American Journal of Pharmaceutics.
1(1):1-4, August 2019

Review paper

A Comprehensive Study of Retinex Based Image Enhancement Techniques

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To cite this article: Mahalakshmi Badiginchala, Shaik Taz Mahaboob and K.Siva Chandra. A comprehensive study of retinex based image enhancement techniques. American Journal of Nano Science and Technology, 1(1):1-3, May –June 2019

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Received: 18th May 2019.| Revised: 24th May 2019.| Accepted: 30th June 2019.

Abstract: Image enhancement is often defined as one of the most significant problems or challenges in the field of image processing. Retinex enhancement is a standard procedure utilized for improvising the contrast feature of an image and is an effectual and a simple technique for enhancing a particular image. However, the standard procedures employed in enhancing the contrast feature of an image exceeds at the time, which creates an unnatural look and the visual elements of the image appear to be processed. This paper explores and analyzes the new methods of retinex adopted for the enhancement of the image. Differences between these methods are gauged on the basis of the criterions that are utilized for removing noise from the image and enhancing it.

Keywords: Conventional retinex, Denoising, Image enhancement, Retinex enhancement, Visual artifacts.

1. Introduction

Image enhancement can be defined as a process that is used for altering or changing the pixels of the image and intensifies the input image so that a better and enhanced output image can be generated **[1].** The main objective of this technique is to improvise the interpretation of the information present within the image so that a better output image can be generated for the viewers. Also, this technique is used to generate a better quality image which can be employed for the automation of other image processing techniques or methods.

Key Applications

- Forensic Sciences
- Biomedical
- Robotic vision
- Machine vision
- Health sciences
- Low vision interpretation that consists of an electronic display

Numerous methods have been proposed for enhancing images, amongst which a popular method is retinex algorithms. It is a standard method that is used for enhancing the image because it is simple in its working and performs comparatively better on all forms or types of the image. Retinex is a conception that is grounded upon the algorithms used for image enhancement and helps in changing the sharpness as well as the brightness of the image through the method of Dynamic variety compression. It also allows a color steady output image and helps in eliminating high levels of luminance from the image setting. This method also joins the color fidelity with evaluation enhancement. The unique retinex is grounded upon a model that allows precision and color fidelity. Retinex is a grouping that encompasses a set of middle setting capabilities. The Retinex principle is offered via Land **[2], [3].**it is the maximum influential of the visible effect based enhancement strategies, and is an effectual method for enhancing the image. Retinex theory can hold the stability of enhancement impact most of the dynamic variety compression, face enhancement, and shade constancy. Now, Retinex theory is widely used to decorate night photograph, fog photo, rain photograph, infrared image, far-flung sensing image, and so on. The traditional retinex image enhancement algorithms are direction-based totally retinex algorithms **[4], [5],** version retinex set of rules [6], middle/surround retinex set of rules **[7] - [9]** etc. however, these are hard to discover Illuminance and reflectance completely.

In section II, the discussion of literature evaluate is done. In section III, the assessment of various image enhancement techniques is finished. In segment IV, the review of various enhancement strategies is concluded, observed by using the references used.

2. Literature Review

The research that has been conducted on the initial level of the undertaking assisted in the creation of single scale retinex (SSR) **[10].** This scale is based upon the algorithm related to retinex and provided dynamic range compression as well as high color constancy. However, one limitation of this scale is that it can provide only one feature from tonal rendition and Dynamic range compression and fails in providing both at the same time which leads to color alteration.

The research **[11]** utilizes a combination of a multi-scale retinex (MSR) which incorporates numerous versions of the local Retinex. This research combined several outputs of SSR and can be defined as a multi-level form of the local Retinex. MSR amalgamates small scale Retinex of the dynamic range compression that has tonal rendition at a large-scale retinex. The benefits of this are that it provides both tonal renditions as well as the dynamic range compression by keeping intact the details. Also, the Haloing objects are removed, however, the tonal rendition of the scene loses its uniformity and have gray-out patches, making the quality of the image poor.

Multi-Scale Retinex with color recovery (MSRCR) can be referred as an ideal or perfect option for images that are gray, however, it can be problematic for the colored inputs and the relative intensities of the color bands. This can be understood through the MSR method in which the output consists of a unique domain of the relative reflectance. While talking about the gray images in which the average depth of the three shade band is not quite the same, the output drawn from the MSR have very close bands or channels which makes the output greyer. The solution to this problem is to present the weights of the three color bands or channels depending on their relative depth in the original image **[12].**

The MSRCR plays top enhancement in maximum photos, the output image can once in a while be further visually optimized at some stage in our experiments. An advanced MSRCR+ Auto levels (AL**) [13]** set of rules is offered, that can help in dealing with the impact of a limited assortment of outliers present in the image histogram and helps in enhancing the contrast feature of the output. The new extension assists in improvising the visual presentation of the MSRCR set of rules. Nonetheless, the MSRCR+AL encompasses a large number of multifaceted calculations that are computed, low-priced and have little application real-time situations.

In NECI **[14],** Image enhancement can help in dealing with any changes within the image mainly related to light setting, color temperature modification or any other items within the image that have MSR algorithm. It is a very good option for outputs that are natural and is not a very good option for images that are unnatural. Shaohua Chen et.al **[15]** suggested a new technique for rendering a natural colored image with the help of Retinex (NRCIR). The word natural over here can be defined as the overall ambiance of a particular image (whether warm or cool color) and should not be confused with image enhancing. While combining the one-filter retinex with the histogram, image rescaling can help in improving the overall natural look of the image.

Though this suggested technique is not a very good option for unnatural images such as medical images. The changes or the treatment of the image should add additional light sources and should not create a Halo effect, by the amplification of the blocking impact within the image. In the research paper **[16]** a method has been suggested that is grounded upon the retinex algorithm. This method is based upon the calculation of the anticipated value or variable within an appropriate random value that is weighted with the help of the kernel operation or function. This calculation is free from noise and reduced the complexity within the calculation and also directs to the ACE (Automatic Color Equalization). In the research paper **[17],** a combination of the WP. WP algorithm (Random Spray Retinex (RSR)) and with a GW (Automatic Color Equalization (ACE) helps in the creation of a performance framework known as RACE which is a color correcting method. However, this method can have an effect upon the uniformity of the image.

In order to deal with these above-mentioned issues which include making slight modifications in the image or eliminating the stationary objects in the background, a method can be used that can help in making estimations in relation to reflectance or illumination within recordings known as the illumination-reflectance version (IRM) **[18].** This method is popular for estimating the illumination and reflectance levels within an image. However computing both these components within an image is quite a difficult task, as it encompasses a number of unknown aspects or factors like light description within the scenery etc.

3. Performance Analysis

On this section, we evaluate three algorithms (MSRCR, MSRCR+AL, and IRME) with the aid of measuring SNR, PSNR, and MSE. We also incorporate a subsequent dataset that consist of four images: NASA image dataset (disposing of three fog images), Litao photograph dataset **[19],** BJTU IE image dataset (captured in BJTU) and HSRI (excessive velocity Railway Inspection) image dataset. The smaller fee of MSE manner the higher de-noising impact, even as the larger price of PSNR and SNR constitute the higher de-noising influence.

Table -1: Comparison of various Retinex based methods

S.No	Methods	Measuring Parameters	Advantages	disadvantages
1	SSR	PSNR(dB)-10.8351 SSIM-0.1108	It helps in providing color reliability or constancy	Can suffer color misrepresentation.
2	MSR	PSNR(dB)-12.8166 SSIM-0.4472	It provides tonal rendition as well as the dynamic range compression	Only appropriate for gray scale images
3	MSRCR	PSNR(dB)-12.0913 SSIM-0.2573	Reduces the halo object or effect from the image	It is quite problematic to recognize the details as well as the edges of the image while making an estimation of how much noise needs to be reduced and how much illumination is required in the image.
4	MSRCR+AL	PSNR(dB)-14.2416 SSIM-0.5895	Helps in enhancing the visual presentation of the MSRCR algorithm	Performing a large quantity of calculations can be expensive. Also, it has limited applications in real time situations.
5	IRME	PSNR(dB)-24.441 SSIM-8.477	Reduces the light changes and motionless objects	It involves many unknown factors difficult to compute.
6	IRME guided	PSNR(dB)-25.935 SSIM-9.971	Preserves sharp edges as well as existing global filters.	Amplify noise.

4. Conclusion

This research paper presents a variety of retinex primarily based upon the image enhancement methods that can be incorporated. Traditional retinex algorithms recollect the best luminance which can help in increasing the noise. But details within the image can be inappropriate for the methods that are employed for removing the noise. So we should further use a de-noising set of rules. But most de-noising algorithms can be harmful to the details within the image and can be problematic in enhancing the image before the de-noising process. Additionally, there can be a problem if you opt for image de-noising before the image enhancement process, particularly for distinguishing the noise element within a low-quality image setting. To triumph over those problems, in subsequent work, we can further optimize the algorithm with enhancement and de-noising will perform at the same time.

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