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RESEARCH ARTICLE

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COMPREHENSIVE EQUALIZATION MODEL FOR PICTURE ENRICHMENT

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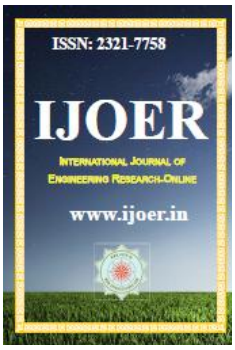

ABSTRACT

This paper introduces a new Generalized Equalization Model for image enhancement in graphical use. The algorithm for image enhancement is capable to correct contrast for some certain areas of an image which is based on edges contained in the image and some statistical properties; variance of the whole image and mean value of an image block. A contrast correction gain is chosen for each image tile based on statistical properties. The algorithm improves the visual quality of an image and also restricts noise amplification. The algorithm is tested with gray scale images as well as color images and results are compared with histogram equalization (HE), Contrast-limited adaptive histogram equalization (CLAHE), Bi-histogram Equalization (BBHE) techniques by image quality metrics parameters that shows results of proposed method are best in compare to Peak Signal-To-Noise Ratio (PSNR), Mean Square Error (MSE) values of other algorithms.

Keywords: Image Enhancement, Peak Signal-To-Noise Ratio (PSNR), Mean Square Error (MSE), histogram equalization (HE), Contrast-limited adaptive histogram equalization(CLAHE), Bi-histogram Equalization (BBHE).

INTRODUCTION

With the fast advance of technologies and the prevalence of imaging devices, billions of digital images are being created every day. Due to undesirable light source, unfavorable weather or failure of the imaging device itself, the contrast and tone of the captured image may not always be satisfactory. Therefore, image enhancement is often required for both the aesthetic and pragmatic purposes. In fact, image enhancement algorithms have already been widely applied in imaging devices for tone mapping[1]. For example, in a typical digital camera, the CCD or CMOS array receives the photons passing through lens and then the charge levels are transformed to the original image. Today, contrast enhancement process plays an important role in enhancing medical images' quality[2]. Several previous studies proved that contrast enhancement techniques capable to clean up the unwanted noises and enhance the images' brightness and contrast. The resulting enhanced medical images provided clearer images for better and easier disease screening process by doctor. Usually, the original image is stored in RAW format, with a bit-length too big for normal displays. So tone mapping techniques, e.g. the widely known gamma correction, are used to transfer the image into a suitable dynamic range. More sophisticated tone mapping algorithms were developed through the years[3].

Motivation: The images which are taken in low light do not give good appearance. To get good

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appearance of image, image must have good contrast and white balancing. The algorithm available either works on contrast enhancement or white balancing, but not on both. If algorithm of contrast enhancement is applied on image which disturbs white balancing and if white balancing algorithm is used which disturbs the contrast of image? So there is limitation in using this algorithm. So to enhance image this is taken in low light, we have to go for contrast as well as white balancing also. But no algorithm gives justification to both enhancement parameter simultaneously, hence the algorithm which can give justification to both image enhancement parameter needs to be developed.

Objective: The objective of establishing the generalized equalization model includes:

- Giving a unified explanation to white balancing problem and contrast enhancement problem.
- Providing an explicit objective function for these two problems and proposing a joint algorithm for them.
- Controlling the performance of the algorithm by as few parameters as possible.

a. **White Balancing***:* Because of the undesirable luminance or the physical limitations of inexpensive imaging sensors, the captured image may carry obvious color bias.1 To calibrate the color bias of image, we need to estimate the value of light source, the problem of which called color constancy a suitable physical imaging model, one can get an approximated luminance, and then a linear transform can be applied to map the original image into an ideal one[4-10].

b. **Contrast Enhancement***:* Contrast enhancement algorithms are widely used for the restoration of degraded media, among which global histogram equalization is the most well liked choice. Other variant includes local histogram equalization and the spatial filtering type of methods. In the fractional filter is used to promote the variance of texture so as to enhance the image. In a texture synthesis based algorithm is proposed for degraded media, such as old pictures or films. On the other hand, transform based methods also exist, e.g. curvelet based algorithm. In an adaptive steering regression kernel is make to combine image sharpening with denoising. Despite of the abundant literature on image enhancement, including those representatives listed above, two challenging problems for image enhancement are still not solved[11-13].

1) PROPOSED SCHEME

First step to achieve good contrast enhancement with preserving a good tone**.** The contrast and tone of an image have mutual influence. Because of the complicated interaction, those algorithms merely aiming towards contrast enhancement or white balancing cannot provide optimal visual effect. Most, if not all, of current image enhancement systems divide white balancing and contrast enhancement into two separate and independent phases. This strategy has an obvious drawback: although tone has adjusted in the white balancing phase, contrast enhancement may undesirably bias it again. This trouble has been observed in many applications[14], e.g. the de-hazing algorithms in achieve contrast enhancement by increasing saturation of the image, but cause tonal distortion in some cases.

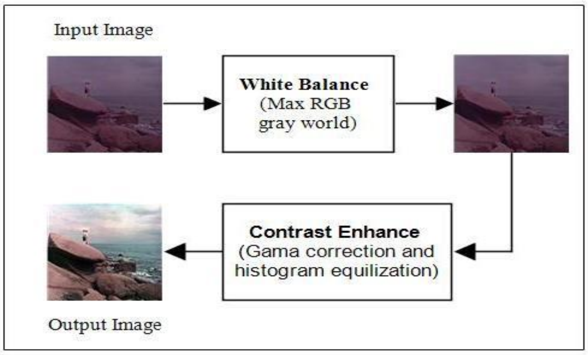

Fig. 1: Traditional Method for image contrast enhancement

It is easy to imagine that joint white balancing and contrast enhancement, is a more efficient solution towards overall quality enhancement. Different types of enhancement algorithms to each other are related theoretically. In this aspect[15], the work in unifies spatial filtering based enhancement methods, including bilateral filter, non-local means filter, steering regression and so on, which has potential applications in image enhancement. However, the computational complexity of filtering based method is much higher than traditional histogram based method in most situations. In many cases, such as real-time video surveillance, the histogram based methods are still being widely used. Taking its significance in practical situations into consideration, finding a unified framework of histogram based methods is a meaningful work that may bring more inspirations to the image enhancement problem and facilitate future research[16]. Although being originated from different applications, both of contrast enhancement and white balancing are essentially tone manipulation processes[17].

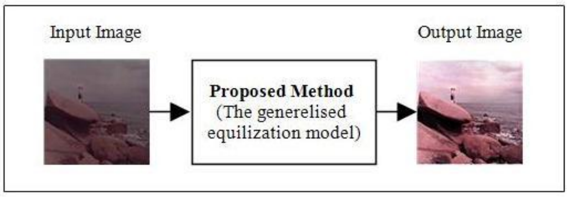

Fig. 2: Generalized equalization model for image contrast enhancement

In fact, it is noticed that almost all global algorithms of contrast enhancement and white balancing are based on histogram transform. Recently on the concept of low-level visual information contents, however this unified model does not take contrast into consideration, so it is limited to the application of white balancing[18]. A strict definition of expected context-free contrast and devised a method called Optimal Contrast-Tone Mapping (OCTM) to solve contrast enhancement problem by maximizing the expected contrast gain subject to an upper limit on tone distortion. OCTM is a promising solution for the intensity channel, but it does not elucidate the relationship between contrast and tone on the color channels. In this dissertation I will analyze the relationships between image histogram and tone/contrast of image, and establish a generalized equalization model [18]. We will propose a series of definitions for context free contrast, tone distortion and its nonlinearity, and clarify their relationships in terms of different parameters in the unified model. The generalized equalization model amalgamates histogram-based tone mapping algorithms in a generalized framework of convex programming and therefore is a joint strategy as shown in Fig. (b). Experimental results show that the proposed method can be widely used in a series of enhancement applications with promising results.

2) SIMULATION RESULTS

A basic application of the proposed algorithm is image contrast enhancement. In the experiments we have used data sets from [31-37], the configuration of parameters is chosen according to the optimal image enhancement algorithm introduced in the former section. To demonstrate the validity of the proposed algorithm we design a subjective experiment. In this paper, we analyzed the relationships between image histogram and contrast/tone. We established a generalized equalization model for global image tone mapping[19-22].

Extensive experimental results suggest that the proposed method has good performances in many typical applications including image contrast enhancement, tone correction, white balancing and post-processing of de-hazed images. In this work, all types of images are used for evaluating the performance of proposed system. Images are taken from the website and also from daily use camera or mobile camera[23]. Images are taken from the websites. These images are of tourism, infrastructure, mining, environmental monitoring, disasters, oil spill, defense and intelligence, etc. Analysis of enhancement of images is done on the basis of two parameters mean square error and peak signal to noise ratio which is explored in details next section[24-26].

Mean Square Error (MSE): The Mean Square Error (MSE) measures the square of errors. The MSE represents the cumulative squared error between the reconstructed image and the original image. The squaring of the errors tends to heavily weight statistical outliers, affecting the accuracy of the results[27]. Mean Square Error (MSE) is defined as in equation below Where, *I* and *R* can be interpreted as input and reconstructed images respectively. *m* and *n* defines number of pixel in vertical and horizontal dimension of images I and R. MSE is the mean square error.

$$\text{MSE} = {}^{1}/_{mn} \sum_{m=0}^{m-1} \sum_{n=0}^{n-1} (\text{I}(\text{i},\text{j}) - \text{R}(\text{i},\text{j}))^2$$ ...1

Peak Signal to Noise Ratio (PSNR) : The Peak Signal-To-Noise Ratio (PSNR) represents a measure of the peak error. PSNR is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR generally indicates that the reconstruction is of higher quality[28], in some cases it may not. Following formula shows PSNR is most easily defined via the mean squared error (MSE).

$$PSNR = 10\ log_{10}({}^{255*255}/_{MSE})$$ ...2

In case of ideal condition, if noise is zero, then MSE=0 and PSNR=∞. Results of images using proposed, histogram equalization, adaptive histogram equalization and bi-histogram equalization methods shown in following images[31], left most images shows result of enhanced image with HE, middle left images shows Enhanced image with CLAHE, right middle images shows result with BBHE and right most images shows Enhanced image with Proposed method. From figure 3 it is clear that the image obtained through histogram equalization and bi-histogram equalization is looks like over enhanced. It shows that images will loss the details[28-30]. To enhance those images with low contrast proposed method is used. While working with these contrast and brightness issues proposed method preserves both of them. Also proposed method produces less mean square error, high PSNR. Above analysis of results for proposed work shows that the work is promising.

Values in table 1 and figure 4 clearly indicate that the yellow colored bars of proposed method having approximately high value. Maximum PSNR value shows that amount of noise is less and it ultimately produces maximum power of a signal.

MSE values in table 2 and figure 5 states that MSE is cumulative squared error between compressed and original image. A lower Value of MSE means lesser error. Lesser values of MSE show that proposed method produces fewer errors.

Fig. 3: Shows Results of 4 Different Input Images with HE, CLAHE, BBHE and Proposed Method

Table 1 Peak signal to Noise Ratio for High Resolution Images

PSNR					
Sr. No.	Name	CLAHE	HE	BBHE	Proposed Method
1	Image 1	19.7949	14.1757	14.5454	15.0460
2	Image 2	15.9670	12.4756	16.4168	14.6117
3	Image 3	18.8431	19.5798	19.2056	21.4703
4	Image 4	18.7625	19.4582	22.9800	22.3813
5	Image 5	16.7176	23.4560	24.1997	25.4972
6	Image 6	17.0125	21.4352	21.7250	20.9290
7	Image 7	17.0069	20.4294	21.8672	21.8108
8	Image 8	14.6941	15.4459	22.2464	16.9157

9	Image 9	17.7277	14.4526	20.9996	15.9469
10	Image 10	14.5665	11.6476	22.8017	12.9405

Table 2 Mean Square Error for High Resolution Images

MSE					
Sr. No.	**Name**	**CLAHE**	**HE**	**BBHE**	**Proposed Method**
1	Image 1	0.0105	0.0382	0.0351	0.0313
2	Image 2	0.0253	0.0566	0.0228	0.0346
3	Image 3	0.0131	0.0110	0.0120	0.0071
4	Image 4	0.0133	0.0113	0.0050	0.0058
5	Image 5	0.0213	0.0045	0.0038	0.0028
6	Image 6	0.0199	0.0072	0.0067	0.0081
7	Image 7	0.0199	0.0091	0.0065	0.0066
8	Image 8	0.0339	0.0285	0.0060	0.0203
9	Image 9	0.0169	0.0359	0.0079	0.0254
10	Image 10	0.0349	0.0684	0.0052	0.0508

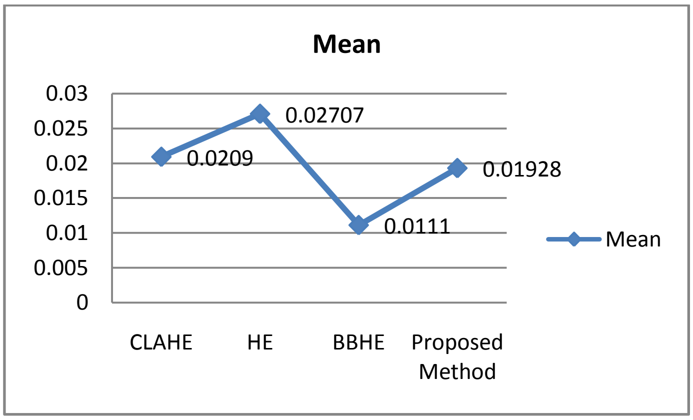

Fig. 3: Shows Results of 4 Different Input Images with HE, CLAHE, BBHE and Proposed Method

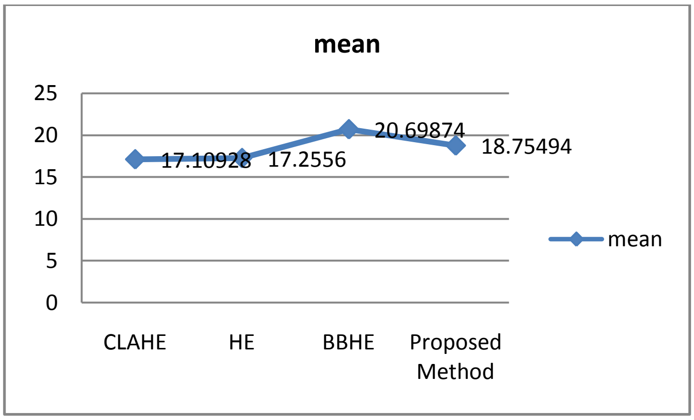

Fig. 3: Shows Results of 4 Different Input Images with HE, CLAHE, BBHE and Proposed Method

CONCLUSION

In this paper, we have presented a color image enhancement method for low contrast images. We established a generalized equalization model for global image tone mapping. Extensive experimental results and The RGB images are first enhanced using HE, CHALE and BBHE algorithm then compared with proposed method suggest that the proposed method has good performances in many typical applications including image contrast enhancement, tone correction, white balancing and post-processing of de-hazed images and A lower Value of MSE means lesser error. Lesser values of MSE show that proposed method produces fewer errors and Maximum PSNR value shows that amount of noise is less and it ultimately produces maximum power of a signal.

REFERENCES

[1]. Paolo Addesso, Maurizio Longo, Antonino Maltese, Rocco Restaino and Gemine Vivone , " Batch Methods for Resolution Enhancement of TIR Image Sequences, IEEE Journal Of Selected Topics In Applied Earth 4 Observations And Remote Sensing, Vol. 8, No. 7, pp. 3372-3384, July 2015

[2]. Md. Imtiyaz Anwar and Arun Khosla, " Classification of Foggy Images for Vision Enhancement , pp. 233-237, IEEE, 2015.

[3]. Guanghui Deng, Zengli Liu,"Comparison and Analysis for Edge Detection Algorithms based on SQI Image Enhancement, 27th Chinese Control and Decision Conference (CCDC), IEEE, pp. 3615-3617, 2015.

[4]. Wei Fan, Kai Wang, Francois Cayre, and Zhang Xiong, " Median Filtered Image Quality Enhancement and Anti-Forensics via Variational Deconvolution, IEEE Transactions on Information Forensics and Security, pp. 1-16, IEEE , 2015.

[5]. Naman Garg, Akshita Angra and Prateek Sengar, "Image Enhancement by Scaling the Discrete Wavelet Coefficients based on Segmentation, 2nd International Conference on Signal Processing and Integrated Networks (SPIN), IEEE, pp. 520-525, 2015.

[6]. Muhammad Talal Ibrahim, A. N. Venetsanopoulos, Ling Guan, "A Comparative Study of Directional Filters with Application to Angiogram Image Enhancement, 28th Canadian conference on electrical and computer engineering Helifax, Canada, may 3-6, , IEEE, pp. 626-629, 2015.

[7]. Jinho Park, Donggyun Kim, Daehee Kim and Joonki Paik, "Non-Dyadic Lens Distortion Correction and Enhancement of Fish-eye Lens Images, international conference on consumer electronics, IEEE, pp. 275-276, 2015.

[8]. Mrs. Preeti.Kale and Dr. S. T. Gandhe, Prof. G. M. Phade and Prof. Pravin A. Dhulekar, " Enhancement of old images and documents by Digital Image Processing Techniques, International Conference on Communication, Information and Computing Technology (ICCICT), Jan. 16-17, Mumbai, India, IEEE, pp. 1-5, 2015.

[9]. Fei Kou, Weihai Chen, Zhengguo Li and Changyun Wen, "Content Adaptive Image Detail Enhancement, IEEE Signal Processing Letters, Vol. 22, No. 2, pp. 211-215, February 2015.

[10]. Saber Yaghoobi, Saeed Hemayat, Hamed Mojallali, "Image Gray-level Enhancement using Black Hole Algorithm, 2nd International Conference on Pattern Recognition and Image Analysis (IPRIA 2015) March 11-12, IEEE, pp. 2015.

[11]. G. A. Licciardi and J. Chanussot, "Nonlinear PCA for Visible and Thermal Hyperspectral Images Quality Enhancement,IEEE Geoscience And Remote Sensing Letters, Vol. 12, No. 6, pp. 1228-1231, June 2015.

[12]. Zhao Wei, Huang Lidong, Wang Jun, Sun Zebin, "Entropy maximization histogram modification scheme for image enhancement, IET Image Process., 2015, Vol. 9, Iss. 3, pp. 226235.

[13]. Xianming Liu, Gene Cheung and Xiaolin Wu,"Joint Denoising and Contrast Enhancement of Images using Graph Laplacian Operator, ICASSP 2015, pp. 2274-2278, IEEE, 2015.

[14]. Preethi Medukonduru and Dr. Madhuri A. Joshi, " Enhancement of Low Contrast Biometric Images using Genetic Algorithm, International Conference on Industrial Instrumentation and Control (ICIC) College of Engineering Pune, India. May 28-30, IEEE, pp. 735-739, 2015.

[15]. Afshan Mulla, Jaypal Baviskar, Rashid Mohhamed and Amol Baviskar, " Adaptive Band Specific Image Enhancement Scheme for Segmented Satellite Images, International Conference on Pervasive Computing (ICPC), IEEE, 2015.

[16]. Wei Fan, Kai Wang, Francois Cayre and Zhang Xiong, Median Filtered Image Quality Enhancement and Anti-Forensics via Variational Deconvolution ,IEEE Transactions on Information Forensics and Security, pp. 1-16, 2015.

[17]. Hongteng Xu, Guangtao Zhai, Member, Xiaolin Wu, Fellow, and Xiaokang Yang, Generalized Equalization Model for Image Enhancement, IEEE TRANSACTIONS ON MULTIMEDIA, VOL. 16, NO. 1, pp. 68- 82, 2014.

[18]. Tarun Kumar Agarwal, Mayank Tiwari and Subir Singh Lamba, Modified Histogram Based Contrast Enhancement using Homomorphic Filtering for Medical Images, International Advance Computing Conference (IACC), pp. 964-968, 2014.

[19]. Omprakash Patel, Yogendra, P. S. Maravi And Sanjeev Sharma, A Comparative Study of Histogram Equalization Based Image Enhancement Techniques for Brightness Preservation and Contrast Enhancement, Signal & Image Processing: An International Journal (SIPIJ), Vol.4, No.5, Pp. 11-25, 2013.

[20]. Bibo Lu, Hui Wang, Chunli Miao, Medical Image Fusion with Adaptive Local Geometrical Structure and Wavelet Transform, ICESB 2011: 25-26 November 2011,

[21]. N. Mohanapriya, B. Kalaavathi, Comparative Study of Different Enhancement Techniques for Medical Images, International Journal of Computer Applications (0975 8887) Volume 61 No.20, January 2013.

[22]. Tamalika Chaira, An improved medical Image enhancement scheme using Type II fuzzy set, Applied soft computing 25(2014)293-308.

[23]. A. R. Rivera, B. Ryu, and O. Chae, Content-Aware Dark Image Enhancement Through Channel Division IEEE Transactions On Image Processing, Vol. 21, No. 9, September 2012.

[24]. D. Ghimire and J. Lee , Nonlinear Transfer Function-Based Local Approach for Color Image Enhancement, IEEE Transactions on Consumer Electronics, Vol. 57, No. 2, May 2011.

[25]. S. Parthasarathy, P. Sankaran, Fusion Based Multi Scale RETINEX with Color Restoration for Image Enhancement, 2012 International Conference on Computer Communication and Informatics (ICCCI -2012), Jan. 10 12, 2012, Coimbatore, India.

[26]. S. Bronte, L. M. Bergasa, P. F. Alcantarilla, Fog Detection System Based on Computer Vision Techniques.

[27]. Z. Chaofu, M. Li-ni, J. Lu-na , Mixed Frequency domain and spatial of enhancement algorithm for infrared image, 2012 9th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2012).

[28]. A. Poljicak, L. Mandic, M. Strgar Kurecic , Improvement of the Watermark Detector Performance Using Image Enhancement Filters, IWSSIP 2012,11-13 April 2012,Vienna, Austria.

[29]. S. W. Jung, J.Y. Jeong, and S.J. K , Sharpness Enhancement of Stereo Images Using Binocular Just-Noticeable Difference, IEEE Transactions On Image Processing, Vol. 21, No. 3, March 2012.

[30]. H. ZhangQ. ZhaoLu Li, Y.c. LiY.h. You , Muti-scale Image Enhancement Based on Properties of Human Visual System, 2011

4th International Congress on Image and Signal Processing.
[31]. R. K. Jha, R. Chouhan, P. K. Biswas , Noise-induced Contrast Enhancement of Dark Images using Non-dynamic Stochastic Resonance, 978-1-4673-0816-8/12S 2012 IEEE.
[32]. http://www.cs.sfu.ca/ ,
[33]. https://www.lib.utexas.edu ,
[34]. http://perso.lcpc.fr/ ,
[35]. http://homepages.inf.ed.ac.uk/
[36]. http://peipa.essex.ac.uk/
[37]. http://riemenschneider.hayko.at/

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