ISSN: 0975-766X
CODEN: IJPTFI
Available Online through ***Research Article***
www.ijptonline.com

EXPLORING MULTI SCALE MATHEMATICAL MORPHOLOGY FOR DARK IMAGE ENHANCEMENT

P. Kiran Kumar*, C. Raghavendra*, Dr.S. Sivasubramanian, Dr.S. Sivasubramanian*****
*Research Scholar, Dept. of CSE, Bharath Institute of Higher Education and Research,
Bharath University, Chennai, 600073.
**Professor & HOD, Department of IT, Danalakshmi Engineering College, Chennai.
*** Assistant Professor, Department of CSE, KITS Engineering College, Guntur (A.P)
Received on: 15.10.2016 *Accepted on: 22.11.2016*

Abstract

Dark image enhancement is an essential requirement in image processing domain. As images are captured in different illumination conditions, it is important to enhance dark images or color images suffering from lack of contrast. The present algorithmsfor contrast enhancement sometimes result in artifacts andunnecessary changes. Recently Rivera et al. proposed a content aware algorithm for dark image enhancement. The technique used by them is known as channel division. This paper proposes and implements a new technique which is then compared with the work of Rivera et al. The technique used to enhance gray scale images in this paper is "multiscale mathematical morphology". This technique enhances the magnitude image constructed from RGB using hue-preserving multi-scale morphological filters. By combining original direction cosine values and the enhanced magnitude image the enhanced image is obtained. A prototype application is built to test the efficiency of this technique. The results are compared with Channel Division technique. The experiments revealed that the proposed method outperforms the channel division approach.

Keywords: Contrast enhancement; Multi scaling; Mathematical morphology; Local contrast enhancement.

I. Introduction

Usage of images is increased in many real world applications. For instance all government applications need to work with photos of citizens and enhancing them or comparing them besides many other operations. This is the need for building tools that work with images. There are some models to represents an image. They include YIQ, CMY and RGB. These models are widely used in image processing. However, they do not truly reflect human vision perception. To overcome this problem other models came into existence to represent colors. They include HVC, HSV and HSL [1]. These representations are used in image processing for contrast enhancement which is an essential feature of any tool that is meant for image processing. Especially dark images or images with low contrast need to be enhanced. Many algorithms came into existence to solve this problem. They include Histogram Equalization (HE) [2], Bi-Histogram Equalization (BHE) [3], [4], Adaptive Histogram Equalization (AHE)[5], [6], Multi-Scale Retinex (MSR) [7], orthogonal retino-morphic image transform (ORMIT) [8]and Channel Division [9]. All the algorithms except Channel Division, sometimes, produce artifacts and unnecessary changes. Instead of depending on global features of image, the channel division focuses on content aware approach in which the given image is divided into HSV values. Then the value part is taken as input and intensity pairs are identified. Similar intensity pairs are group to form intensity channels and similar regions are clubbed to become intensity regions. This process is named as channel division. Thus various characteristics of image are separately taken and grouped using human visual characteristics. Finally individual channels are processed in order to enhance the image which does not result in artifacts. The success of this technique depends on the concept of content awareness.

This paper presents a local contrast enhancement method for enhancing color images using the technique multiscale morphology (MMS). It combines usual notions of image processing domain [10] with mathematical morphology [1]. We have developed and tested a prototype application in Java. The results are then compared with Channel division. The empirical results revealed that the proposed method outperforms the channel division method. The rest of this paper is organized into the following sections. Section II reviews literature on contrast enhancement. Section III focuses on the proposed technique for contrast enhancement. Section IV provides details of experiments and results while section V concludes this paper.

II. Prior Work

As found in the literature there are many algorithms or techniques that have been used to enhance the contrast of color images that suffer from low contrast. Very simple and most widely used algorithm is HE [2]. It makes use of histogram of given image withcumulative density functions (CDFs). The HE enhances image content evenly. This results in artifacts or unnecessary symbols in the image. To overcome the drawbacks of HE, BHE [3], [4]came into existence. It makes two parts of histogram and enhances each part independently by maintaining intensity mean of original image. It is able to overcome over enhancement problem but still shows unnatural images. Another technique by name adaptive histogram equalization (AHE) came into existence [5], [6] which equalizes histogram to achieve better results. However, it still produces unnatural images occasionally. Based on alpha-blending and contrast stretching are used in [11] for contrast enhancement. However it is a complex algorithm. Another complex algorithm is proposed whosenameis MSR [7] which enhances the contrast of image using the following equation.

$$Ie = \sum_{k=1}^{n} (\log(I) - \log(LPFn(1)) \quad (1)$$

All these algorithms are producing artifacts or unnatural images or computationally complex. To overcome these drawbacks Channel Division [9] was proposed. This technique is content aware. Instead of applying contrast to the entire image, it applies only to the required content. Hence it is known as Channel Division. This technique identifies intensity channels and apply them contrast in order to enhance dark images. Multi-scale processing [12], [13] techniques are also used to enhance images. The filters pertaining to this were proved to be very useful. They used morphological towers [14], [15] to achieve this. In [16] a multiscale approach is used for enhancing the contrast of color images. Toet [13] proposed another approach of this kind using the combination of non-linear pyramids. Multi-scale techniques for gray scale images were proposed in [17] and [18]. A technique is known as Chromaticity Diffusion is used in [19] for enhancing color images. This paper presents yet another technique based on Multi-Scale Mathematical Morphology.

III. Proposed Approach to Contrast Enhancement

The proposed contrast enhancement algorithm is known as "multi-scale morphological algorithm".It uses the three color components namely Red, Green and Blue to construct a magnitude image. Apart from the magnitude image, it also generates direction cosines of color vectors. The color vectors are taken from each pixel. Then multiscale morphological filters are applied to enhance the contrast of magnitude image. Then the direction cosines are combined with the resultant magnitude image to obtain enhanced color image. The implementation details are as given below. RGB color representation is used in this approach. In this representation a pixel's intensity is built as a 3 component vector. Then the magnitude of this vector is computed as:

$$g(r,c) = \frac{-b \pm \sqrt{R2(r,c) + G2(r,c) + B2(r,c)}}{} \quad (2)$$

In order to extract bright features top – hat transformation is used. This is done using the equation:

g(r,c) = (g o B) (r,c) + [g(r,c) – (g o B) (r,c)]   (3)

The second part of the equation (2) is used to measure local contrast original image. It is possible due to the availability of bright features. For local contrast stretching the following equation is used.

g(r,c) = (g o B) (r,c) + K [g(r,c) – (g o B) (r,c)]   (4)

When the equation is generalized for number of scales it appears as follows.

$g(r,c) = g(r,c) + K1\delta 1(r,c) + K2\delta 2(r,c) + \ldots\ldots$ (5)

In order to restrict the process to the scale m, the following equation is used.

$g(r,c) = g(r,c) + \Sigma^{m}_{i=1} K1\delta 1(r,c)$ (6)

Finally the local contrast stretching for obtaining bright features is achieved using

$g(r,c) = g(r,c) + \Sigma^{m}_{i=1} F^{0}_{iB}(r,c)$ (7)

In the same fashion, dark features are extracted using the following equation.

$g(r,c) = g(r,c) - \Sigma^{m}_{i=1} F^{c}_{iB}(r,c)$ (8)

By assigning equal weights to both bright and dark features, the enhanced grayscale image is obtained.

$g(r,c) = g(r,c) + 1/2\ \Sigma^{m}_{i=1} F^{0}_{iB}(r,c) - 1/2\ \Sigma^{m}_{i=1} F^{c}_{iB}(r,c)$ (9)

The final enhanced magnitude image which is nothing but the stretched color image is obtained by (R(r,c) G(r,c) B(r,c)) = ǵ(r,c) / g(r,c) (R(r,c) G(r,c) B(r,c)) (10)

IV. Experimental Results

The environment used to build the prototype application which demonstrates the efficiency of the proposed algorithm named “multi-scale morphological algorithm” is a PC with 3 GB or RAM and Core 2 Dual processor. JDK 1.6 is used for coding the functionality while NetBeans is used as an Integrated Development Environemnt (IDE) for rapid application development. A set of color images is used to test the algorithm. The results of the experiments revealed that the resultant images have more contrast when compared with original images. Then the results are compared with that of Channel Division algorithm proposed in [9].

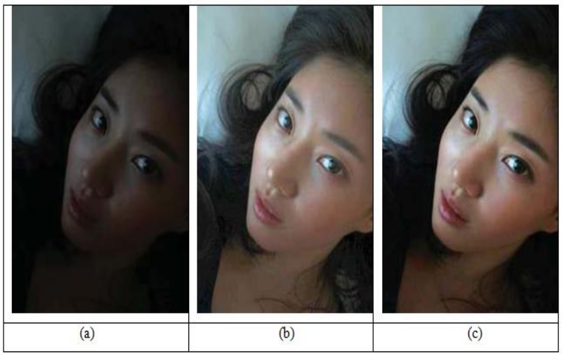

Fig. 1 – Result of Enhancements – Girl Example.a) Original Image b) Channel Division c) Proposed Method

As can be seen in fig. 1, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

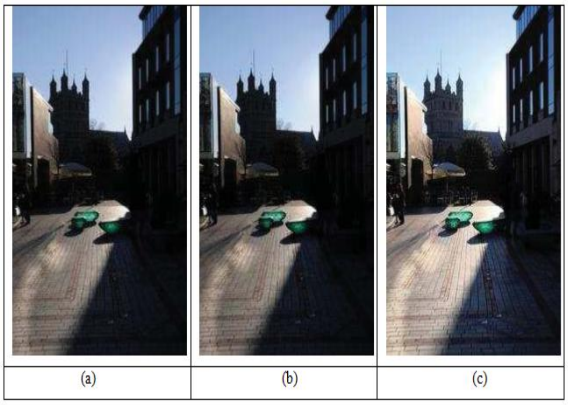

Fig. 2 – Result of Enhancements – Street Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 2, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

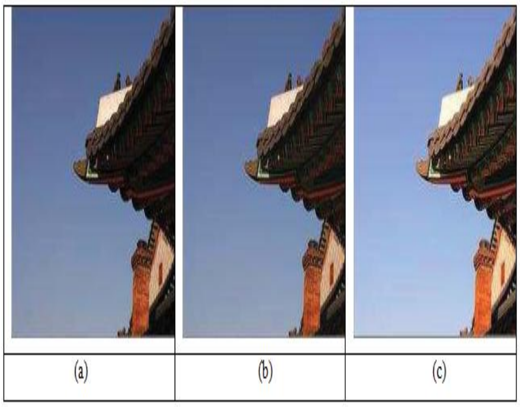

Fig. 3 – Result of Enhancements – Building Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 3, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

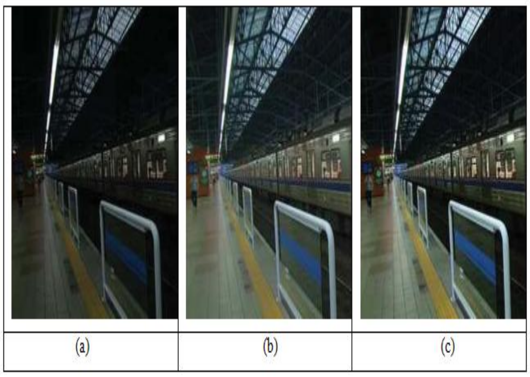

Fig. 4 – Result of Enhancements – Subway Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 4, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

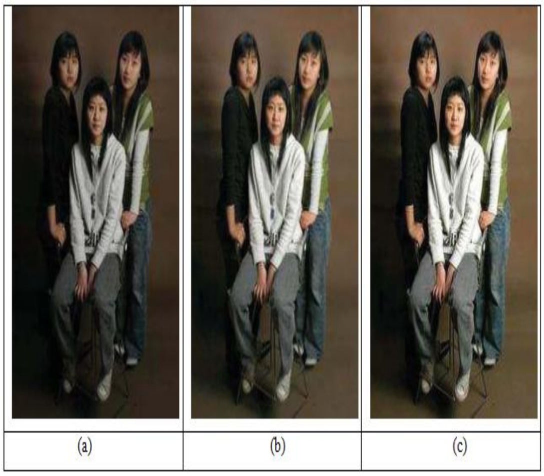

Fig. 5 – Result of Enhancements – Girls Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 5, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

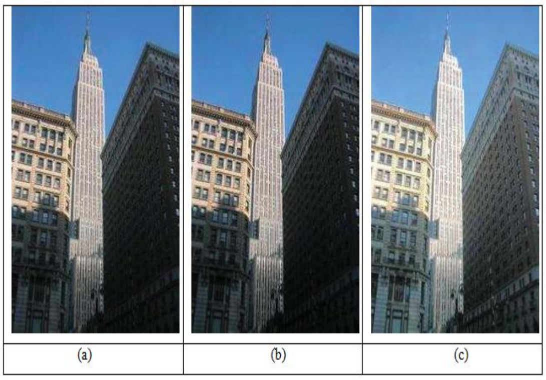

Fig. 6 – Result of Enhancements – Empire State Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 6, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

Fig. 7 – Result of Enhancements – Boat Example. a) Original Image. b) Channel Division. c) Proposed Method.

As can be seen in fig. 7, the original image is a color image which suffers from low contrast. The result of the proposed method appears better than that of Channel Division.

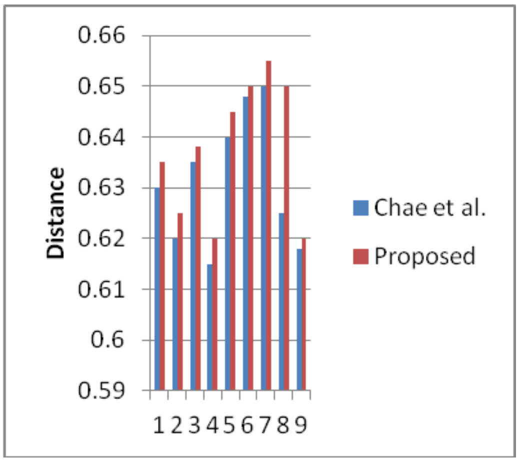

Fig. 8 –Distance from Diagonal of Results of Channel Division and Proposed.

As can be seen in fig. 2, it is evident that the distances of methods are presented. The methods that show smaller distances are capable of producing better enhanced images.

V. Conclusion

In this paper, we presented a multi-scale mathematical morphology technique for contrast enhancement of color images. This technique takes red, green and blue colors from input image and generates a magnitude image. Then multi-scale morphological filters are applied to obtain an enhanced magnitude image. This process does not change the color vector. Afterwards, the original direction cosine values and the enhanced magnitude image are combined to get an enhanced color image. The proposed technique is applied to a set of images and the results are compared with that of channel division. The empirical results reveal that the proposed technique outperforms channel division approach.

VI. References

1. J. D. Foley, A. V. Dam, S. K. Feiner, and J. F. Hughes. *Computer Graphics Priciples and Practice*. Addison-WesleyPublishing Company, second edition, Reading, MA, 1997.
2. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3rd ed.Upper Saddle River, NJ: Prentice-Hall, 2006.
3. Y.-T. Kim, “Contrast enhancement using brightness preserving bihistogramequalization,” *IEEE Trans. Consumer Electron.*, vol. 43, no.1, pp. 1–8, Feb. 1997.
4. K. Wongsritong, K. Kittayaruasiriwat, F. Cheevasuvit, K. Dejhan, andA. Somboonkaew, “Contrast enhancement using multipeak histogramequalization with brightness preserving,” in *Proc. IEEE Asia-PacificConf. Circuits Syst.*, Nov. 1998, pp. 455–458.

5. T. K. Kim, J. K. Paik, and B. S. Kang, "Contrast enhancement systemusing spatially adaptive histogram equalization with temporal filtering,"*IEEE Trans. Consumer Electron.*, vol. 44, no. 1, pp. 82–87, Feb. 1998.
6. J.-Y. Kim, L.-S. Kim, and S.-H. Hwang, "An advanced contrast enhancementusing partially overlapped sub-block histogram equalization," *IEEETrans. Circuits Syst. Video Technol.*, vol. 11, no. 4, pp. 475–484, Apr.2001.
7. D. J. Jobson, Z. Rahman, and G. A. Woodell, "A multiscale retinex forbridging the gap between color images and the human observation ofscenes," *IEEE Trans. Image Process.*, vol. 6, no. 7, pp. 965–976, Jul.1997.
8. V. Chesnokov, "Image enhancement methods and apparatus therefor,"U.S. Patent 7 302 110, Apr. 10, 2002.
9. Adin Ramirez Rivera, Byungyong Ryu, and Oksam Chae, *Member, IEEE, "*Content-Aware Dark Image Enhancement Through Channel Division". 2012.
10. B. Chanda and D. D. Majumder. *Digital Image Processing and Analysis*. Prentice-Hall of India Pvt. Ltd., New Delhi,2000.
11. I. V. Safonov, M. N. Rychagov, K. Kang, and S. H. Kim, "Automaticcorrection of exposure problems in photo printer," in *Proc. IEEE 10thInt. Symp. Consumer Electron.*, 2006, pp. 1–6.
12. P. Maragos. Pattern spectrum and multiscale shape representation. *IEEE Trans. on PAMI*, 11:701–716, 1989.
13. A. Toet. A hierarchical morphological image decomposition. *Pattern Recognition Letters*, 11(4):267–274, 1990.
14. S. Mukhopadhyay and B. Chanda. Fusion of 2d grays-cale images using multiscale morphology. *Pattern Recognition*, 34(10):–, 2001.
15. S. Mukhopadhyay and B. Chanda. An edge preserving noise smoothing technique using multiscale morphology. *SignalProcessing, In press*, -:–, 2001.
16. G.Boccignone and A. Picariello Multiscale contrast enhancement of medical.