International Journal of Engineering & Technology, 7 (2.22) (2018) 1-4

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Contrast Enhancement of Grayscale and Color images using Adaptive Techniques

Mariena A. A.[1*], J.G.R Sathiaseelan [2]

[1]Research Scholar, Department of Computer Science, Bishop Heber College,Trichy-17
[2]Associate Professor and Head, Department of Computer Science, Bishop Heber College,Trichy-17
**Email: aloormariena@gmail.com*

Abstract

Contrast enhancement is an emerging research area in digital image processing domain. It is an important factor in any subjective evaluation of image quality in medical image processing. As there are possibilities for degradation of image quality during the acquisition, there arises the need of an efficient contrast enhancement technique that can remove the redundant pixels from the images prior to final processing. In this paper, we have proposed two adaptive approaches for contrast enhancement. The first approach is used for enhancing grayscale image using mathematical morphology and second approach is for color image using enhanced sigmoid function. The enhancement process of grayscale image was evaluated by using PSNR and that of color image was evaluated by using a factor called measure of contrast. The experimental results indicate that the two proposed methods show better performance for image in grayscale as well as in color.

Keywords: *Contrast Enhancement; Histogram Equalization; Measure of Contrast; Morphology; Sigmoid Function..*

1. Introduction

Contrast enhancement plays a crucial role in the field of image analysis especially in medical image processing. It provides better enhanced image for further image processing tasks. Color images convey numerous hidden information with them in which human eye fails to analyse. So, we need a proficient contrast enhancement technique to reveal those information. Edge enhancement, contrast enhancement, and noise reduction are the various forms of Image enhancement. Contrast enhancement algorithms can be classified into two types; point operations and spatial neighbourhood techniques. Histogram equalization is commonly used for contrast enhancement in a variety of image applications due to its simplicity. It works by stretching the gray levels by using the cumulative density function. One disadvantage of this method is that the brightness of an image is altered after the process. Mathematical morphology is an image processing technique that deals with the shape of image features. The commonly used morphological transformations are dilation, erosion, opening and closing. Usually morphological operations use structuring element which interacts with the image to see how it fits the shapes in the image. Color image enhancement techniques are more difficult than the gray image enhancement techniques since color image consider vectors rather than scalars. In this paper grayscale images were enhanced using mathematical morphology and color images were enhanced using modified sigmoid function.

The rest of this paper is organized as follows. Section II describes the related works; in section III the methodology of the paper is described and finally the conclusion is drawn in section IV.

2. Related Work

An exhaustive literature study has been made on the work done by various researchers and the findings are summarized as follows:

Kanika Kapoor et al. [12] proposed a novel approach for color image enhancement based on histogram equalization. Here the acquired image is converted into HSV then the image is decomposed into two parts by using threshold and equalized them independently. For measuring the performance of the enhanced image, contrast of image and entropy are calculated. Still there is over enhancement. Monica Agarwal et al. [4] devised an efficient algorithm to furnish the limitation of over enhancement with maximum entropy preservation. In the algorithm, input image histogram is segmented based on its valley positions and then weighted distribution is applied to all segmented sub histograms followed by the histogram equalization, gamma correction and homomorphic filtering. Results shows that the proposed technique performs well than the other conventional techniques both in terms of visual quality along with maximum entropy preservation and contrast enhancement. Haidi Ibrahim et al. [14] introduced a technique that use smoothing of an image histogram by Gaussian Kernel followed by its segmentation of valley regions for their dynamic equalization. The crisp statistics of digital images suffer from the inherent limitation that it does not take in to account the vagueness of gray values. Swati Sharma et al. [6] suggested an efficient contrast enhancement algorithm using Gaussian mixture modeling (GMM) for showing the image gray level distribution. It incorporates an enhancement criterion based on image equalization with improved threshold median filter which targets at enhancing the contrast along with suppression of impulse noise and preservation of edges.

3. Methodology

Many image enhancement algorithms have been developed to improve the visual appearance of images. Histogram equalization (HE) is a general method for contrast enhancement for both color and grayscale images. The histogram of an image is a graph that plots the occurrences of gray levels in the image against the gray level values. If an image whose histogram covers a wide range of gray scale than it is a high contrasted image. Equalized histogram equalization method is an improved histogram equalization method. First of all the input image is enhanced using the histogram equalization and the output image is summed up with input image [7]. In this paper two algorithms are proposed one for contrast enhancement of gray scale image and another for color image using mathematical morphology and enhanced sigmoid function respectively.

3.1. Proposed Contrast Enhancement based on Mathematical Morphology (CEMM) Algorithm for gray scale image

Mathematical morphology is a tool for extracting image components that are useful for further processing tasks. Erosion and Dilation are the basic morphological operations, which are used for the *closing and* opening operations [*10]*.They are defined as

$$\text{Opening, } AoB = (A \ominus B) \oplus B$$
$$\text{Closing, } A \bullet B = (A \oplus B) \ominus B$$

Opening smoothes the edges of an object, closing joins the narrow breaks, fills the gaps in the edges and eliminates the small holes. Different types of structuring elements are available for morphological processing like square, line, and disc. Working of Image enhancement is shown in Fig. 1.

Implementation Steps Involved in the Proposed CEMM Algorithm

1: Read the image
2: Find the maximum intensity value: Max
3: Subtract the image from Maximum value: B=Max-G
4: Find the structural element using disk: S
5: Do bothat transformation with the result D= (B●S)-B
6: Subtract the result from maximum value E=Max-D
7: Subtract original image from that result G_{diff}=G-E
8: Add the original image with the result; $G_{enhanced}$=G+G_{diff}

Fig. 1: Proposed CEMM Algorithm

3.1.2. Experimental Results of CEMM Algorithm

The experimental results of proposed 'Contrast Enhancement based on Mathematical Morphology (CEMM)' algorithm are analyzed by comparing the existing methods on low contrast blood cell images. Proposed technique has been implemented using MATLAB version R2015b. Comparison of the test images are shown in Fig. 2, 3 and 4. Figure (2a) is the original image; (2b) is the results obtained by using histogram equalization method; (2c) shows the results obtained by using Equalized histogram equalization method; (2d) shows the result obtained by using CLAHE method (2e) shows the results obtained using proposed algorithm. Similarly figure 3 and figure 4 are the results for B2 and B3 image respectively. From the results it is clear that the proposed algorithm got highest value for PSNR than other methods. From the results it is clear that the proposed algorithm performs better than the conventional methods.

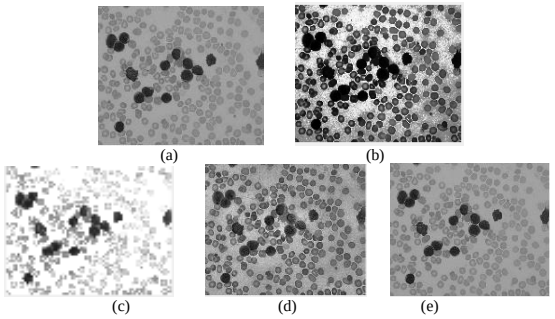


Fig. 2: Enhancement results of B1 image: (a) Original (b)HE (c) EHE (d) CLAHE (e) Proposed Method

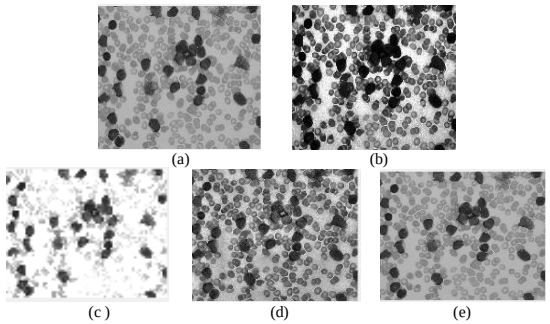


Fig. 3: Enhancement results of B2 image: (a) Original (b) HE (c) EHE (d) CLAHE (e) Proposed Method

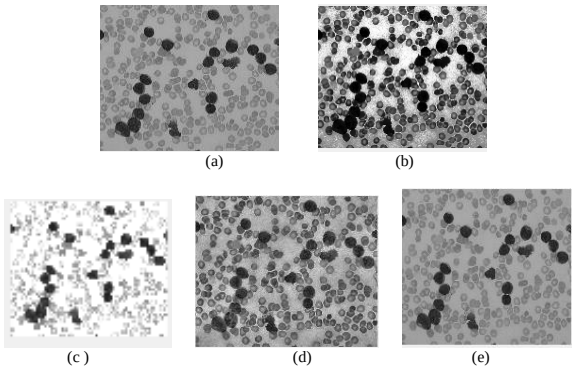


Fig. 4: Enhancement results of B3 image: (a) Original (b) HE (c) EHE (d) CLAHE (e) Proposed Method

Table 1: Comparison of PSNR of all images.

Method	B1 Image	B2 Image	B3 Image
HE	13.1331	14.8725	13.9531
EHE	9.7756	10.4410	9.7835
CLAHE	21.0473	19.4501	20.9959
CEMM	52.6875	50.6875	52.2670

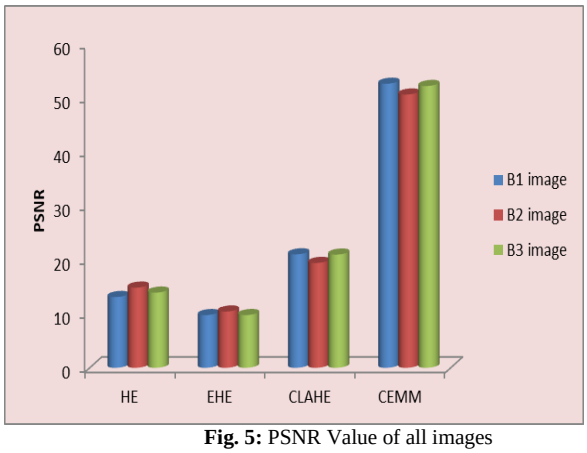


Fig. 5: PSNR Value of all images

3.2. Proposed Contrast Enhancement based on Enhanced Sigmoid Function (CEESF) Algorithm for color image.

Here we propose a adaptive technique for contrast enhancement color images captured with poor illumination. Here we first extracting the RGB planes and each plane rescaled in to [0-1] then apply modified sigmoid function to each individual plane. The enhanced R, G, B Color planes are finally combined to obtain the resultant color image. A sigmoid function is a continuous non-linear mathematical function having an "S" shaped curve. The sigmoid function has the characteristics that it is a smooth continuous function.

$$F(x) = \frac{1}{1 + e^{-tx}} \quad (1)$$

Sigmoid function is altered in order to add the contrast, threshold value and maximum grey value. The modified sigmoid function which we have used in our proposed algorithm is

$$G(x,y) = \frac{1}{1 + e^{c(t-I)*L}} \quad (2)$$

G(x,y) - Enhanced pixel value , c is contrast factor, t - threshold value which is the average intensity value or histogram mean of the input image I- original image L-highest gray value in the individual color planes. By adjusting the contrast factor 'c' and threshold value it is possible to modify the amount of lightening and darkening to control the overall contrast enhancement. We have analyzed the proposed algorithm on various blood cell images and the results are found to be higher than existing algorithms. The step by step description of Contrast Enhancement based on Enhanced Sigmoid Function (CEESF) method is explained in Fig.

Implementation Steps Involved in the Proposed CEESF Method

1. Acquire the input image
2. Extract the RGB color planes separately.
3. Normalize the RGB color planes to the range 0-1
4. The enhanced sigmoid function is applied on the separate RGB color planes.
5. Combine the enhanced RGB color planes to get the output image.

Fig. 6: Proposed CEESF Algorithm

3.2.1. Performance Evaluation

Performance of this algorithm is conducted on several blood cell images. To evaluate the contrast enhancement performance, we have considered the following evaluation parameter discussed in [13].

$$\text{Measure of Contrast} = \frac{Ie - Ii}{Ii} \quad (3)$$

I_e is the average intensity of the enhanced image and $I_{i\,is}$ the average intensity of the input image. Three low contrast blood cell images have been taken as input for evaluating the proposed algorithm. The comparison has been done on the basis of Measure of contrast.

3.2.2. Experimental Results of CEESF Algorithm

The experimental results of proposed 'Contrast Enhancement based on Enhanced Sigmoid Function' (CEESF)' algorithm is analyzed by comparing the existing histogram equalization and proposed method along with various values of contrast factor. Low contrast blood cell images are used for analysis. Proposed technique has been implemented using MATLAB version R2015b. Comparison of the test images are shown in Fig. 7, 8 and 9. Figure (7a) is the original image, (7b) is the results obtained by using Histogram equalization method (7c) is the result obtained by using CLAHE (7d) is the result obtained by using enhanced sigmoid function having c=10. (7e) shows the results obtained by using enhanced sigmoid function having c=9 and (7f) shows the results obtained by using enhanced sigmoid function having c=8. Similarly figure 8 and figure 9 are the results for B2 and B3 image respectively. From the results it is observed that the proposed algorithm with contrast value 8 having the better enhanced output.

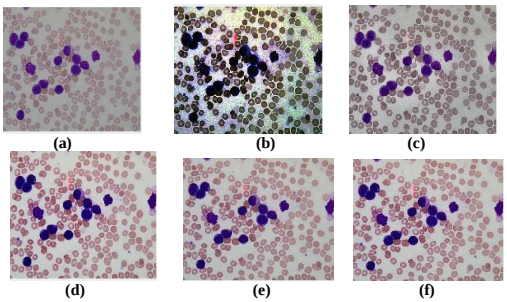


Fig. 7: Enhancement results of B1 image: (a) Original (b) HE (c) CLAHE (d) c=10 (e) c=9 (f) c=8.

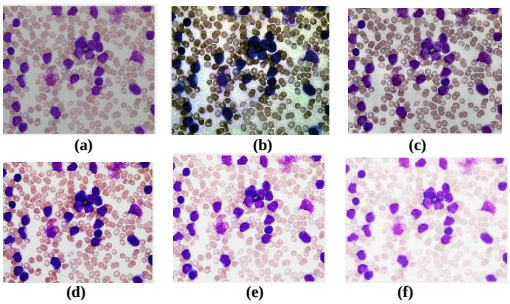
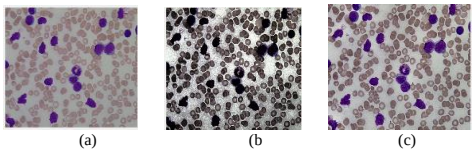


Fig. 8: Enhancement results of B2 image: (a) Original, (b) HE, (c) CLAHE (d)c=10 (e) c=9 (f) c=8



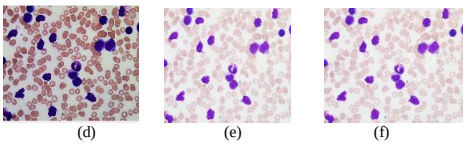


Fig. 9: Enhancement results of B3 image: (a) Original (b) HE (c) CLAHE (d) c=10 (e) c=9 (f) c=8

Table 2: Comparison of 'Measure of Contrast' of all images.

Method	B1 image	B2 image	B3 image
HE	0.0904	0.1288	0.0792
CLAHE	0.0995	0.0793	0.0695
C=10	0.1592	0.1673	0.1261
C=9	0.4064	0.3683	0.3976
C=8	0.5416	0.4850	0.5429

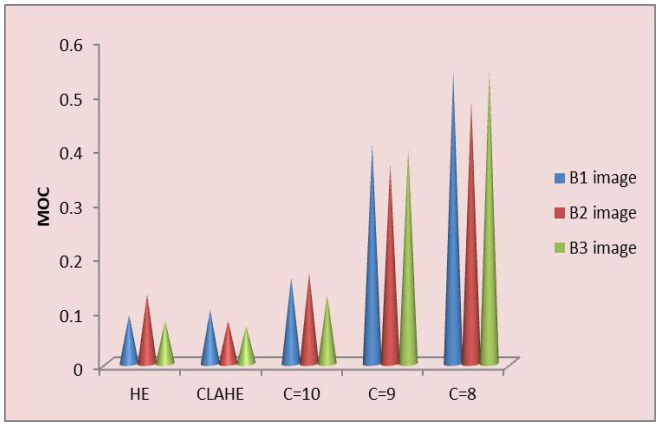


Fig. 10: Contrast of all images

4. Conclusion

In this paper an effort is made to develop two algorithms for contrast enhancement of grayscale using mathematical morphology and for enhancement of color image using enhanced sigmoid function. The performance of both the techniques is analyzed with a set of blood cell images. The enhancement process of grayscale image was evaluated by using PSNR and that of color image was evaluated by using a factor called measure of contrast. On comparing the proposed methods with the existing methods, it has been concluded that the proposed techniques have given much better results than the existing ones.

References

[1] Kotkar, V.A. and S.S. Gharde, "Image contrast enhancement by preserving brightness using global and local features." Third International Conference on Computational Intelligence and *Information Technology, (CIIT 2013)*, 2013.

[2] He, Renjie, Sheng Luo, Zhanrong Jing and Yangyu Fan, "Adjustable weighting image contrast enhancement algorithm and its implementation." *2011 6th IEEE Conference on Industrial Electronics and Applications*, 2011.

[3] Singh, Shivendra, Manish Soni, Arun Patel, Ravi Shankar Mishra, "Performance Evaluation of Spatial Domain Contrast Enhancement Techniques for Underwater Images." *International Journal of Computer Applications*, vol. 93, no. 11, 2014, pp. 41-46.

[4] Agarwal, Monika, and Rashima Mahajan. "Medical Images Contrast Enhancement using Quad Weighted Histogram Equalization with Adaptive Gama Correction and Homomorphic Filtering." *Procedia Computer Science*, vol. 115, 2017, pp. 509-517.

[5] Aimi Salihah, A.N., Mohd Yusoff Mashor, Nor Hazlyna Harun, and H. Rosline, "Color image enhancement techniques for acute Leukaemia blood cell morphological features." *2010 IEEE International Conference on Systems, Man and Cybernetics*, 2010.

[6] Swati Sharma, Prof. R.N.Mandavgane, A.P. Bagade,"Review on Efficient Contrast Enhancement Technique for Low Illumination Color Images" *International Journal on Recent and Innovation Trends in Computing and Communication* ISSN: 2321-8169 Volume: 5 Issue: 3, 2017.

[7] Irmak, Emrah, and Ahmet H. Ertas, "A review of robust image enhancement algorithms and their applications." *2016 IEEE Smart Energy Grid Engineering (SEGE)*, 2016.

[8] Deng, He, Xianping Sun, Maili Liu, Chaohui Ye, Xin Zhou, "Image enhancement based on intuitionistic fuzzy sets theory." *IET Image Processing*, vol. 10, no. 10, 2016, pp. 701-709.

[9] Khairunnisa Hasikin, Nor Ashidi Mat Isa, "Enhancement of the low contrast image using fuzzy set theory" 2012 14th *International Conference on Modeling and Simulation*, 978-0-7695-4682-7/12 , 2012 IEEE.

[10] Benson C.C, Lajish V.L., "Morphology Based Enhancement and Skull Stripping of MRI Brain Images." *2014 International Conference on Intelligent Computing Applications*, 2014.

[11] Sunita Dhariwal "Comparative Analysis of Various Image Enhancement Techniques", *IJECT*, Vol. 2, Issue 3, Sept. 2011.

[12] Kanika Kapoor and Shaveta Arora, "Color Image Enhancement Based on Histogram Equalization", Electrical & Computer Engineering: An International Journal (ECIJ) Volume 4, Number 3, and September 2015.

[13] P. Kannan, S. Deepa, and R. Ramakrishnan, "Contrast Enhancement of Sports Images Using Two Comparative Approaches" American Journal of Intelligent Systems 2012, 2(6): 141-147.

[14] Haidi Ibrahim, Nicholas sia pik Kong,"Brightness Preserving Dynamic Histogram Equalization for Image Contrast Enhancement" IEEE Transactions on Consumer Electronics Volume: 53, Issue: 4, Nov. 2007.

[15] Dibya jyoti "bora, "importance of image enhancement techniques in color image segmentation: a comprehensive and comparative study" Indian J. Sci. Res. 15 (1): 115-131, 2017.

[16] ALL-IDB "Acute Lymphoblastic Leukemia Image Database for Image Processing," Department of Information Technology - Università degli Studi di Milano, 2005. Available: http://crema.di.unimi.it/~fscotti/all/