Single Scale Decomposition And Improving Contrast Of Satellite Images Using Svd

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Abstract—

In this letter, a new satellite image contrast enhancement technique based on the discrete wavelet transform (DWT) and singular value decomposition has been proposed. The technique decomposes the input image into the four frequency sub bands by using DWT and estimates the singular value matrix of the low–low sub band image, and, then, it reconstructs the enhanced image by applying inverse DWT. The technique is compared with conventional image equalization techniques such as standard general histogram equalization and local histogram equalization, as well as state-of-the-art techniques such as brightness preserving dynamic histogram equalization and singular value equalization. The experimental results show the superiority of the proposed method over conventional and state-of-the-art techniques.

***Index Terms*—Discrete wavelet transforms, histogram equalization, image equalization, satellite image contrast enhancement**

I. INTRODUCTION

Satellite images are used in many applications such as Geosciences studies, astronomy, and geographical information systems. One of the most important quality factors in satellite images comes from its contrast. Contrast enhancement is frequently referred to as one of the most important issues in image processing. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In visual perception, contrast is determined by the difference in the color and brightness of an object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. If the contrast of an image is highly concentrated on aspecific range, the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to optimize the contrast of an image in order to represent all and brightness of an object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions.

If the contrast of an image is highly concentrated on a specific range, the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to optimize the contrast of an image in order to represent all the information in the input image. There have been several Techniques to overcome this issue, such as general Histogram equalization (GHE) and local histogram equalization (LHE). In this letter, we are comparing our results with two State-of-the-art techniques, namely, brightness preserving dynamic Histogram equalization (BPDHE) and our previously In many image processing applications, the GHE technique is one of the simplest and most effective primitives for contrast Enhancement, which attempts to produce an output Histogram that is uniform. One of the disadvantages of GHE is that the information laid on the histogram or probability distribution function (PDF) of the image will be lost. Demirel and Anbarjafari showed that the PDF of face images can be used for face recognition; hence, preserving the shape of the PDF of an image is of vital importance. Techniques such as BPDHE or SVE are preserving the general pattern of the PDF of an image. BPDHE is obtained from dynamic histogram specification Which generates the specified histogram dynamically from the Input image. The singular-value-based image equalization (SVE) technique, is based on equalizing the singular value matrix Obtained by singular value decomposition (SVD). SVD of an Image, which can be interpreted as a matrix, is written as Follows:

$$A = U_A \sum{}_A V_A^T \qquad (1)$$

Where UA and VA are orthogonal square matrices known as Hanger and aligner, respectively, and the ΣA matrix contains The sorted singular values on its main diagonal. The idea of Using SVD for image equalization comes from this fact that ΣA Contains the intensity information of a given image. In our earlier work SVD was used to deal with an Illumination problem. The method uses the ratio of the largest Singular value of the generated normalized matrix, with mean Zero and variance of one, over a normalized image which can be calculated according to

$$\xi = \frac{\max\left(\sum_{N(\mu=0,Var=1)}\right)}{\max\left(\sum_{A}\right)} \quad (2)$$

Where $\Sigma N(\mu=0,var=1)$ is the singular value matrix of the synthetic intensity matrix. This coefficient can be used to regenerate an equalized image using

$$\Xi_{equalized_A} = U_A\left(\xi \sum_A\right)V_A^T \quad (3)$$

II. PROPOSED IMAGE CONTRAST ENHANCEMENT

There are two significant parts of the proposed method. The first one is the use of SVD. As it was mentioned, the singular value matrix obtained by SVD contains the illumination information. Therefore, changing the singular values will directly affect the illumination of the image; hence, the other information in the image will not be changed. The second important aspect of this work is the application of DWT. As it was mentioned in Section I, the illumination information is embedded in the LL sub band. The edges are concentrated in the other sub bands (i.e., LH, HL, and HH). Hence, separating the high-frequency sub bands and applying the illumination enhancement in the LL sub band only will protect the edge information from possible degradation. After reconstructing the final image by using IDWT, the resultant image will not only be enhanced with respect to illumination but also will be sharper.

The general procedure of the proposed technique is as follows.

The input image A is first processed by using GHE to Generate $A\hat{}$. Then, both of these images are transformed by DWT into four sub band images. The correction coefficient For the singular value matrix is calculated by using the following equation:

$$\xi = \frac{\max(\Sigma_{LL_{\hat{A}}})}{\max(\Sigma_{LL_A})} \quad (4)$$

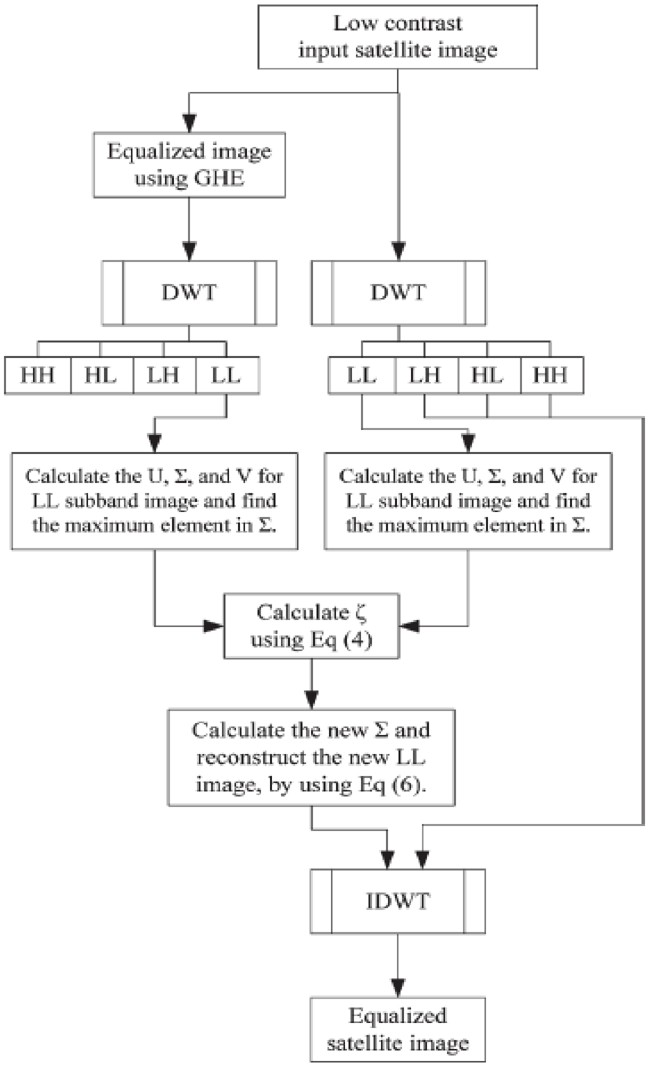
Where ΣLLA is the LL singular value matrix of the input image
and $\Sigma LL\ \hat{}A$ is the LL singular value matrix of the output of the GHE. The new LL image is composed by

$$\overline{\Sigma}_{LL_{\hat{A}}} = \xi \Sigma_{LL_A}$$

$$\overline{LL}_A = U_{LL_A}\overline{\Sigma}_{LL_A}V_{LL_A} \quad (5)$$

Now, the *LLA*, *LHA*, *HLA*, and *HHA* sub band images of the
original image are recombined by applying IDWT to generate
the resultant equalized image *A*

A = IDWT(*LLA*, *LHA*,*HLA*,*HHA*).*(6)*



We have used the db.9/7 wavelet function as the Mother function of the DWT. In the following section, the Experimental results and the comparison of the aforementioned conventional and state-of-the-art techniques are discussed..

III.EXPERIMENTAL RESULTS AND DISCUSSIONS

ORIGINAL IMAGE LOW CONTRAST IMAGE

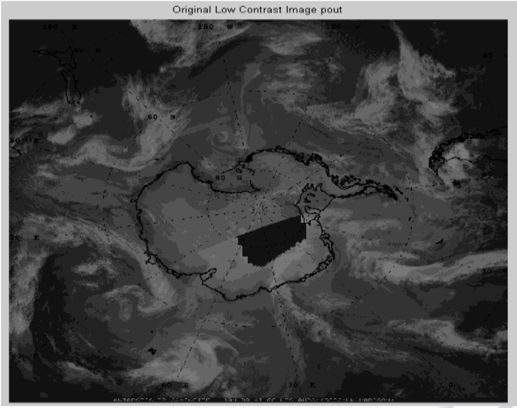


Figure:1 Original Low Contrast Image

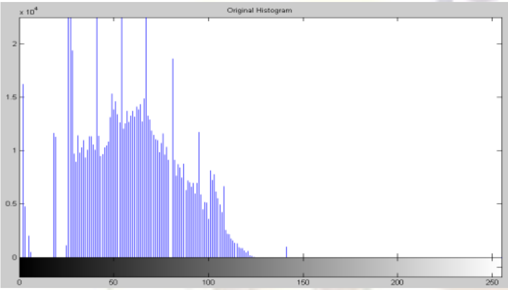


Figure:1.1 Original Low Contrast Histogram

The fig shows the grey level distribution of low contrast image. By using this grey level distribution, the contrast adjustments can be studied.

HISTOGRAM EQUALIZED:

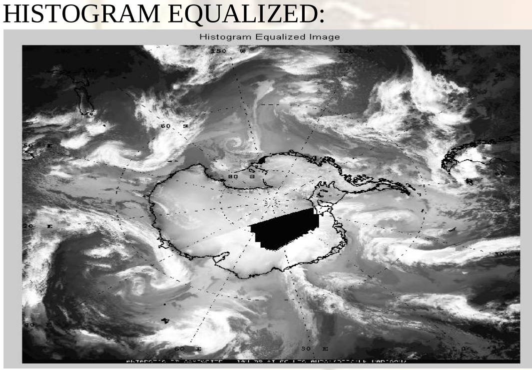


Figure:2 Histogram Equalized Image

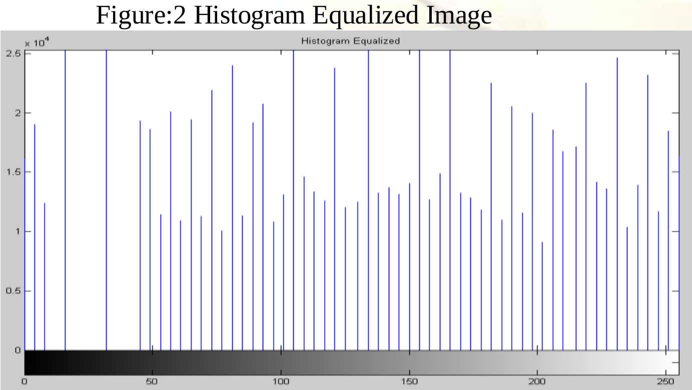


Figure:2 .1Histogram Equalized Histogram

The grey level distribution of general Histogram equalization was not clearly distributed over the entire scale as shown in fig.

ADAPTIVE HISTOGRAM EQUALIZED IMAGE:

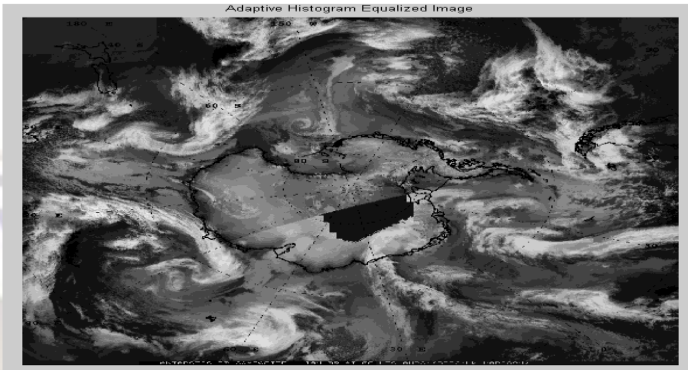
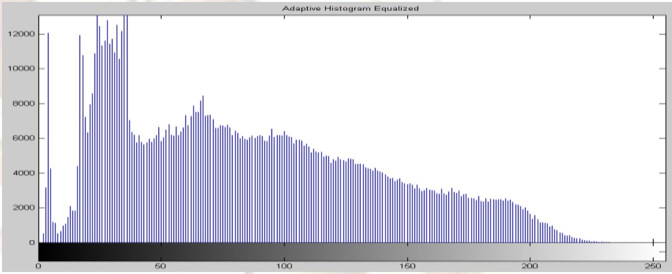


Figure:3 Adaptive Histogram Equalized Image



The Figure:3.1 Adaptive Histogram Equalized Histogram

grey level distribution of adaptive Histogram equalization was improved when compared to the general Histogram method as shown in fig. But Probability distribution function (PDF) is not Clearly achieved

SVD ENHANCED IMAGE:

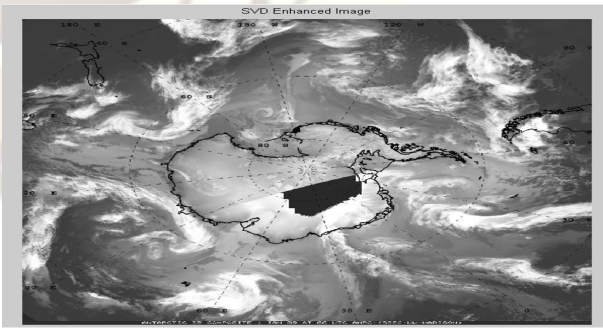


Figure:4 SVD enhanced image

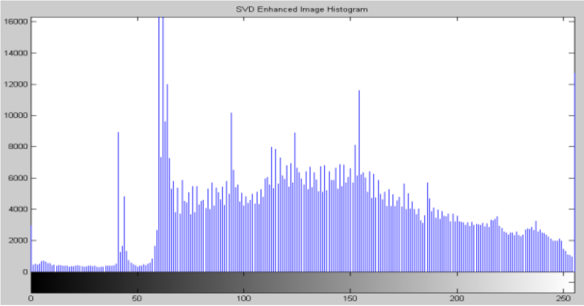


Figure:4.1 SVD enhanced Histogram

The peak values from the grey level distribution of SVD enhanced image histogram are almost identical to the peak Values of the original image over the entire scale.

IV.CONCLUSION

A new satellite image contrast enhancement technique based on DWT and SVD was proposed. Singular Value Decomposition is employed to address the contrast variation of Images. The Visual Quality of images is superior to wavelet Coefficient filtering & GHE Qualitative Metrics (Information Theory) are computed and can be used to improve decision making and pattern recognition applications.

The proposed technique decomposed the input image into the DWT sub bands, and, after updating the singular value matrix of the LL sub band, it reconstructed the image by using IDWT. The technique was compared with the GHE, LHE, BPDHE, and SVE techniques. The visual results on the final image quality show the superiority of the proposed method over the conventional and the state-of-the-art techniques.

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