Contrast Enhancement Technique for Remote Sensing Images

[1]Prafullita Patil , [2]Dr. A. M. Patil

[1]M. E. Student

[2]HoD Electronics and Telecommunication Dept., J. T. Mahajan College of Engg. Faizpur

Abstract

Image enhancement improves the quality of poor images. Distinctive procedures have been projected so far for getting better the feature of the digital images such as remote sensing images. A new satellite image contrast enhancement technique based on the Discrete wavelet transform (DWT), Brightness level analysis and Adaptive Intensity Transformation has been proposed. By the use of discrete wavelet transform wavelet transform, the input image decomposed into four directional sub-bands and the brightness level is computed in the LL subband using log average luminance. Based on the brightness level LL decomposes into low, middle and high intensity layers. Then Adaptive Intensity Transformation is applied to each decomposed layer of the image and reconstructs the enhanced image by applying inverse DWT. Out of various contrast enhancement approaches have been proposed in the literature, proposed algo- rithm overcomes the problems using the Lapped Transform func- tion. The experimental results show that the proposed algorithm enhances the overall contrast and visibility of local details better than existing techniques. The proposed method can effectively enhance any low-contrast images acquired by a satellite camera and are also suitable for other various imaging devices such as consumer digital cameras, photorealistic3-D reconstruction systems, and computational cameras.

Index Terms:-dominant brightness level analysis, Adaptive intensity transfer function(AITF), contrast enhancement (CE), discrete wavelet transform (DWT), remote sensing images.

I. INTRODUCTION

Mage enhancement, which is one of the significant tech- niques in digital image processing, plays an important role in many fields, such as medical image analysis, re- mote sensing, high definition television, hyper spectral image processing, industrial X-ray image processing, microscopic imaging etc. Image enhancement is a processing on image in order to make it more appropriate for certain applications [1]. It is mainly utilized to improve the visual effects and the clarity of the image or to make the original image more conducive for other automated processes[3]. Generally an image may have poor dynamic range or distortion due to the poor quality of the imaging devices or the adverse external conditions at the tim of acquisition and so on.

Many methods for image contrast enhancement have been published and widely used which can be broadly cate- gorized into two groups: direct methods and indirect methods. Among the indirect methods, the histogram modification tech- niques have been widely utilized because of its simplicity and explicitness, in which the histogram equalization (HE) is one of the most frequently, used technique[8]. The fundamental principle of Histogram equalization is to make the histogram of the enhanced image to have approximately uniform distri- bution so that the dynamic range of the image can be fully exploited. However the original HE always causes several problems:

1) It lacks of adjustment mechanism to control the level of the enhancement and cannot make satisfying balance on the details between bright parts and dark parts.
2) It may over enhance or generate excessive noise to the image in certain applications.
3) It may sometimes dramatically change the average brightness of the image.

To overcome these problems various methods have been published to limit the level of contrast enhancement in HE. Most of them are carried out through modifications on the HE. For instance, in the Brightness preserving Bi-Histogram Equalization (BBHE), two separate histograms from the same image are formed and then equalized independently, where the first one is the histogram of intensities that are less than the mean intensity and them second one is the histogram of intensities that are greater than the mean intensity. BBHE can reduce the mean brightness variation. In Dualistic Sub-image Histogram Equalization (DSIHE), two separate histograms are created according to the median gray intensity instead of the mean intensity. Although DSIHE can maintains the brightness and entropy better both DSHE and BBHE cannot adjust the level of enhancement and are not robust to noise. Conse- quently, several problems will emerge when there are spikes in the histogram. The Recursive Mean Separation Histogram Equalization (RMSHE) enhances image by iterating BBHE. The mean intensity of the output image will converge to the average brightness of the original image when the iteration increases. Accordingly the brightness of the enhanced image to the original image can be maintained much better. Although the methods mentioned above can often increase the contrast of the image, these approaches usually bring some undesired effects. Overall the traditional global histogram equalization (GHE) will cause excessive enhancement, and the local his- togram equalization

(LHE) sometimes will bring block effect. In order to overcome these problems an image contrast en-
hancement algorithm based on the Dominant Brightness Level Analysis and Adaptive Intensity Transformation is proposed in this paper, in which the level of contrast enhancement can be controlled by adjusting the intensity levels. The proposed algorithm not only avoids the excessive enhancement and akes the contrast enhancement adjustable, but also main- tain the brightness level. Due to improper lance positions
or insufficient light or unfavorable environment condition or some other causes many time captured images has bad contrast issues. This method uses hybridization of Range Limited Bi-Histogram Equalization and Adaptive Gamma Correction methods. Histogram Equalization is most popular method to enhancement of low contrast image, Bi-Histogram equalization method improved the results of basic Histogram Equalization contrast enhancement but Histogram Equalization method does not performs the brightness improvement in enhanced image. In other hand gamma correction method improves the brightness of dimmed image. The proposed hybridized method Range Limited Bi-Histogram Equalization with Adaptive Gamma Correction is implemented in low contrast color images and efficiently enhanced contrast better than using Range Limited Bi-Histogram Equalization and Adaptive Gamma Correction separately [6]. The rest of this paper is organized as follows:
Section II provides short introduction of proposed algorithm. Section III presents results of proposed method on different satellite images . In Section IV the efficiency of the proposed method is examined by comparing the experimental results obtained by the use of proposed method and the state of art technique. Finally we conclude about proposed method and the future scope of the proposed method.

II. PROPOSED METHOD

To attain the proposed objective step-by-step methodology is used in this paper. Sub sequent are different steps which are used to accomplish this work. Following are the various steps used to accomplish the objectives of the dissertation. The proposed algorithm decomposes the input image into six wavelet subbands and decomposes the LL subband into low[1-5], middle and high-intensity layers by analyzing the log- average luminance of the corresponding layer. The Adaptive Intensity Transformation is computed for each layer and all the contrast enhanced layers are fused with an appropriate smoothing, and the processed LL band undergoes the IDWT together with unprocessed sub-bands as shown in Figure 1.

Steps of Implementation are listed below:

1) Read the input image.
2) Apply DWT for that image.
3) Find out the brightness level in LL sub-band using the formula (1)

$$D_{(x,y)} = \exp\left(\frac{1}{P}\sum_{(x,y)\in S} \log L(x, y) + \zeta(1)\right)$$

4) Based on the brightness level LL sub-band decomposes into low, high and middle intensity layers
5) Applying the Adaptive Intensity Transformation for three layers obtained in step (4)
6) Three intensity transformed layers by using the lapped transform are fused to make the resulting contrast en- hanced Image in the wavelet domain.
7) Extract most significant two bits from the low, middle and high-intensity layers for generating the weighting map and we compute the sum of the two bit values in each layer. We select two weighting maps that have two largest sums. For removing the unnatural borders of fusion, weighting maps are employed with the Gaussian boundary smoothing filter. As a result, the fused image F is estimated

$$F = w_1 * c_1 + (1 - w_1) * \{w_2 * c_m + (1 - w_2 * c_h\}$$

Where w1 represents the largest weighting map, w2 represents the second largest weighting map, c1 represents the contrast enhanced brightness in the low-intensity layer, cm represents the contrast enhanced brightness in the middle-intensity layer, and ch represents the contrastenhanced brightness in the high- intensity layer. Since step (2) represents the point operation, the pixel coordinate (x,y) is omitted. The fused LL subband undergoes the IDWT together with the unprocessed other six subbands to reconstruct the finally enhanced image.

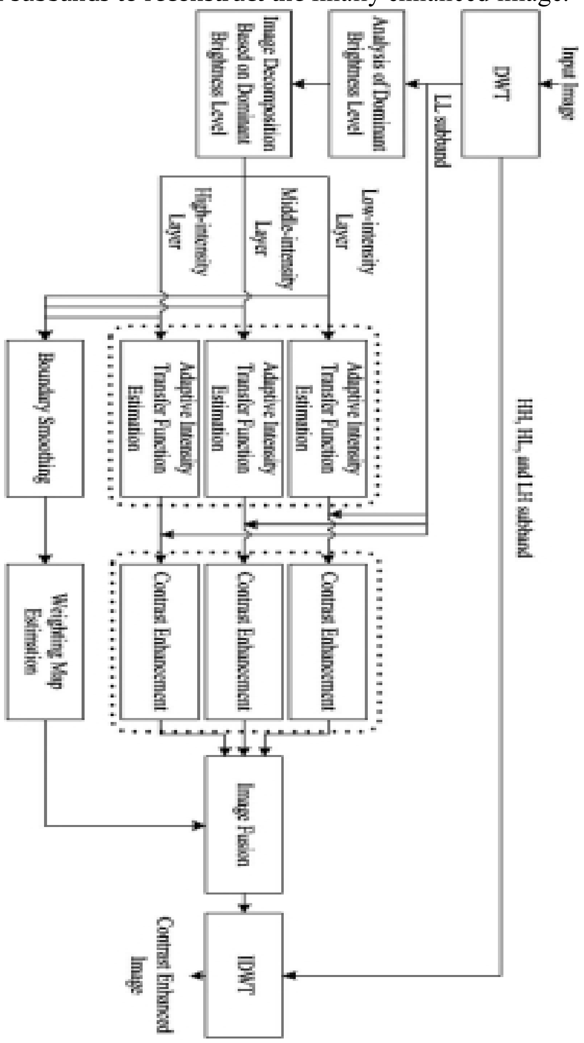

Fig. 1: Block diagram of proposed method [6]

III. EXPERIMENTAL RESULTS

In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox and simulation is carried out to evaluate the performance of the proposed method. Figure 2(left) to 6(left) shows Original low-contrast image from Satellite Imaging Corporation and figure 2(right) to 6(right) shows Dominant brightness analysis level (Proposed Method) results

Fig. 2: Result of proposed method for image 1 (Left) Original image. (right) Output image

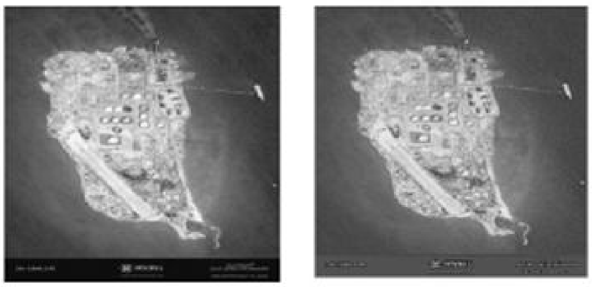

Fig. 3: Result of proposed method for image 2 (Left) Original image. (right) Output image

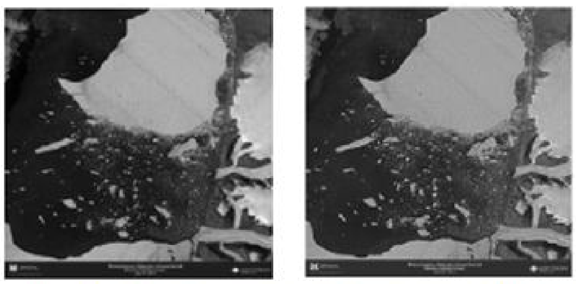

Fig. 4: Result of proposed method for image 3 (Left) Original image. (right) Output image

Fig. 5: Result of proposed method for image 4 (Left) Original image. (right) Output image

IV. PERFORMANCE ANALYSIS

This section Result shows that our proposed approach gives better results than existing techniques. These parameters are very important part of the digital image processing. In this different parameters are used to show the performance of proposed method is better than the existing algorithm.

1) Peak Signal to Noise Ratio:Peak signal to noise ratio measure the degree of image distortion. PSNR is used to measure the quality between the original image and compressed image[10-17]. If the value of PSNR is higher, then the quality of reconstructed image is better PSNR represent the peak error. PSNR is defined as:

$$PSNR : 10\ log_{10}\frac{MAX_I^2}{MSE}$$
$$= 20\ log_{10}\frac{MAX_I}{MSE}$$
$$= 20\ log_{10}MAX_I - 10\ log_{10}MSE$$

Table I shows that PSNR values of proposed method with PSNR values of HE and BHE and figure 7 shows that graphical comparison of proposed method with HE and BHE on the basis of PSNR.

2) Mean Square Error:In image processing mean square error is the most general measure for performance measurement of the existing method and the coded images. It is straightforward method to design system that decreasethe MSE but cannot capture the impurities like blur artefacts. It is computed by using equation.

TABLE I: Peak Signal to Noise Ratio evaluation

Image	HE	BHE	Proposed Method
Image 1	10.3047	10.4637	19.4452
Image 2	12.5331	9.0688	21.6924
Image 3	17.8007	9.8663	22.4649
Image 4	14.3892	12.2844	24.3068
Image 5	23.0894	10.7219	24.7594

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(f_{(i,j)} - f'_{(i,j)})$$

Table II shows that MSE values of proposed method with MSE values of HE and BHE and figure 8 shows that graphical comparison of proposed method with HE and BHE on the basis of MSE.

3) **Entropy:** Entropy of pixel ’X’ in image with possible values of intensity $\{x_1, ..., x_n\}$ and probability mass function P(X) as

$$H_{(X)} = E[I_{(X)}] = E[-ln(P_{(X)})]$$

here E is the expected value of pixel and I is information content of X. $I_{(X)}$ itself pixel range when taken from finite samples entropy can be calculated as

$$H_{(X)} = \sum_i P_{(x_i)} I_{(x_i)} = -\sum_i P_{(x_i)} log_b P_{(x_i)}$$

where b is the base of the logarithm used [18-20].

Table III shows that Entropy values of proposed method with Entropy values of HE and BHE and figure 9 shows that graphical comparison of proposed method with HE and BHE on the basis of Entropy.

5.CONCLUSION

TABLE II: Mean Square Error evaluation

Image	HE	BHE	Proposed Method
Image 1	0.0932	0.0899	0.0114
Image 2	0.0558	0.1239	0.0068
Image 3	0.0166	0.1031	0.0057
Image 4	0.0364	0.0591	0.0037
Image 5	0.0049	0.0847	0.0033

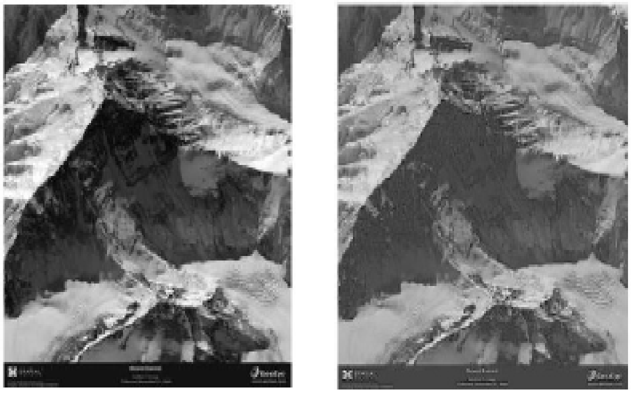

Fig. 6: Result of proposed method for image 5 (Left) Original image. (right) Output image

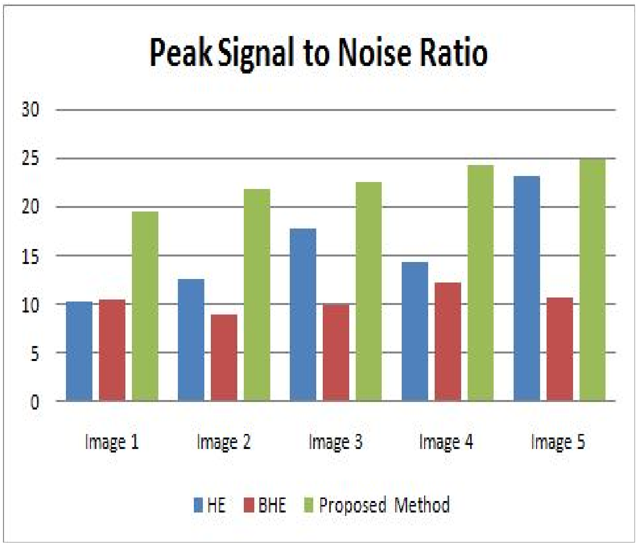

Fig. 7: Graphical Comparison of Proposed method with HE and BHE on the basis of PSNR.

We have presented a novel contrast enhancement method for remote sensing images using DWT , beightness level analysis and Adaptive intensity Transform. The proposed algorithm decomposes the input image into wavelet subbands and decomposes the LL subband into low-, middle-, and highintensity layers by analyzing the logaverage luminance of the corresponding layer. The Adaptive intensity Transform is applied for all these layers and all the contrast enhanced Layers are fused with an appropriate smoothing, and the processed LL band undergoes the IDT-CWT together with unprocessed other subbands. The proposed algorithm can effectively en-

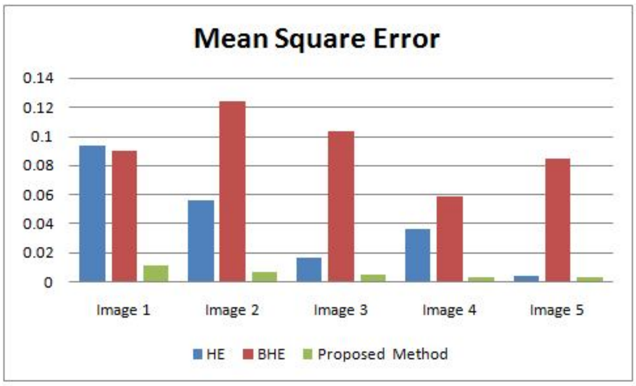

Fig. 8: Graphical Comparison of Proposed method with HE and BHE on the basis of MSE

TABLE III: Entropy evaluation

Image	HE	BHE	Proposed Method
Image 1	5.7511	0.0224	5.3144
Image 2	5.8274	0.017	6.0509
Image 3	5.8689	0.0209	6.3429
Image 4	5.6946	0.0318	6.306
Image 5	5.9613	0.016	6.8487

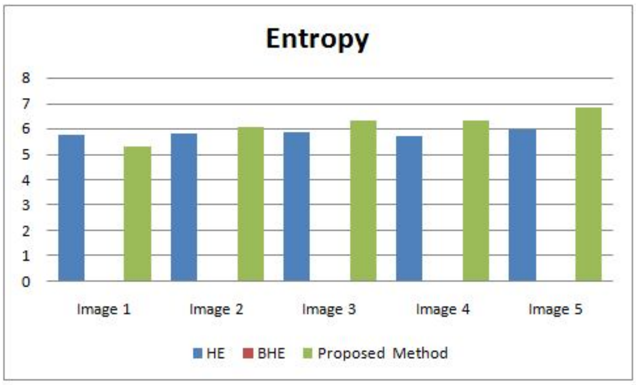

Fig. 9: Graphical Comparison of Proposed method with HE and BHE on the basis of Entropy.

hance the overall quality and visibility of local details better than existing state-of-the-art methods including RMSHE,GCCHE, Demirels and Lapped transform method. Experimental results demonstrate that the proposed algorithm can enhance the low-contrast satellite images and is suitable for various imaging devices such as consumer camcorders, real-time 3- D reconstruction systems, and computational cameras.

FUTURE SCOPE

The review has shown that the most of existing techniques are based upon the transform domain methods which may introduce the colour artifacts. Also some methods may introduce Gaussian noise. In near future we will use a modified image enhancement model to enhance the shortcomings of the earlier work.

ACKNOWLEDGMENT

we are likes to gratefully acknowledge to all the staff member of electronics and Telecommunication department in

J. T. Mahajan College of Engineering, Faizpur for allowing us to conduct the research using its all kinds of facilities.

REFERENCES

[1.] G. Senthamarai, K. Santhi, "Dynamic Multi-Histogram Equalization for image Contrast Enhancement with Improved Brightness Preservation", IEEE Sponsored 2nd International Conference on electronics and communication system (ICECS 2015), pp. 1205-1209, 2015.

[2.] Jeyong Shin, Rae-Hong Park, "Histogram-Based Locality-Preserving Contrast Enhancement", IEEE Signal processing Letters, Vol. 22, No. 9, PP. 1293-1296, September 2015.

[3.] Dr. G. Sudhavani, M. Srilakshmi "Enhancement of Low Contrast Images Using Fuzzy Techniques", SPACES-2015, Dept of ECE, K L University, pp. 286-290, 2015.5

[4.] Vasileios Syrris, Stefano Ferri, Daniele Ehrlich and Martino Pesaresi, "Image Enhancement and Feature Extraction Based on Low-Resolution Satellite Data", IEEE journal of selected topics in applied earth observation and remote sensing, pp. 1-10, 2015.

[5.] Chhaya Gautam, Neeraj Tiwari, "Efficient Color Image Contrast Enhancement Using Range Limited Bi-Histogram Equalization With Adaptive Gamma Correction", International Conference on Industrial Instrumentation and Control (ICIC) Col/ege of Engineering Pune, India. pp. 175-180, May 28-30,2015

[6.] Eunsung Lee, Sangjin Kim, Wonseok Kang, Doochun Seo, and Joonki Paik, "Contrast Enhancement Using Dominant Brightness Level Analysis and Adaptive Intensity Transformation for Remote Sensing Images"'IEEE Geoscience and remote sensing letters, Vol. 10, issue. 1, JANUARY 2013.

[7.] Gautam, Chhaya, and Neeraj Tiwari, "Efficient color image contrast enhancement using Range Limited Bi-Histogram Equalization with Adaptive Gamma Correction", In Industrial Instrumentation and Control (ICIC), 2015 International Conference on, pp. 175-180. IEEE, 2015.

[8.] Chi-Farn Chen, Hung-Yu Chang, Li-Yu Chang,"A Fuzzy-Based Method For Remote Sensing Image Contrast Enhancement", The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B2. Beijing 2008

[9.] Shujun Fu, Qiuqi Ruan, Wenqia Wang," Remote Sensing Image Data Enhancement Based on Robust Inverse Diffusion Equation for Agriculture Applications", ICSP 2008 Proceedings.

[10.] Hasanul Kabir, Abdullah Al-Wadud, and Oksam Chae," Brightness Preserving Image Contrast Enhancement Using Weighted Mixture of Global and Local Transformation Functions", The International Arab Journal of Information Technology, Vol. 7, No. 4, October 2010.

[11.] Hasan Demirel, Cagri Ozcinar, and Gholamreza Anbarjafari," Satellite Image Contrast Enhancement Using Discrete Wavelet Transform and Singular Value Decomposition", IEEE Geoscience and Remote Sensing Letters, vol. 7, no. 2, pp. 333-337, April 2010.

[12.] G.Praveena1, M.Venkatasrinu2," A Modified SVD-DCT Method for Enhancement of Low Contrast Satellite Images", International Journal of Computational Engineering Research, Vol. 2 Issue.5, pp. 1612-1619, September 2012.

[13.] S. Srinivasan and N. Balram, "Adaptive Contrast Enhancement Using Local Region Stretching", Proc.of ASID06, , New Delhi, pp. 152-155,Oct. 2012.

[14.] Ankit Aggarwal, R.S. Chauhan and Kamaljeet Kaur, "An Adaptive Image Enhancement Technique Preserving Brightness Level Using Gamma Correction", Advance in Electronic and Electric Engineering, Vol. 3, N0 9, pp. 1097-1108, 2013.

[15.] Sayali Nimkar, Sucheta Shrivastava and Sanal Varghese, "Contrast Enhancement And Brightness Preservation Using Multi decomposition Histogram Equalization", International Journal (SIPIJ) Vol.4, No.3, Pp. 83-93, June 2013.

[16.] G. Veena, V. Uma, Ch. Ganapathy Reddy, "Contrast Enhancement for Remote Sensing Images with Discrete Wavelet Transform", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-2, Issue-3, July 2013

[17.] Ammu Anna Mathew, S. Kamatchi," Brightness and Resolution Enhancement of Satellite Images using SVD and DWT", International Journal of Engineering Trends and Technology (IJETT), Vol. 4, Issue. 4, pp. 712-718, April 2013.

[18.] R. Kathirvel and Dr. J. Sundararajan," Brightness 3D Based Remote Sensing Image Contrast Enhancement Using SVM", Journal of Theoretical and Applied Information Technology, Vol. 61 No.3, pp. 545-552, March 2014.

[19.] Adin Ramirez Rivera, Byungyong Ryu, and Oksam Chae, "Content Aware Dark Image Enhancement through Channel Divison",IEEE Transactions on Image Processing,volume 21,issue 9, 2012.

[20.] Artur oza, David R. Bull, Paul R. Hill, Alin M .Achim, "Automatic contrast enhancement of low-light images based on local statistics of wavelet coefficients", Digital Signal Processing (2013), www.elsevier.com/locate/dsp.

[21.] Eunsung Lee, S.Kim, W.Kang, D.Seo and Jooki Paik, "Contrast Enhancement using Domonant Brightness Level and Adaptive Intensity Transformation for Remote Sensing Image",IEEE Geoscience and Remote sensing letters, Vol. 10, no.1, January 2013

[22.] Deepak Kumar Pandey, Rajesh Nema "Efficient Contrast Enhancement using Kernel Padding and DWT with Image Fusion", International Journal of Computer Applications (0975 8887) Volume 77 No.15, September 2013.