A Survey on Various Image Enhancement Algorithms for Naturalness Preservation

Divya K A, Roshna K I

Dept of computers science and engineering ,
Federal Institute of Science And Technology(FISAT), Mahathma Gandhi University kottayam
Ernakulam, Kerala, India

Abstract- Image enhancement plays an important role in image processing and analysis. Enhancement of an image in which process an image and the output suitable for various image processing techniques . noise removal and naturalness is essential for image enhancement to achieve pleasing perceptual quality. Here in this paper various image enhancement methods are discussed. It also describes some measurement techniques used in enhancement .

Keywords - color image enhancement, noise removal, naturalness, CEM, bright pass filter

I.   INTRODUCTION

Digitized images usually suffer from poor image quality, particularly lack of contrast and presence of shading and artifacts, due to the deficiencies in focusing, lighting, specimen staining and other factors. One of the most important image processing technique is image enhancement . Image Enhancement is one of the most important and difficult techniques in image research. Image Enhancement is to improve the visibility of one aspect or component of an image. Image enhancement is a common approach to improve the quality of those images in terms of human visual perception. There exist lot of techniques that can enhance a digital image without spoiling it.
Key Applications:
- Health sciences
- Enhance biomedical/medical image qualities
- Robotic surgery
- Low vision reading with electronic display
- Machine vision
- Forensics
- Robot vision

This paper is structured as follows. Section II focuses in detail on the various image enhancement methods. Section III covers conclusion.

II.   LITERATURE SURVEY

Enhancement techniques can be divided into two categories namely:
  Spatial domain methods
  Transform domain methods
Spatial domain technique enhances an image by directly dealing with the intensity value in an image. Large number of techniques have been focussed on the enhancement of gray level images in the spatial domain. Most important spatial domain technique are histogram equalization, high pass filtering, low pass filtering, homomorphic filtering, etc. These methods have been also applied to color image enhancement in the R-G-B space.

Transform domain enhancement techniques involve transforming the image intensity data into a specific domain by using methods such as DFT, DCT, etc. and the image is enhanced by altering the frequency content of the image .Here the image is first transferred into frequency domain ie , the Fourier Transform of the image is computed first then the Inverse Fourier Transform is performed to get the resultant image. These enhancement operations can be used to modify the image brightness, contrast or the distribution of the grey levels. As a result the pixel value intensities of the output image are modified according to the transformation function applied on the input images.

Various techniques are used for image enhancement . some techniques used in image enhancement are Retinex algorithm, Unsharp mask algorithm and Histogram Equalization.

Retinex theory assumes that the sensations of color have a strong correlation with reflectance, and the amount of visible light reaching observers depends on the product of reflectance and illumination

Histogram Equalization is a for contrast adjustment using image histogram. An image histogram is a graphical representation of the tonal distribution in a digital image. It plots the number for each tonal value. The horizontal axis of the graph indicates the tonal variations, while the vertical axis represents the number of pixels in that particular tone.

Unsharp Masking is an image sharpening technique, often available in digital image processing software. The term "Unsharp" derives from the fact that the technique uses an unsharp, positive image to create a mask of original image. The unsharped mask is combined with the negative image, gives an image that is less blurry than the original.

A.   Retinex Based Algorithms

Retinex theory is one of the most important approaches for image enhancement . Retinex is a human perception based image enhancement algorithm to improve the brightness , contrast and sharpness of an image through dynamic range compression.

The algorithm gives color constant output and also it removes the effects caused by different illuminants on a scene. It combines both contrast enhancement and color constancy togethor . The original retinex algorithm is based on a model of human vision's lightness and color constancy. Retinex is a class of center surround functions.

here each output value is determined by the corresponding input value (center) and its neighborhood (surround). For Retinex the center is defined as each pixel value and the surround is a Gaussian function.

Our initial search resulted in single scale retinex (SSR) [1]. It is based on centre-surround retinex algorithm . It provide high color constancy and Dynamic range compression . But its disadvantage is that it either provide dynamic range compression or tonal rendition not both and also suffer color distortion .

The work in [2] uses a multi scale retinex (MSR) combines several SSR outputs and it is a multi level version of local Retinex . MSR combines dynamic range compression of small scale retinex with tonal rendition of large scale retinex . Advantages are it provide both dynamic range compression and tonal rendition by preserving most of the details Haloing artifacts are eliminated. But it Suffer graying-out of uniform scenes and tonal rendition is scene dependent and poor.

In NECI [5], the image enhancement can avoid dramatic modifications to image mainly light condition modification, color temperature variation, and other additional artifacts with concepts of MSR algorithm. It is well suited for natural images. Not suitable for unnatural images like medical images.

Shaohua Chen et.al [6] proposed a new method for Natural Rendering of Color Image based on Retinex (**NRCIR**) . The word "natural" means that the ambience of image (warm or cold color impression) should not be changed after enhancement . It is used to naturally render color image . During the integration of one-filter Retinex and histogram rescaling lead to improvement natural appearance of image However the proposed method works poorly in unnatural images (ie;   medical images).The treatment should not introduce new light sources and should not produce halo effect and amplify blocking effect

In the paper [13] proposes a kernel based retinex algorithm. The proposed model relies on the computation of the expectation value of a suitable random variable weighted with a kernel function. I t is free from noise and hence reduce its computational complexity. It leads to ACE(Automatic Colour Equalization).

In the paper [16], perform the combination of a pure WP algorithm (Random Spray Retinex (RSR)) and an essentially GW one (Automatic Color Equalization (ACE)) leads to a more robust and better performing model (RACE). I t is based on color correction models. It lead to corruption of uniform image areas.

B. Unsharp Masking Algorithm

Guang Deng et.al [9] propsed a generalized unsharp masking algorithm . It is based on Unsharp masking algorithm. Unsharp masking is a classical tool for sharpness enhancement. proposed algorithm is able to significantly improve the contrast and sharpness of an image. Here the user can adjust the two parameters controlling the contrast , sharpness and can produce the desired results. This makes the proposed algorithm practically useful. It provides advantages like enhancing contrast ,sharpness by reducing the halo effect and out-of-range problem. But it fails to achieve good trade off between details and the naturalness.

In the work [3] they employs an adaptive filter.It controls the overall contribution of the sharpening path in such a way that contrast enhancement occurs in detail areas of image and little or no image sharpening in smooth areas. Acheive noise amplication and enhancement

C. Histogram Equalization.

Histogram equalization (HE) is simple and effective algorithm image enhancing technique. But it tends to change the brightness of the image to middle level of the permitted range, therefore it is not very suitable for consumer electronic products. The histogram of an image represents the relative frequency of occurrence of grey levels within an image . Histogram modeling is to modify the greyscale range and contrast values of image such that its intensity histogram fits a desired shape.

Chao Wang [10] in his paper which is an extension of histogram equalization. Here histogram specification, to overcome the drawback as HE. To maximize the entropy is the idea of HE and to make the histogram as flat as possible. Following that the proposed algorithm, tries to find, using variational approach, target histogram which maximizes the entropy, under constraint that the mean brightness is fixed, then it transforms the original histogram to that target one using histogram specification. It is very suitable for consumer electronics such as TV.

In the work by Haidi Ibrahim [7] proposes a new method, called brightness preserving dynamic histogram equalization (BPDHE). It is an extension to HE that produce the output image with the mean intensity almost equal to the mean intensity of the input, thus fulfill the requirement of maintaining the mean brightness of the image. It enhance the images without introducing saturation effect, changing of image focus, enhancement of the partial volume effect. and can be used in real time system. But not suitable for non-uniform illumination images.

In the paper[14] present a new contrast enhancement metric (CEM) that is trained using several simple contrast measures and mean opinion scores obtained from human observations. Goal is to train the algorithm to mimic a human when selecting an image with the best contrast between two images. The algorithm will accept two images of the same scene with differing (unknown) contrast and will choose which of the two images is 'better' according to what a human believes is 'better'.

Shuhang proposed in 2013 [15], the concept of Naturalness Preserved Enhancement Algorithm for Non-Uniform Illumination Images. The ambience of the image never be changed greatly after enhancement, no new light source should be introduced to the scene, no halo effect should be added and no blocking effect should be amplified due to over-enhancement. In this paper they propose a naturalness preserved enhancement algorithm for non-uniform illumination images which not only enhances the details of image but also preserves the naturalness. A LOE measure is proposed as well, which performs well for objective assessment on naturalness preservation

III.. COMPARISON OF THREE METHODS OF ALGORITHMS

Retinex based algorithm efficiently enhances detail and has being widely adopted. Here naturalness is essential for image enhancement to achieve pleasing perceptual quality. In order to preserve naturalness while enhancing details, an enhancement algorithm for naturalness preservation is proposed to assess enhanced images, can be introduced firstly measure for naturalness preservation. Secondly, decompose the image which insures the reflectance is restricted in the range. Thirdly, the process of illumination, that the illumination will not flood details, due to spatial variation while lightness-order is preserved.

Table 1 Comparison of various methods

Methods	Advantages	Disadvantages
Retinex based algorithms	- suffer color distortion - preserve most details	- graying out - poorly with unnatural images
Unsharp Masking Algorithm	-enhancing contrast and sharpness - practical	- fails to achieve good tradeoff between details and naturalness
Histogram equalization	-easy implementation - no severe side effects	- no naturalness

Fig 1 shows the Orginal image and enhanced output.

Fig 1 (a) Orginal image   (b) Enhanced image

IV. CONCLUSION

This paper explained the various image enhancement algorithms .The advantages and disadvantages for various techniques are also mentioned. Various image enhancement algorithms, such as the Retinex based algorithms ,the unsharp masking algorithms ,the histogram equalization (HE) algorithms ,etc., are discussed. It also specifies various metrices to assess enhancement.

REFERENCES

[1]   D. J. Jobson, Z. Rahman, and G. A. Woodell, "Properties and performance of a center/surround retinex," *IEEE Trans. Image Process.*, vol. 6, no. 3, pp. 451–462, Mar. 1996.

[2]   Z. Rahman, D. J. Jobson, and G. A. Woodell, "Multi-scale retinex for color image enhancement," in *Proc. Int. Conf. Image Process.*, Sep. 1996, pp. 1003–1006.

[3]   A. Polesel, G. Ramponi, and V. J. Mathews, "Image enhancement via adaptive unsharp masking," IEEE Trans Image Process., vol. 9, no. 3, pp. 505–510, Mar. 2000.

[4]   M. Bertalmio, V. Caselles, and E. Provenzi, "Issues about retinex theory and contrast enhancement," *Int. J. Comput. Vis.*, vol. 83, no. 1, pp. 101–119, 2009.

[5]   S. Chen and A. Beghdadi, "Natural rendering of color image based on retinex," in *Proc. IEEE Int. Conf. Image Process.*, Nov. 2009, pp. 1813–1816.

[6]   S. Chen and A. Beghdadi, "Natural enhancement of color image," *EURASIP J. Image Video Process.*, vol. 2010, pp. 175203-1– 175203-19, Jan. 2010.

[7]   H. Ibrahim and N. Kong, "Brightness preserving dynamic histogram equalization for image contrast enhancement," *IEEE Trans. Consum. Electron.*, vol. 53, no. 4, pp. 1752–1758, Nov. 2007. *Process.*, vol. 38, no. 1, pp. 35–44, 2004.

[8]   A. Polesel, G. Ramponi, and V. J. Mathews, "Image enhancement via adaptive unsharp masking," *IEEE Trans. Image Process.*, vol. 9, no. 3,pp. 505–510, Mar. 2000.

[9]   G. Deng, "A generalized unsharp masking algorithm," *IEEE Trans. Image Process.*, vol. 20, no. 5, pp. 1249–1261, May2011.

[10] D. Coltuc, P. Bolon, and J. M. Chassery, "Exact histogram specification," *IEEE Trans. Image Process.*, vol. 15, no. 5, pp. 1143–1152, May 2006.

[11] G. Thomas, D. Flores-Tapia, and S. Pistorius, "Histogram specification: A fast and flexible method to process digital images," *IEEE Trans. Instrum. Meas.*, vol. 60, no. 5, pp. 1565–1578, May 2011.

[12] T. Arici, S. Dikbas, and Y. Altunbasak, "A histogram modification framework and its Application for image contrast enhancement," *IEEE Trans. Image Process.*, vol. 18, no. 9, pp. 1921–1935, Sep. 2009.

[13] M. Bertalmio, V. Caselles, and E. Provenzi, "Issues about retinex theory and contrast enhancement," *Int. J. Comput. Vis.*, vol. 83, no. 1, pp. 101–119, 2009.

[14] K. B. Gibson and T. Q. Nguyen, "A perceptual based contrast enhancement metric using AdaBoost," in *Proc. IEEE Int. Symp. Circuits Syst.*, May 2012, pp. 1875–1878

[15] Shuhang Wang, Jin Zheng, Hai-Miao Hu, and Bo Li "Naturalness Preserved Enhancement Algorithm for Non-Uniform Illumination Images" IEEE Transaction on image processing, VOL. 22, NO. 9, SEPTEMBER 2013E.

[16] Provenzi, C. Gatta, M. Fierro, and A. Rizzi, "A spatially variant white-patch and gray-world method for color image enhancement driven bylocal contrast," IEEE Trans. Pattern Anal. Mach. Intell., vol. 30, no. 10,pp. 1757–1770, Oct. 2008.

[17] C. Wang and Z. Ye, "Brightness preserving histogram equalization with maximum entropy: A variational perspective," IEEE Trans. Consum. Electron., vol. 51, no. 4, pp. 1326–1334, Nov. 2005.