International Journal on Emerging Technologies **5**(2): 51-57(2014)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Contrast Enhancement of Remote Sensing Images Using Optimal Edge Detection Technique

Ms. Khushbu Jain*, Mrs. Kavita Burse** and Mrs. Rachna Mishra**
**Research Scholar, Department of Computer Science & Engineering,*
Oriental College of Technology Bhopal, (MP) India
***Associate Professor Department of Computer Science and Engineering*
Oriental College of Technology Bhopal, (MP) India
****Assistant Professor, Department of Computer Science & Engineering,*
Oriental College of Technology Bhopal, (MP) India

(Corresponding author: Ms. Khushbu Jain)
(Received 05 September 2014 Accepted 06 October, 2014)

ABSTRACT: Contrast Enhancement is incredibly vital for better visual perception and color reproduction. This paper presents a new contrast enhancement technique based on central intensity level analysis for remote sensing images. Firstly execute discrete wavelet transform (DWT) on the processed images and in that case using the log-average luminance the LL sub-band into low, middle, and high intensity layers will be decomposed. Intensity transfer functions are adaptively calculable with the knee transfer function and the gamma adjustment function depend on the dominant brightness level of all layer. After that, optimal edge detection technique is applied for detecting edges of remote sensing images. Finally, the produce enhanced image is achieved by with the inverse DWT. Although various approaches have histogram equalization proposed in the literature tend to the overall image quality by introducing objects into two saturation regions of low and high intensity to deteriorate. In this paper we compare the existing technique and the proposed method Contrast enhancement of remote sensing images using optimal edge detection technique. The performance is evaluated with parameters such as Measure of Enhancement (EME), Mean Square Error (MSE), and Peak Signal to Noise Ratio (PSNR), Normalized Absolute Error (NAE) and Normalized Cross Correlation (NCC).

Index Terms: Histogram equalization, Discrete wavelet transform, MSE, PSNR.

I. INTRODUCTION

A digital image is binary representation of a 2-D image. The digital representation is an array of picture elements called pixels. Each of these pixels encompasses a numerical value which in monochromatic images represents a grey level. A good histogram is that which spans all the possible values within the gray scale used. Histogram equalization is widely used for contrast enhancement in a variety of applications due to its easy performance and effectiveness. Histogram equalization is a method to obtain a uniform histogram for the output image. It flattens the histogram and stretches the dynamic range of gray levels or in other words histogram equalization maps the input images intensity values over the range (0 to 255) so that the histogram of the resulting image will have an approximately uniform distribution. HE based methods cannot, preserve average intensity level, which may outcome in either over or under saturation in the processed image. To solve these problems, bi-histogram equalization (BHE) [4] and dualistic sub image of HE methods have been proposed histograms using two sub-decomposition [5].

To improve further, the recursive mean HE (RMSHE) [6] distinct method performs several times on the BHE and produces sub-balanced histograms separately. After all, the best contrast enhancement cannot be achieved since iterations converged towards unacceptable processing. Recently, gain controlled clipped HE (GC-CHE) has been proposed, to GC-CHE technical controls and increasing performance of HE for maintaining brightness [7]. HE modified method, based on the singular value decomposition of the LL band of the discrete wavelet transform (DWT). Despite the improved image contrast, this method distorted image detail in low and high intensity. Demirel *et.al.* Suggested a modified procedure, the HE of the singular value decomposition of the LL sub-band discrete wavelet transform based (DWT) is proposed [8], [9].

Common problems caused by the existing contrast enhancement technique, such as brightness, saturation and objects distorted edge detail should be minimized, as it follows the important information is spread to the entire image, as well as in the sense of spatial locations and intensity.

For this cause, contrast enhancement algorithms for remote sensing Images not only improves the contrast of the pixels in order to minimize distortions in regions of low and high intensity and preserving edge detail. The existing system performs analysis of dominant brightness level and used adaptive intensity transformation function for enhancing the contrast of images [13]. DWT decomposes the input images into four frequency layers - LL, LH, HL, and HH. From that LL include the explanation information so this LL is break down into high, medium and low layers and intensity of every layer is converting according to the dominant brightness level of every layer. The intensity transformation is computed using the knee transfer function [10] and gamma adjustment function [11] [12]. But the existing system [13] cannot preserve edge detail, so we can use an additional technique for edge detection called optimal edge detection.

This paper is organized as follows: Section II contains study of image enhancement technique. We propose a Contrast enhancement using optimal edge detection in section III. To illustrate the performance and the property of the proposed algorithm, experimental results are drawn in Section IV. At last, conclusion is made in Section V.

II. IMAGE ENHANCEMENT

Image enhancement technique improves the qualities of an image. Enhancement algorithms can be used to improve the contrast enhancement in the quality and brightness of the pixels, to reduce the level of noise or sharpen the edge details. Technologies to improve the image can be classified as subjective or objective enhancement. Subjective improvement technique is also applied several times in different forms until the observer sees the image gives the details necessary for a particular application. Improvement of the target image rectifies an image to known degradations. This enhancement isn't repeatedly applied but show a time based on measurements made by the system

Image enhancement includes two broad categories as below:

(a) Spatial domain technique

(b) Frequency domain technique

Spatial domain introduce to the image plane and on the explicit handling of pixels in an image. Frequency domain technique for modification of the Fourier transformation of an image. Spatial domain refers to the combination of the pixels of an image. They work directly on pixels, space domain method shown by the following expression.

$G(x, y) = T(f(x, y))$

Where

F (x, y) is the input image

G (x, y) is the processed image and

T is an operator on f.

Fig. 1. The original image and the result of enhancement.

III. PROPOSED METHOD

Proposed technique consists of following steps. Take remote sensing image as an input image. Apply DWT transformation of the input image, dominant brightness level analysis of the LL band of the DWT is processed out. The decomposition of the image is performed on the basis of the dominant brightness level. Then, the transfer function of intensity adaptation is decomposed applied at different levels of intensity of the image, then smoothed. The smoothen image is passed to the optimal edge detection techniques which is then integrated with the Contrast enhancement techniques and is phased out. The inverse DWT is then fused image bands and HH, HL, LH applied to obtain the image contrast.

A. Discrete wavelet transforms

Wavelets have been used quite often in image processing. Nowadays, they have been used for feature extraction, compression, denoising, image super resolution, and face recognition. The decomposition of images into totally different frequency ranges allows isolating the frequency components introduced "intrinsic deformations" or "extrinsic factors" into certain sub bands. This process results in isolating minute changes in an image for the most part in high frequency sub band images. Hence, discrete wavelet transform (DWT) is an appropriate tool to be used for designing a classification system. The two dimensional wavelet decomposition of an image is performed by applying one dimensional DWT to the lines of the image and the results are decomposed on the columns. This DWT operation results in four sub-band images of decomposed called low -low (LL), low-high (LH), high-low (HL) and high-high (HH). Where, the signal is represented by the sequence CA_j, where A_j is an integer. The low pass filter is represented by Lo_D where as the high pass filter is represented by Hi_D. At each level, the high-frequency filter produces detailed information where produced as low-pass filter associated with the scaling function approaches. At each decomposed level, the half band filters produce signals covers only half the frequency band. This doubles these frequency resolution because the uncertainty in frequency is minimized by half. The frequency components of image sub-bands extending over the frequency components of the original image, as shown in Fig. 2.

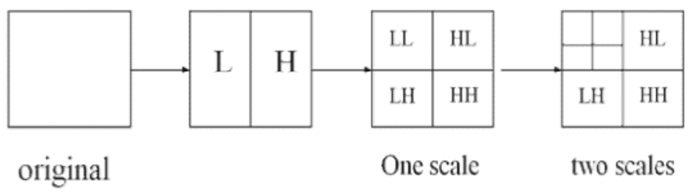


Fig. 2. Decomposition levels of 2-D DWT.

B. Analysis of dominant brightness levels

If we don't consider spatially varied intensity distributions, the corresponding contrast-enhanced images could have intensity distortion and lose image details in some regions. For overcoming these issues, we decompose the key image into multiple layers of single dominant brightness levels. Using the Low-frequency luminance component, we introduce the discrete wavelet transform (DWT) on the satellite sensing images as input and estimate the brightness with the dominant newspaper luminance average in the very low sub-band. Since the values of high intensity are dominant in the luminous area and vice versa, position of the dominant brightness at the position (x, y) is calculated as

$$D(x, y) = exp\left(\frac{1}{N_L}\sum_{(x,y)\in S}\{log\ L(x,y) + \epsilon\}\right) \quad \ldots (1)$$

Where S denotes a rectangular region encompassing (x, y), L(x, y) denotes the pixel intensity at (x, y), N_L denotes the number of pixels in S, and ε represents a small constant that stops the log function from divergence to negative infinity.

C. Adaptive intensity transformation for contrast enhancement:

On the basis of dominant brightness of each decomposed layer, the adaptive transfer function is generated. The adaptive transfer function is a combination of knee transfer and the gamma adjustment functions. For the global contrast enhancement of an image, the knee transfer function stretches the low-intensity range by determining knee points according to the dominant brightness of each layer. In the low-intensity layer, a single knee point is calculated as

$$P_l = b_l + w_l(b_l + m_l) \quad \ldots (2)$$

Where b_l denotes the low bound, w_l represents the tuning parameter, and m_l denotes the mean of brightness in the low intensity layer. For the high-intensity layer, the corresponding knee point is computed as

$$P_h = b_h - w_h(b_h - m_h) \quad \ldots (3)$$

Where b_h denotes the high bound, w_h denotes the tuning parameter, and m_h denotes the mean brightness in the high intensity layer. In the middle-intensity layer, the two knee points are calculated as

$$P_{ml} = b_l - w_m(b_{ml} - m_m) + (P_l - P_h) \quad (4)$$

$$P_{mh} = b_h + w_m(b_{mh} - m_m) + (P_l - P_h) \quad (5)$$

Where w_m tuning parameter and m_m mean brightness in the middle-intensity layer.

The global image contrast is determined by tuning parameter w_i for i □ {*l, m, h*}. Although the contrast is more enhanced as the w_i increases, the resulting image is saturated and contains intensity discontinuity. In paper, we can adjust only the middle-intensity tuning parameter w_m for minimizing such artifacts. Since the knee transfer function tends image details in the low and high intensity distort layers, is compensation using the static gamma adjustment function. The gamma adjustment function is changed from the original version of translation and scaling, to accept the transfer of knee function

$$G_k(L) = \left\{ \left(\frac{L}{M_k}\right)^{\frac{1}{\gamma}} - \left(1 - \frac{L}{M_k}\right)^{\frac{1}{\gamma}} + 1 \right\} \quad \ldots(6)$$

for k □ {*l, m, h*}

Where M represents the size of each section intensity range, such as $M_l = b_l$, $M_m = b_h - b_l$ and $M_h = 1 - b_h$, L represents the intensity value, and γ denotes the pre-specified constant. The pre-specified constant γ is used to adjust the local image contrast. If γ increases, the resulting image is saturated around $\frac{b_l}{2}$,$b_h - \frac{b_l}{2}$, and $1 - \frac{b_h}{2}$. Therefore, the γ value is selected by calculating maximum values of adaptive intensity transfer function in ranges $\{0 \le L < \frac{b_l}{2}\}$, $\{b_l \le L < b_h - \frac{b_l}{2}\}$, and $\{b_h \le L < (1 - \frac{b_h}{2})\}$, which are lesser than $\frac{b_l}{2}$, $b_h - \frac{b_l}{2}$ and $1 - \frac{b_h}{2}$ respectively.

To remove the artificial boundaries of the merger, maps weights are used with the limit of Gaussian smoothing filter As a result, the fused image F is computed as

$$F = W_1 \times c_l + (1 - W_1) \times \{W_2 \times c_m + (1 - W_2) \times c_h\} \quad \ldots(7)$$

Where W_1 denotes the largest weighting map, W_2 denotes the second largest weighting map, c_l denotes the contrast enhanced brightness in the low-intensity layer, c_m denotes the contrast-enhanced brightness in the middle-intensity layer, and c_h represents the contrast-enhanced brightness in the high-intensity layer. Since the above equation represents the point operation, the pixel coordinate (x, y) is omitted. The fused LL sub band undergoes the inverse DWT (IDWT) together with the unprocessed HL, LH, and HH sub bands to reconstruct the finally enhanced image.

D. Optimal edge Detection:

Edge detection is a element of the digital image processing. The edge is the set of the picture element, whose surrounding gray is rapidly changing. The edge is the basic property of the image. There is a wealth of information in the image on the edge. Edge detection is to extract the characteristics of the individual components of the difference in the characteristics of the image of the object and subsequently to determine the image area on the basis of the closing edge. Edge detection is widely used in the personal computer vision, image analysis, segmentation, etc. Edge detection methods are mainly as follows:

1. Gradient operator. The discontinuity in the edge of the gray level values, so that the method of causing the operator of the most commonly used gradient. The conventional gradient operators are Sobel operator, Prewitt operator, Roberts's operator, Laplacian operator.

2. Optimum operator. The slope of the edge is the maximum value, the agent, the turning point of the gray image is the edge. Mathematically, variation point of the second derivative of the function is zero.

Detecting this point, whose second derivative value is zero, is a way of edge detection, for example, Canny operator, Marr-Hildreth operator.

Fig. 3. Original image and result of optimal edge detection operator.

The aim of Optimal edge Detection algorithm was to have good detection (minimum number of false edges), good localization (closeness of the real edge and also the detected edge) and minimal response (one edge should be detected solely once). Canny operator is the best possible approach to entrepreneurs from the product of Signal to Noise Ratio (SNR) and the location. Canny operator smoothes image by removing noise through Gaussian filter, computes the size and direction of gray level slope, has the non-maxima suppression on gradient magnitude, and recognize and attach the edge from the contender points by the high and low thresholds. Basic Steps of Optimal edge Detection is a step-by-step process and figure 4 shows these steps.

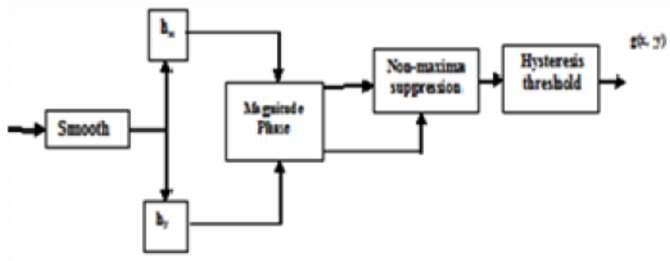
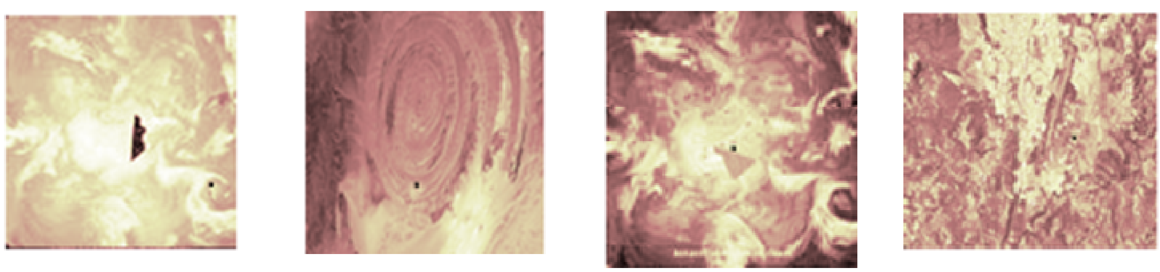


Fig.4. Shows steps of optimal edge detection algorithm.

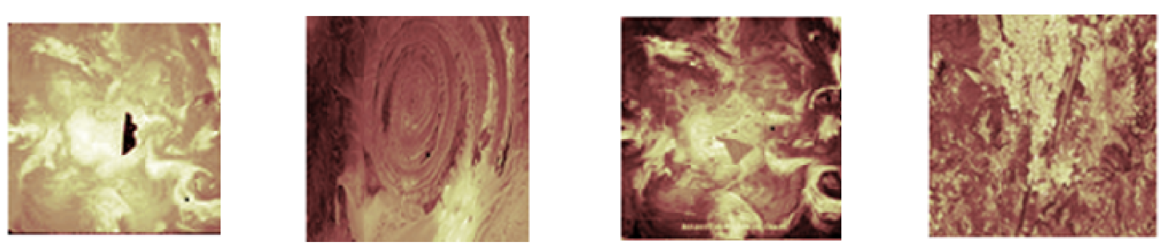
IV. EXPERIMENTAL RESULT

In this section, four images are taken for evaluating the performance of the proposed image enhancement algorithms.

The proposed method is evaluated using the Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Normalized Absolute Error (NAE), Normalized cross correlation (NCC) and Measure of Enhancement (EME). PSNR is the quality measurement between the original image and the reconstructed image which is calculated through the Mean Squared Error (MSE). The MSE is the cumulative squared error between the shrink and the unique image while the peak signal to noise ratio calculate of the highest error Normalized absolute error (NAE) is a calculate of how far is the decompressed image from the new image with the value of zero being the perfect fit. Large value of NAE indicates poor quality of the image. Normalized cross-correlation (NCC) can be used to determine how to bring into line the images by translating one of them. The Measure of Enhancement (EME) produce on the whole image quality improved with preserving the average intensity level and edge details in all intensity ranges.



Existing Method

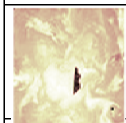
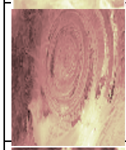
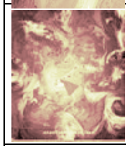


Proposed Method

Fig. 5. Original satellite images from KARI (a) Enhanced images using the existing method and (b) Enhanced images using proposed method.

In above figure shows the result of proposed method that is obtain better as compare to existing method as well as good brightness and contrast. The result image is shows the local edge detail and global edge detail of remote sensing images. PSNR, MSE, NCC, NAE and EME produce better result as compare to existing method. So its produce better result.

Table 1. Performance Comparison of the Proposed and Existing Algorithm (EM- Existing Method and PM- Proposed Method).

Input Image	Algorithm	Different Parameters				
		MSE	***PSNR***	***NAE***	***NCC***	***EME***
	**E M**	2.0622e+004	4.9874	0.9929	0.0067	8.5830
	P M	3.9216e+003	12.1962	0.4108	0.6711	40.8836
	**E M**	1.0575e+004	7.8881	0.9 895	0.0089	17.0690
	P M	2.6475e+003	13.9024	0.4983	0.6673	72.8612
	**E M**	1.3679e+004	6.7703	0.9905	0.0076	22.9747
	P M	2.7668e+003	13.7111	0.4369	0.7299	72.5444
	**E M**	1.6510e+004	5.9533	0.9918	0.0073	28.7244
	P M	2.3715e+003	14.3805	0.3635	0.7292	96.5166

V. CONCLUSION

In this article we have described a method for improving the contrast fresh remote sensing images with the analysis of the dominant brightness, intensity adjustment processing and edge detection technology optimally. The proposed algorithm decomposes the input image into four wavelet sub bands and decomposes the LL sub band into low, middle, and high-intensity layers by analyzing the log-average luminance of the corresponding layer. The adaptive intensity transfer functions are computed by combining the knee transfer function and the gamma adjustment function and then smoothened out. The smoothen image is passed to the optimal edge detection techniques which is then integrated with the Contrast enhancement techniques and is phased out. All the contrast enhanced layers are fused with an appropriate smoothing, and the processed LL band undergoes the IDWT together with unprocessed LH, HL, and HH sub bands. The proposed algorithm can effectively enhance the overall quality and visibility of local information better than actual state-of-the-art methods including RMSHE, GC-CHE, and Demirel’s Methods. Experimental results demonstrate that the proposed algorithm can enhance the low-contrast remote sensing images and is suitable for various Imaging devices such as consumer camcorders, and real-time 3-D reconstruction systems.

REFERENCES

[1]. Rafael C. Gonzalez, and Richard E. Woods, 2nd edition, Prentice Hall, *Digital Image Processing* 2004.

[2]. R. Gonzalez and R. Woods, 2007, 3rd ed. *Englewood Cliffs, NJ: Prentice-Hall, Digital image processing*.

[3]. Kaur M, Kaur J, Kaur J, "Survey of Contrast Enhancement Techniques based on Histogram Equalization", *IJASA*, Vol. **2**, No. 7, 2011 ,pp. 137-141.

[4]. Y. Kim, "Contrast enhancement using brightness preserving bi-histogram equalization", *IEEE Trans. Consum. Electron.*, vol. **43**, no. 1,(Feb 1997), pp. 1–8,

[5]. Y. Wan, Q. Chen, and B. M. 1999 Zhang," Image enhancement based on equal area dualistic sub-image histogram equalization method", *IEEE Trans. Consum. Electron*, vol. **45**, no. 1, (Feb 1999), 68–75.

[6]. S. Chen and A. Ramli, "Contrast enhancement using recursive mean separate histogram equalization for scalable brightness preservation", *IEEE Trans. Consum. Electron.*, vol. **49**, no. 4,(Nov. 2003), 1301–1309.

[7]. T. Kim and J. Paik, "Adaptive contrast enhancement using gain controllable clipped histogram equalization", *IEEE Trans. Consum. Electron.*, vol. **54**, no. 4,(Nov. 2008), 1803–1810.

[8]. H. Demirel, C. Ozcinar, and G. Anbarjafari, “Satellite image contrast enhancement using discrete wavelettransform and singular value decomposition,” *IEEE Geosci. Reomte Sens. Lett*, vol. **7**, no. 2, pp. 3333–337, Apr. 2010.

[9]. H. Demirel, G. Anbarjafari, and M. Jahromi, “Image equalization based on singular value decomposition,” *in Proc. 23rd IEEE Int. Symp. Comput. Inf. Sci.*, *Istanbul, Turkey*, Oct. 2008, pp. 1–5.

[10]. Y. Monobe, H. Yamashita, T. Kurosawa, and H. Kotera, “Dynamic range compression preserving local image contrast for digital video camera,” *IEEE Trans. Consum. Electron*, vol. **51**, no. 1, pp. 1–10, Feb. 2005.

[11]. S. Lee, “An efficient contrast-based image enhancement in the compressed domain using retinex theory,” *IEEE Trans. Circuit Syst. Video Technol.*, vol. **17**, no. 2, pp. 199–213, Feb. 2007.

[12]. W. Ke, C. Chen, and C. Chiu, “BiTA/SWCE: Image enhancement with bilateral tone adjustment and saliency weighted contrast enhancement,” *IEEE Trans. Circuit Syst. Video Technol.*, vol. **21**, no. 3, pp. 360–364, Mar. 2010.

[13]. Eunsung Lee, S.BKim, W.BKang, D.BSeo and Jooki Paik "Contrast Enhancement using Domonant Brightness Level and Adaptive Intensity Transrormation for Remote Sensing Image" *IEEE Geoscience and Remote sensing letters*, Vol. **10**, no.1, January 2013.