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DWT and P C a Based Image Enhancement with local Neighborhood filter Mask

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Abstract: *In this letter, a new satellite image contrast enhance- ment technique based on the discrete wavelet transform (DWT) and singular value decomposition has been proposed. The tech- nique decomposes the input image into the four frequency sub- bands by using DWT and estimates the singular value matrix of the low–low subband image, and, then, it reconstructs the en- hanced image by applying inverse DWT. The technique is com- pared 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 bright- ness 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.*
Keywords: *Discrete wavelet transform, image equalization, satellite image contrast enhancement.*

I. Introduction:

SATELLITE images are used in many applications such as geosciences studies, astronomy, and geographical info mation 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.

In many image processing applications, the GHE technique is one of the simplest and most effective primitives for con- trast enhancement [7], which attempts to produce an output histogram that is uniform [8]. One of the disadvantages of GHE is that the information laid on the histogram or probability dis- tribution function (PDF) of the image will be lost. Demirel and Anbarjafari [9] 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 [10] which generates the specified histogram dynamically from the input image.

II. Satellite Image Contrast Enhancement

In this paper we proposed satellite image contrast enhanced by couple of decomposition method discrete wavelet transform and principle component analysis with kernel filter of Gaussian function we described the algorithm and frequency spectrum analysis of our proposed method in detail given below ,

2.1.Discrete Wavelet Transform :

wavelets have been used quite frequently in im- age processing. The decomposition of im- ages into different frequency ranges permits the isolation of the frequency components introduced by “intrinsic deformations” or “extrinsic factors” into certain subbands [17]. This process results in isolating small changes in an image mainly in high- frequency subband images. The 2-D wavelet decomposi- tion of an image is performed by applying 1-D DWT along the rows of the image first, and, then, the results are decomposed along the columns. This operation results in four decomposed subband images referred to as low–low (LL), low–high (LH), high–low (HL), and high–high (HH). The frequency compo- nents of those subband images cover the frequency components of the original image.

In this letter, we have proposed a new method for satellite image equalization which is an extension of SVE, and it is based on the SVD of an LL subband image ob- tained by DWT. DWT is used to separate the input low- contrast satellite image into different frequency subbands, where the LL subband concentrates the illumination infor- mation. That is why only the LL subband goes through the SVE process, which preserves the high- frequency components (i.e., edges). Hence, after inverse DWT (IDWT), the resultant image will be sharper with good contrast. In this letter, the proposed method has been compared with the conventional GHE technique as well as LHE and some state-of-the-art techniques such as BPDHE and SVE. The results indicate the superiority of the proposed method over the aforementioned methods.

2.2. Principle Component Analysis

There are two significant parts of the proposed method. The first one is the use of PCA. As it was mentioned, the Eigen value matrix obtained by P C A contains the illumination information. Therefore, changing the Eigen 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.

2.3 Neighborhood filter

In electronics and signal processing, a Neighborhood filter is a filter whose impulse response is a Gaussian function. Neighborhood filter are designed to give no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Neighborhood filter has the minimum possible group delay. Mathematically, a Neighborhood filter modifies the input signal by convolution with a Gaussian function; this transformation is also known as the Weierstrass transform.

Neighborhood filter formula is given below

$$h = \frac{1}{sqrt\,(2*3.14)}\, e\,(x^2 + y\text{^}2)/\,2^{1}$$

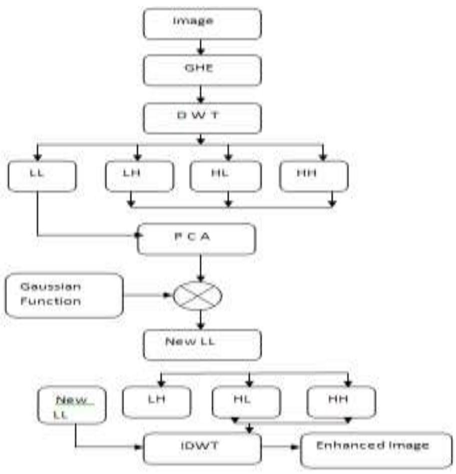
Another methods uses one source image, one array of the same size for the accumulation and a sequence of shifted images. This shifted image is made once for each position x,y for all pixels in the source image. The author prefers the standard structure, because this is valid for any linear filter, like softening, sharpening and contour finding filters, also for some effects which use oszillations in the box. A 5 x 5 binary Gaussian Filter, programmed mainly in Intel Assembly Language, needs about one second for 1000 x 1000 pixels.

2.3.1 Matlab Code For Gaussian

```
S=0
r2=2·Sqr(r)
For y=-n to +n Do
For x=-n to +n Do
Begin
 a=(Sqr(x)+Sqr(y))/r2
 w(x,y)=exp(-a)
 S=S+w(x,y)
End
```

III. Steps of Implementation

3. 1 .Block Diagram:



3.2. Explanation Of Block Diagram

Step 1 : Read the Input Image
Step 2 : Apply G H E for that Image
Step 3 : Apply D W T for histogram image.
Step 4 : Finding P C A for LL Band of DWT

1 . Convert the LL band image into 1 Dimension vector (a)
  a = [x1,x2,x3……..xn] (i = 1 to m x n)
  m = row n = column.
2 . Finding the mean value a by using this formula
  $k = 1/(m \times n) \sum_{i=1}^{m\,x\,n} ai$
3 . Subtract the mean.
4 . Calculate the covariance matrix.
5 . Calculate the eigenvectors and eigen values of the covariance matrix.

Step 5 : Finding Gaussian Factor with 5 x5 Mask

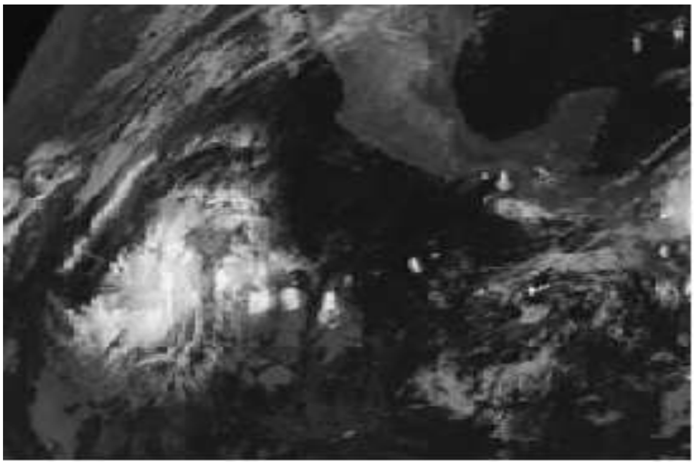
$$h = \frac{1}{\text{sqrt}\ (2*3.14)} e\,(x^2 + y\text{^}2)/\,2^{\,1}$$

step 6 : Finding maximum value of Gaussian co – efficient(s1) and eigen values(s)
step 7 : multiply s1 with s this value will be the enhanced factor
step 8 : multiplying all sub bands with this enhanced factor
step 9 : Applying inverse D W T

IV. Results And Discussion:

4.1 Results

Original image



Enhanced image

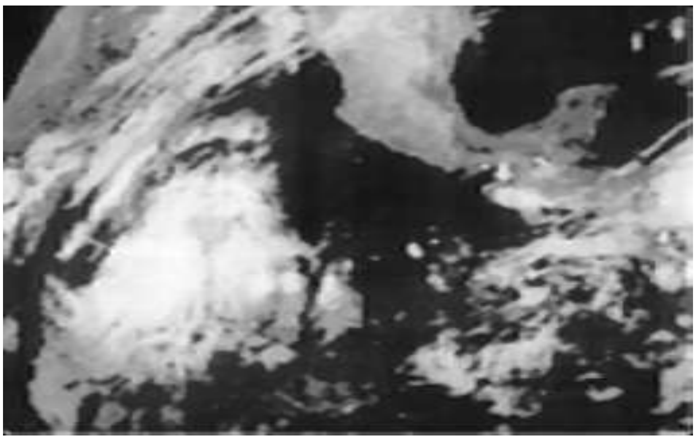


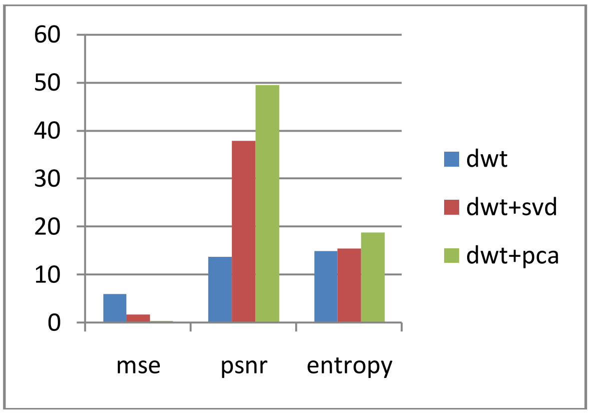
Fig. 1 (a) Original low-contrast image from Satellite Imaging Corporation. Equalized image by using (b) the proposed technique.

4.2 Matric Valuve Comparition :

Peak signal-to-noise ratio (PSNR) and root mean square error (RMSE) have been implemented in order to obtain some quantitative results for comparison. PSNR can be obtained by using the following formula

PSNR = 10 LOG 10 (255 *255 / MSE)

MSE = (1/ M X N) (I/p img – O/p img)^2



Figs. 1(a), show the low-contrast images taken from several aerospace and geosciences resources mentioned in the acknowledgment section. These images have been equalized by using GHE and the proposed equalization technique. The quality of the visual results indicates that the proposed equalization technique is sharper and brighter than the one achieved by BPDHE, SVE, GHE, and LHE. Experiments have been performed on over 100 randomly selected images from various sources which confirmed the qualitative results.

V. Conclusion

In this letter, a new satellite image contrast enhancement technique based on DWT and P C A was proposed. The proposed technique decomposed the input image into the DWT sub bands, and, after updating the Eigen 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. It brings good PSNR Values and Reduce the MSE Value.

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