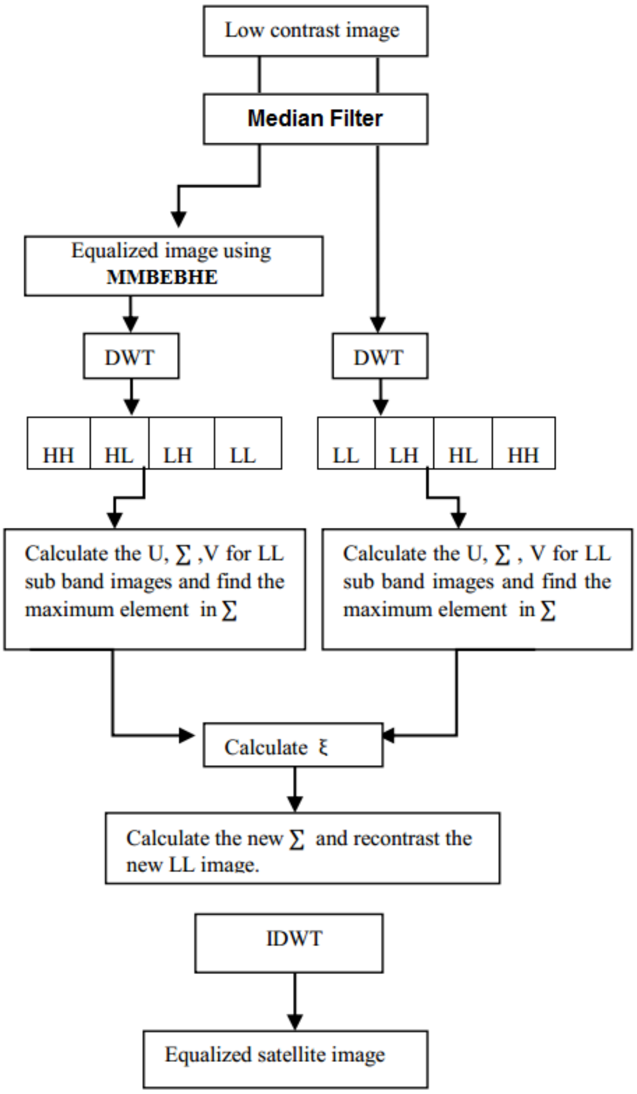

Fig. 3 The proposed method.

As shown in Fig. 3 the overall processing of proposed method can be understood from the following simple steps.

1. Median filter is applied on the input satellite image for removal of noise.
2. Then input image I is enhanced using MMBEBHE. Let this enhanced image is I'.
3. Now the discrete wavelet transform DWT is separately applied to I and I' respectively and these images are converted into four frequency sub-bands.
4. LL part of each image I and I' is taken and singular value decomposition method is applied on it.
5. Now on the basis of singular value decomposition value of ξ is calculated.
6. After that the new enhanced image is reconstructed by using value of ξ and LL frequency sub-band of image I.

5- EXPERIMENTAL RESULTS

Here we are showing results of our method with other methods like GHE and DWT-SVD-GHE.

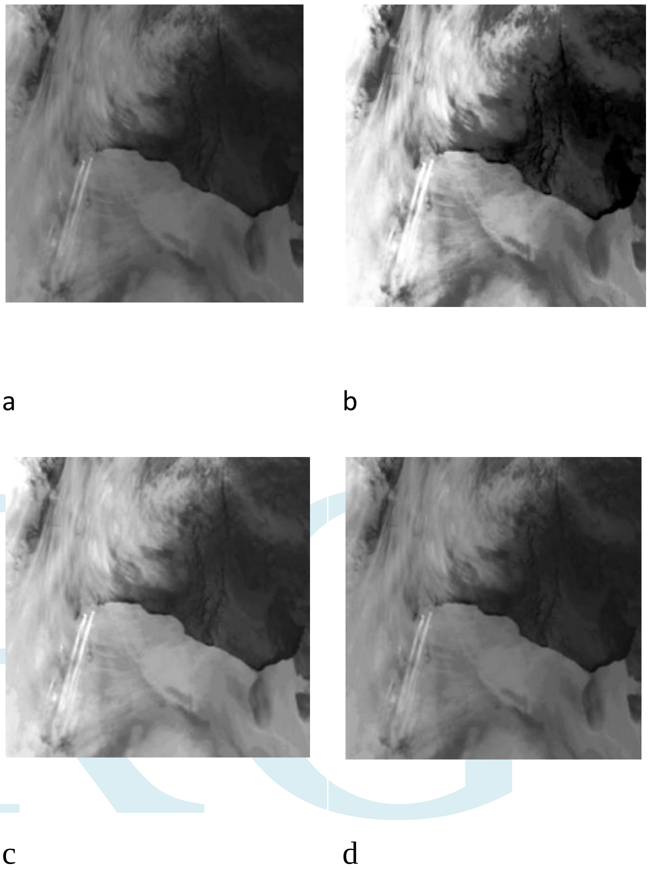

Fig 4 results of proposed method with other methods. (a) Input satellite image; (b) histogram equalized image PSNR = {13.841505}; (c) DWT-SVD-GHE method's image PSNR = {14.763356}; (d) proposed method PSNR = {32.456103}.

Fig 4 shows that our method does not over enhance the given satellite image also it achieves better PSNR values than other methods.

Now we show results of proposed method for same satellite image corrupted with salt and pepper noise.

Fig 5 shows that our method removes noises from the given satellite image also it achieve better PSNR values than other methods.

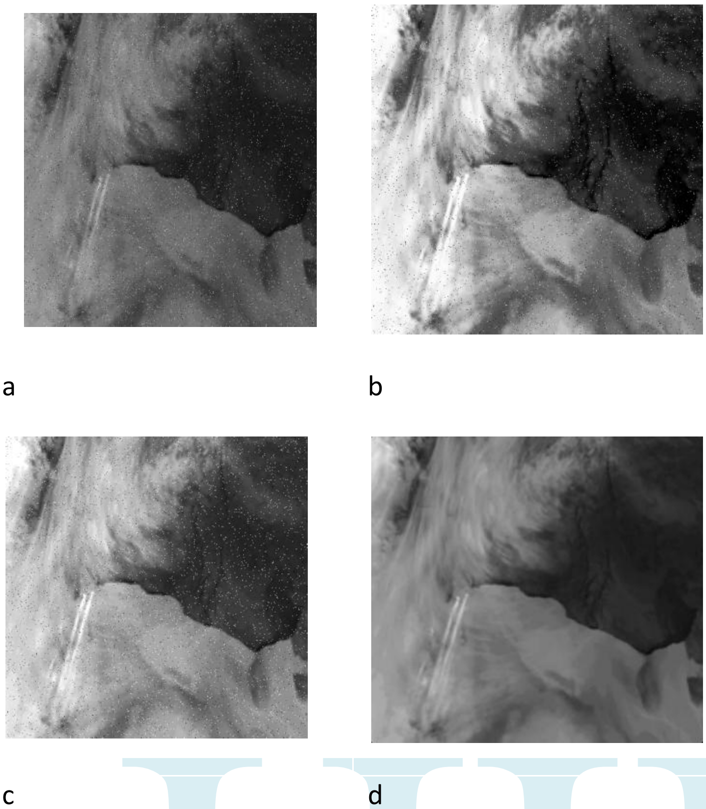

Fig 5 results of proposed method when input satellite image is corrupted with noise. (a) Input noisy satellite image; (b) histogram equalized image PSNR = {14.075132}; (c) DWT-SVD-GHE method's image PSNR = {15.085215}; (d) proposed method PSNR = {33.206529}.

6- CONCLUSION

In this work we have developed an improved version of this method. The conventional method uses global histogram equalization (GHE) in its processing. In the improved method we have applied median filter for noise removal also we have replaced GHE with minimum mean brightness error bi-histogram equalization method. Experimental results shows that the improved method works better than the conventional DWT-SVD-GHE based methods. This method is also able to remove noise from given satellite images which is not possible by other methods.

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