Proposed Algorithm
For Color Image Enhancement

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Abstract

This paper introduces an algorithm for image enhancement for color images. The proposed algorithm focused to improve the visibility of images , which caused from bad illumination of scenes captured by digital still camera. This algorithm is a combination of two processes which are luminance and contrast enhancement with a dynamic range compression of images. This algorithm, also ensure that remove any discontinuities may happened after processing by using a LPF as a post processing step. A comparison with a Global histogram equalization algorithm also made to verify the activity of the proposed algorithm. The proposed algorithm contains several computation steps, but taking into account the computation speed and best enhancement degree.

D Əʒzǐ

يقدّمُ هذا البحث خوارزميـةً لتحسينِ الصـورالملونةِ. ركّزتْ الخوارزميـةُ المُقتَرَحـةُ لتَحسين رؤيةِ الصورِ، الذي ينتج بسبّبَ الإضاءةِ السيئةِ للمشاهدِ التي تم التقاطها بكاميرا رقميـةِ . الخوارزميـةِ هي عبـارة عن مجموع عمليتين ، الاولـى تحسين مدى الاضـاءة والثانيـة تحسين التبـاين مَـع ضـغط المدى الديناميكي للصورِ. ان هذه الخوارزميةِ، أيضاً يَضْمنُ تجاوز أي تقطعات ممكن ان تحدث بعد المعالجة وذلك باستعمال LPF ، وذلك كخطوة بعد المعالجة . كذلك في هذا البحث تمت مقارنة النتائج مع النتائج التي يمكن ان نحصل عليها من تطيق طريقة (Global histogram equalization) . ان الخوارزمية المقترحة تحتوي على العديد من الحسابات مع الأخذ بالحسبان سرعة انجاز الحسابَات وأفضل درجةِ تحسين.

Introduction

A common problem with color imagery is that of successful capture of the dynamic range and colors seen through the viewfinder onto the acquired image. More often than not, this image is a poor rendition of the actual observed scene [1]. The basic mechanism of image enhancement for improving the visibility of the dark regions in digital images is the dynamic range compression of all the spectral bands or just the luminance of the original image. The processing of the image's luminance instead of every spectral band may be preferred for faster processing, more predictable and controllable results of the color rendition. In 1986, Edwin Land presented the last version of his retinex [2] as a model for human color constancy. The single scale of retinex (SSR)[3, 4, 5] shows exceptional promise for dynamic range compression but does not provide good tonal rendition. In fact, a distinct trade off controlled by the scale of the surround function exists between dynamic range compression and tonal rendition, and one can be improved only at the cost of reducing the other. There are many algorithms introduced for image enhancement, One of them which is widely used is the global histogram equalization[6], which adjusts the intensity histogram to approximate a uniform distribution. The main disadvantage of global histogram equalization is that the global image properties may not be appropriately applied in a local context [7]. In fact, global histogram modification treats all regions of the image equally and, thus, often yields poor local performance in terms of detail preservation. Therefore, several local image enhancement algorithms have been introduced to improve enhancement [7,8,9]. In this paper an algorithm for image enhancement is introduced, this algorithm is based on the illumination degree of the scene . This approach is bright the darkened regions and don't affect the normal brightness regions. After many experiments done may occur some discontinuities in the images processed by this algorithm, therefore we used a LPF as a post processing step to overcome this problem , but this may blurring the scene in a little degree.

Approach

The goal of image enhancement is to improve the image quality so that the resultant image is better than the original image for a specific application or set of objective.

In this section , we proposed an algorithm for enhancing color images. This algorithm can be used to enhance traditional 24 bit images as well as to compress high dynamic range images that are linear RGB images.

The first step of this algorithm is to convert an RGB image to normalized gray space , this step is useful for enhancing the computation speed of the algorithm , and can easily enhance the luminance of the image which is an essential step for enhancing images that have dark regions . The luminance enhancing is done by using nonlinear transformation shown in figure(1) , and represented by the following relation: :

$$L = \frac{I^{0.2} + (1-I) \cdot 0.7 + I^2}{2} \qquad \text{..................(1)}$$

Where I is the normalized gray scale image, and L is the luminance enhanced image.

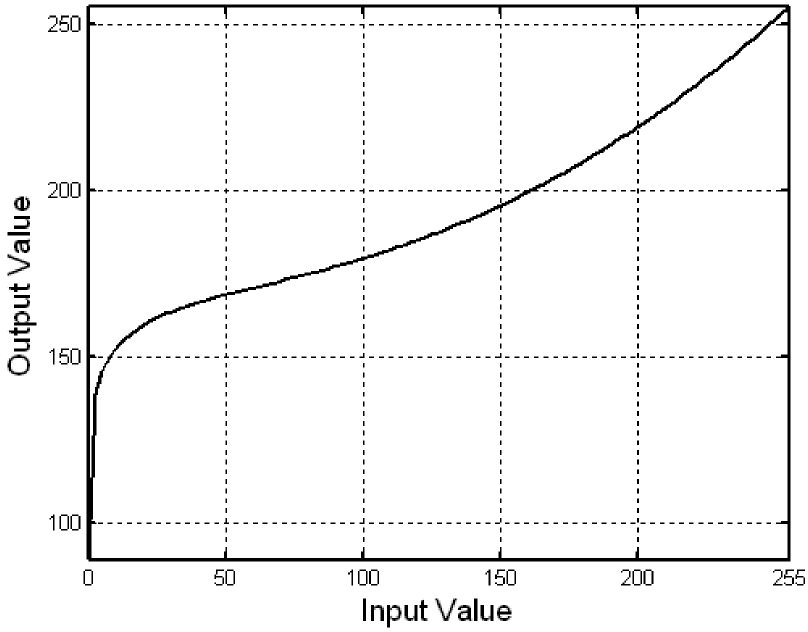

Fig.(1). Non linear transformation used in this algorithm.

Equation (1) and Fig.(1) shows that the weight of the dark pixels (approaches to zero) is high while the other pixels get lower and lower, and preserve white pixels not changed.

The second step of this algorithm is to make each pixel contains an information of the luminance of the neighbors pixels , this is done by convolving a Gaussian mask function with the gray scale image results from the first step. The Gaussian function is shown in equation (2) shown below:

$$G(x,y) = K \cdot \exp\left(\frac{-(x^2 + y^2)}{(2\sigma)^2}\right) \qquad \text{……………….(2)}$$

Where σ is the variance of the mask or may called the scale, and K is set to make the area under Gaussian curve =1 and computed from the following equation:

$$\sum\sum K \cdot \exp\left(\frac{-(x^2 + y^2)}{(2\sigma)^2}\right) = 1 \qquad \text{……………….(3)}$$

The result from convolution process is compared by the contrast enhancement process and the contrast can be enhanced for the image produced by the luminance enhancement (results from equation(1)) by using the following equation:

$$R(x,y) = 255 \cdot (L)^{r(x,y)} \qquad \text{…………………(4)}$$

Where r(x,y) is computed by the following equation :

$$r(x,y) = \frac{I'(x,y)}{L(x,y)} \qquad \text{………………(5)}$$

Where I'(x,y) is the image results from convolution process.

The last step of the algorithm is to collect the resultant color image by using a linear restoration process which is defined by the following relation :

$$R_c(x,y) = R(x,y) \cdot \frac{I_c(x,y)}{I(x,y)} \qquad \text{…………………..(6)}$$

Where $I_c(x,y)$ and $R_c(x,y)$ are input and output color images respectively and I(x,y) is the input gray scale image.

From experiments done to many images , we noticed that may happen a discontinuities in some images results from the previous process , therefore we used a LPF to overcome this problem , but this my little blurring the resultant image. The algorithm used is shown in figure(2).

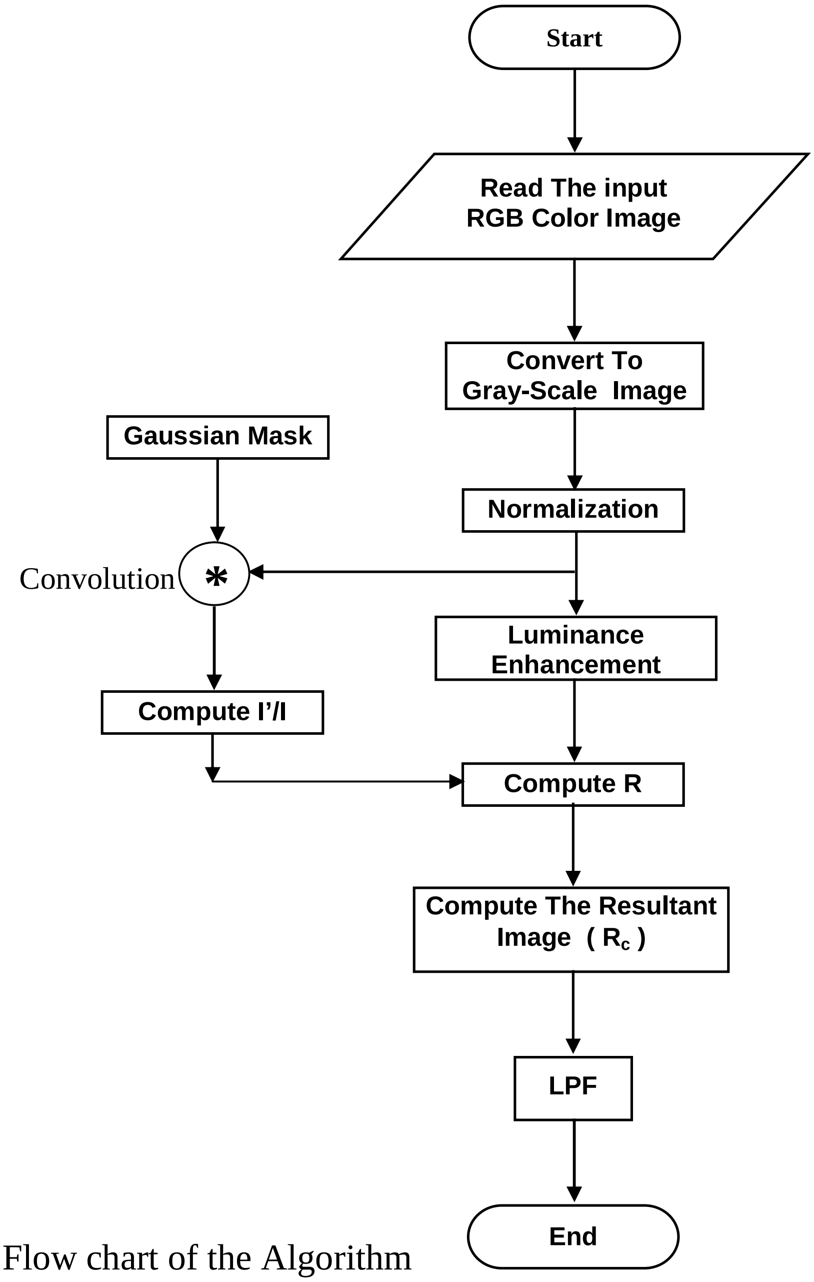

Fig.(2). Flow chart of the Algorithm

Results and Discussion

In the results we used a JPEG compressed images to evaluate the performance of the algorithm. Two of images processed by this algorithm are listed to show its performance in enhancing images with different illumination quality .Figures(3-a and 4-a) show two images with a gray resolution of 8 bits. The enhanced images obtained by global histogram equalization(GHE) method shown in figures (3-b and 4-b), while images produced by the proposed algorithm shown in figures (3-c,3-d,4-c, and 4-d). Images in figures (3-c,and 4-c) shown an enhanced images without using a LPF , and shows a good enhancing degree and making an illumination uniform , and the features of images are cleared with a comparison of the original two images. The comparison with images obtained by global histogram equalization also shows that these images suffering from bad illumination and some features not cleared. We can notice from these figures that's the proposed algorithm gives best compromise between illumination degree and features detection or features clearing. Some discontinuities may results from the process , as we explained by the previous sections we used a LPF to remove that , these results are shown in figures (3-d,and 4-d). These figures shows little blurring in the resultant two images but not happened with high degree. Also by comparing the resultant with original images , both histogram equalization and proposed algorithm produced an enhanced images with clearer details and better visual quality , but in histogram equalization some regions of images are overly darkened and the other are overly lightened (figures (3-b and 4-b)).The overall comparison shows that the proposed algorithm is better than the histogram equalization algorithm.

Conclusions

The algorithm which is presented is focused and gives better performance essentially for bad lighting images , also make a balance between lighting degree and contrast enhancement degree. By experiments done we noticed that the algorithm improves the visibility and features of images . the comparison with GHE algorithm shows that the proposed algorithm has better performance .

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