Images Enhancement for Low Lightness by Using Hybrid Retinex Wavelet Methods

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Abstract

This study focused on low lightness effect on captured images using two types of cameras (Samsung Camera (SM-Cam) and Sony Camera (SN-Cam)). Lighting environment is controlled by a lighting system depending on three fluorescents of light with different sizes and power. Three different images studied like chart color block and colored flowers. The outline of this paper divided to: **First**: Enhancement of lighting and contrast for images (colored test images and flower images) depending on three methods (Histogram Equalization, Retinex method and introduced method combined between (Retinex and wavelet) and depending on enhancement results and quality inspection standards for the image, the best method for enhancement is the introduce method then Retinex method then the Histogram Equalization method. **Second**: removing the noise by using traditional filters (mean and medium) and after removing the noise the efficiency of filters has been calculated by using two parameters (μ and σ) for the Homogeneous regions, where the best filter found to be is the mean filter.

Keywords: Histogram Equalization, Images Lightness, Lux meter, Retinex, Wavelet, Quality factor

الخلاصة:

هذه الدراسه تركيزت على تأثيرالاضاءة الخافتة على الصور الملتقطة باستخدام نوعين من الكاميرات (سامسونج وسوني) حيث تم التحكم بالاضاءة بأعتماد منظومة اضاءة تعتمد على ثلاث مصابيح فلورسنت مختلفة الاحجام والقدرة ، حيث تم دراسة صور مختلفة (بلوكات ملونه و زهورمختلفه

الالون). بعد ذلك تم التوجه في العمل الى حاللتين دراسيتين.**أولاً**:تحسين الإضاءة والتباين في الصور (الصور الاختبارية الملونة وصور الازهار) بالأعتماد على ثلاث طرق (مساواة المخطط التكراري ، طريقة ريتنكس وطريقة مستحدثة تدمج بين ريتنكس و ويفلت) ومن خلال النتائج التحسين ونتائج معايير فحص الجودة للصورة تبين أن أفضل طريقة للتحسين هي طريقة المستحدثة ثم طريقة ريتنكس يليها طريقه مساواة المخطط التكراري. **ثانياً**: ازالة الضوضاء بأعتماد مرشحين تقليديين (المعدل والوسيط) وبعد ازالة الضوضاء تم حساب كفاءة المرشحات بالأعتماد على معيارين (μ, σ) للمناطق المتجانسة وتبين بأن افضل مرشح هو مرشح المعدل.

1. Introduction

The amount of light coming from an object to the eye depends on light that striking from the surface, and on the amount of light that is reflected. Human eyes made a single measurement of luminance, acting as a detector, then there would be no way to separate a white surface in dim light from a black surface in bright light. However, our eyes can usually do that, and this behavior is known as lightness constancy [1]. Most vision applications such as surveillance, security, etc. required robust detection of image features. Images taken under low-light conditions (e.g. night time, indoor and underexposure), affected by poor lightness and severely distorted color and thus result with very little scene information. Therefore, it is important to correct image lightness, contrast and color fidelity in order to provide a clearer view of the scene in order to make vision systems more reliable [2].

Illumination considered an important factor that affect image quality during digitization image scene in the real world. Image quality assessment affected by level, type, distribution and uniformity of illumination. Hence, various image processing algorithm developed to recover the meaningful information of an imaged that captured under change light conditions. Algorithms based on integrated neighborhood dependency of pixel characteristics as well as on the illumination reflectance model that performed well for enhancement visual quality of digital images captured under non uniform or extremely low high conditions [3]. It was used in this study three algorithms (Histogram equalization algorithm method [4], retenix algorithm [5], and Hybrid Retinex Wavelet Methods which will be explained later.

The previous works within this search focus on the enhancement study of color images captured under low lighting conditions. A brief description to each of them is:

- ***Rajlaxmi Ch., et al. (2012)*** proposed a dynamic stochastic resonance (DSR)-based technique in discrete wavelet transform (DWT) domain. This technique is used enhance very dark grayscale and colored images. The resulted image compared with common enhancement techniques such as histogram equalization, gamma correction, single-scale retinex, multi-scale retinex, modified high-pass filtering and Fourier-based DSR. DWT-based DSR technique give better performance in terms of visual information, color preservation and computational complexity of the enhancement process [6].

- ***Ruchika Mishra et al. (2014)*** presented a new method to improve the contrast and intensity of the image data. The method employs that the discrete wavelet transform with Kernel adaptive filtering. The performance of this algorithm analyzed and compared between EME and PSNR using simulator MATLAB 2009A [7].
- ***Devanand Bhonsle et al. (2015)*** introduced a bivariate threshold technique based dual tree complex Wavelet transform (DTCWT) to remove both additive and multiplicative noise. Since both noise types are different in nature, therefore, it is difficult to remove both noise types by using single filter. Hence, two different filters are required to remove noise from medical images which are corrupted by either noises simultaneously [8].

2. Wavelet Transformation (WT)

The wavelet transform provides a framework to decompose (also called analysis) images into a number of new images, each one of them with a different degree of resolution as well as a perfect reconstruction of the signal (also called synthesis). Wavelet-based methods Multi-resolution or multi-scale method is a mathematical tool developed in the field of signal processing [9]. Wavelet-based approaches show some favorable properties compared to the Fourier transform [10]. While the Fourier transform gives an idea of the frequency content in the image, the wavelet representation is an intermediate representation between the Fourier and the spatial representation, and it can provide good localization in both frequency and space domains [11]. Furthermore, the multi-resolution nature of the wavelet transforms allows for control of fusion quality by controlling the number of resolutions [12] as well as the wavelet transform does not operate on color images directly so can be transformed the color image from RGB domain to another domain. The 2D discrete wavelet transform, F (u, v) of an image I(x, y) is given by [13]:

$$F(a_1, b_1, a_2, b_1) = \sum_{x=1}^{M-1} \sum_{y=1}^{N-1} I(x,y) \frac{1}{\sqrt{b_1\, b_2}}\, \psi\left(\frac{x-a_1}{b_1}, \frac{y-a_2}{b_2}\right) \qquad (1)$$

Where $\frac{1}{\sqrt{b_1 b_2}} \psi$ represents a specific type of wavelet with scaling and shifting in x and y axes as (a_1, b_1) and (a_2, b_2), respectively. The inverse wavelet transform is used to reconstruct the function from its wavelet representation. This is represented as follows [13]:

$$I(x,y) = \sum_{a_1=0}^{A_1-1} \sum_{b_1=0}^{b_1-1} \sum_{a_2=0}^{A_2-1} \cdot \sum_{b_2=0}^{b_2-1} F(a_1,b_1,a_2,b_1) \frac{1}{\sqrt{b_1 b_2}} \psi^{-1} \left(\frac{x-a_1}{b_1}, \frac{y-a_2}{b_2} \right) \quad (2)$$

Discrete wavelet analysis is usually computed using the concept of filter banks. Filters of different cutoff frequencies analyze the signal at different scales. Resolution is changed by the filtering, the scale is changed by up sampling and down sampling. If a signal is put through two filters [13]:

- High-pass filter—High-frequency information is retained, low frequency information is lost
- Low-pass filter—Low-frequency information is retained, high frequency information is lost.

3. Image Quality Assessment

The image quality assessment is important process to determining the level of enhancement, in this section, many algorithms will present to assess the quality of the color image based in lightness change such as Structural Similarity Index Metric (SSIM), local mean and standard deviation (μ, σ) model, and quality factor (QF) assessment.

3.1 Quality Factor (QF)

In this method the image quality has determined depending on edge regions for lightness component in RGB basic color space. it can be write as[5]:

$$y = 0.299r + 0.587g + 0.114b \quad (1)$$

Where the edge image gets by using Sobel edge detection with two kernels [14]: So, edge image can be determined using [14]:

$$f_x = y \otimes M_x \quad (2)$$

$$f_y = y \otimes M_y \quad (3)$$

$$E_i = \sqrt{f_x^2 + f_y^2} \qquad (4)$$

Where M_x, M_y being horizontal and vertical of Sobel kernel and E_i is the edge image. The edge determined in the image depending on threshold value *(th)* from (0 to 255) or (0 to 1) if the image is normalized. Let n_b is the number of black pixel and n_w the number of white pixel the contrast factor given by:

$$CF(th) = \begin{cases} 1 & \text{if } n_w = nb \\ \dfrac{\min(n_w, n_b)}{\max(n_w, n_b)} & \text{if } n_w \neq nb \end{cases} \qquad (5)$$

This means that the maximum value of contrast factor is *CF* =1 (high contrast), and the minimum value is near to zero (low contrast). The contrast factor is the function of threshold value (*th*), where the threshold value variety form (0 to 255) the relationship between *CF* and *th* is the logarithmic normal distribution, this distribution is used when the data have a lower limit and the general form [14]

$$[CF(th) = a + b * n\,(1 - n)] \qquad (6)$$

$$n = e^{\frac{-(x-c)}{d}} \qquad (7)$$

Where *a, b, c* and *d* are constants dependent on distribution (locally and globally) contrast and lightness in the image, if we attempt to determine *CF* would be used a large number of images captured with different lightness levels it has different standard deviation [14].

The Quality Factor *(QF)* is determined by area under the curve that is given by summation of the contrast factor *CF (th)* over all threshold value *(th)*.

$$QF = \sum_{th=0}^{255} CF(th) \qquad (8)$$

That is obtained by using a trapezoidal numerical integration rule.

4. Experimental

Experimental and algorithms are discussed within this chapter. This chapter has two parts: The first part is the experimental setup of the lighting system belonging to the distribution of the lightness and features of images. These images are captured under the fluorescent lightness systems. The benefit of this setup is to control the exposure light from low to moderate lightness and from moderate to high lightness levels on test images. Second part includes image enhancement algorithms. All algorithms and calculations are implemented using Matlab version 7.14 (2012a), and fitting processes are implemented using table curve version 5.01, (2007).

4.1 Lighting Systems and Images Features

There are many images that used within this study. The summarized details as follow:

1- Test Color chart blocks image as shown in fig. (1a).
2- Flowers color image as shown in fig. (1 b).

These images are placed at a distance one meter in front of the two cameras type (SN-Cam and SM-Cam) and the light source placed behind the cameras. The light source is consist of three fluorescent lamps. The reached light to the target image from the light source measured by using Lux meter device as shown in fig. (2). Then images captured in different lighting condition depending on the Lux meter value. These images are saved in JPEG format and size of (640×480 pixel).


(a)


(a)

Fig (1) The utilized images: (a) Test Black and White target image (b) Test color chart blocks images (c) Flowers color images

Fig. (2): Imaging System for Variant Lighting Condition.

5. Image Enhancement Algorithms

Enhancement process to captured images under low lightness conditions is performed by using three methods. First algorithm is the Histogram equalization (H.E). Second algorithm is Retinex algorithm (R), (both of them mentioned see [4] and [5]. Third algorithm introduced to improve Retinex algorithm by merging with wavelet (RW). Using wavelet transform (WT) for the color images is to convert the compounds (LL, LH, HL, and HH). After that, Retinex algorithm applied to improve the first composite (LL) for Three band of color (LLR, LLG, LLB), and implement the inverse conversion on all images. The suggested algorithm is shown in the following steps:

"Algorithm 1: Enhancement using hybrid Retinex wavelet methods"

Input: Image (img)

Output: Image Enhancement by wavelet

Start:

1. Load image (img). img (h w i)
2. Wavelet transformtion (WT) for each Compounds i=(r,g,b) to get (LL_i, LHi, HLi, HHi).
3. Apply retenx for (i) is Compounds (LL).
4. Apply inverse wavelet transformation (IWT).
5. **End algorithm**.

6. Filtering Image Noise

It is an understanding that the captured image under low lightness is accompanied with different types of noise. In this study, using two types of filters to reduce this noise by applying (mean and median) filters algorithms. Where 12 blocks have been extracted from the homogeneous targeted images in different regions for the image see fig (3) and applied algorithms on the enhanced images. Steps of this algorithm are:

Figure (3) 12 blocks on different regains

"Algorithm 2: Median filter"

Input: 1. Image (img), RGB color of size (S).
2. The number of images n.

Output: filtering image, same size of (img).

Start:

1. Stare loop from i = 1 to n.
2. Load image (img).
3. Convert RGB color values (img), to color space, YIQ, where the luminance Y is the intensity of the signal, and other component scary, I & Q, are the hue and saturation information. Using the following equation:

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

4. Apply median filter only for Y compound (YIQ). Each output pixel contains the median value in the (7x7) neighborhood around the corresponding pixel in (img).
5. Convert YIQ image to RGB image.
6. Save filtering image.
7. End loop.
8. **End algorithm.**

7. Enhancement Results for Color Image

Images that captured under low lightness (i.e. low quality images), always noisy and have low contrast. This leads to lose its original color, features, and information. Image enhancement is an important process to improve image quality by computer aided. In this work, three algorithms (HE, R and W) are used to enhance color images with different lightness. Two camera types (SM-Cam and SN-Cam) used to capture images under lightness (L = 1 - 10, 15, 20, 30, 40, 60, 80, and 120) Lux. Two test images were used color test chart image and flowers image. The captured images enhanced by three ways H.E., Retinex, and W.R. Results demonstrated by the following subsections.

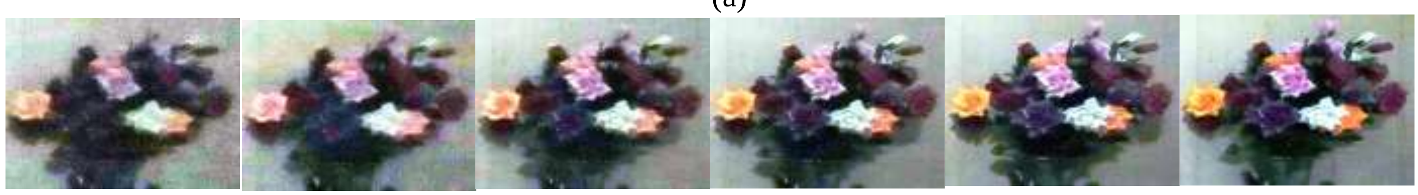
7.1 H.E. Enhancement Result

Figures (4 and 5) show enhanced images using H.E algorithms for the captured images under low lightness for the two test images (test color chart image and flower image). The resulted images improved by means of contrast and illumination. The enhancement image results for SN-Cam show are better than SM-Cam. By comparing enhancement images result with the original captured images (with good lightness), the enhancement process gives good quality images, but of course not reach to the quality of original good images.

The enhanced images by using (H.E.) method for SM-Cam are better than SN-Cam. The aspect of mathematical result enhanced images for (SN-Cam) is better also than the result of the enhanced images for (SM-Cam) according to the quality assessment methods that used in this study. For color enhancement due to the saturation (ratio of color to white), the colors dark owns satiated little affected more distortion resulting from a low lightness, while light colored have high satiation shall be affected by lower, for that reason be best result when enhancement.

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)



L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5 Lux L=6 Lux

(b)

Figure (4): The enhanced images by H.E. algorithm for captured images by SM-Cam under low lightness values. (a) Test color chart enhancement image, (b) Flowers enhanced Images

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(b)

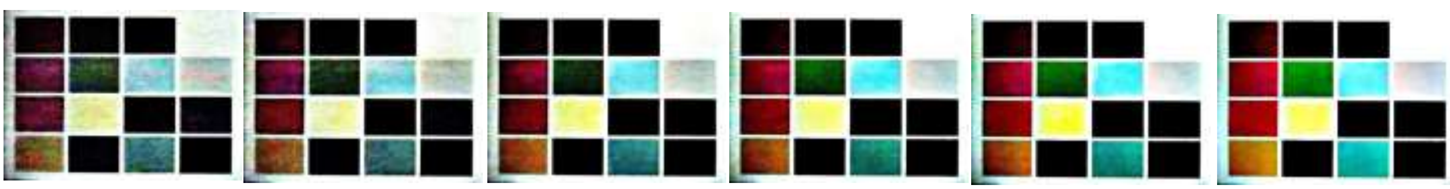
Figure (5): The enhanced images by H.E. Algorithm for captured images by SN-Cam under low lightness values. (a) Test color chart enhancement image, (b) Flowers enhanced Images

7.2 Retinex (R) Enhancement Results

The resulted enhancement images by using R algorithms for the captured images under low lightness by the SM-Cam and SN-Cam demonstrated in figs. (6, and 7) for the two images (test color chart image and flower image). Where can be noted that the images and improved in its appearance (contrast and lightness), but the enhancement results for SM-Cam images are always better than that of SN-Cam images.

By comparing the resulted enhancement images with the original captured images with good lightness, can be seen that the enhancement process are given good quality images, but not reached to the quality of original good images.

The enhanced images by using (R) for the images that captured by the two types camera (SM-Cam and SN-Cam), can be seen visually the resulted images for SM-Cam are so good with respect to the resulted images for SN-Cam. The aspect of mathematical result enhanced images for (SN-Cam) is better also than the result of the enhanced images for (SM-Cam) according by methods image quality assessment used in this study. Distortion resulting from a low lightness while light colored have high satiation shall be affected by lower, for that reason be best result when enhancement.



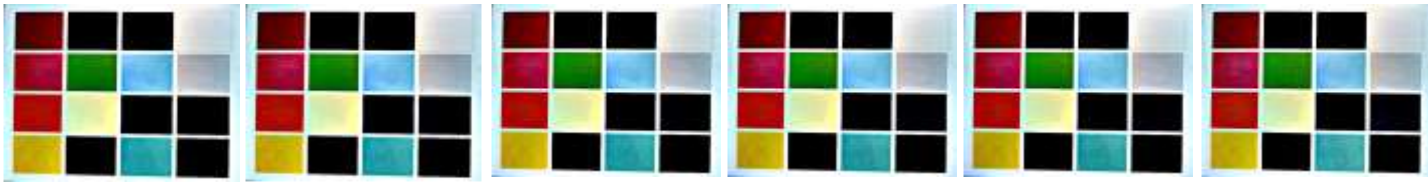
L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5 Lux L=6 Lux

(b)

Figure (6): The enhanced images by Retinx (R) algorithm for captured images by SM-Cam under low lightness values.(a) Test color chart enhancement image,(b) Flowers enhanced Images



L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5 Lux L=6 Lux

(b)

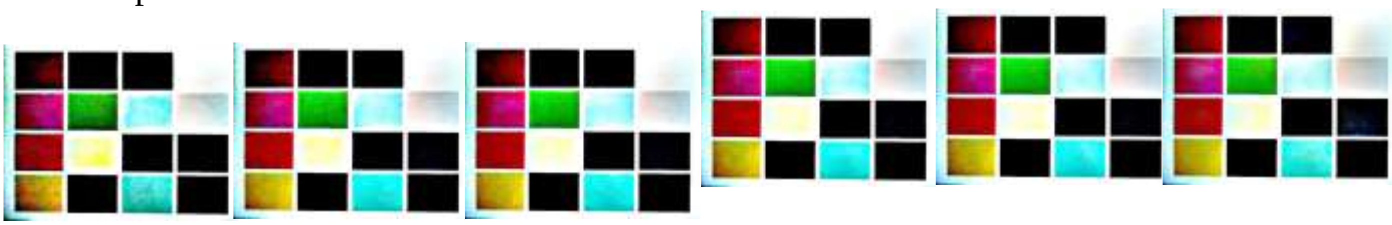
Figure (7): The enhanced images by H.E. Algorithm for captured images by SN-Cam under low lightness values. (a) Test color chart enhancement image, (b) Flowers enhanced Images

7.3 The Suggest Modify Retinex and Wavelet (M.R.W) Results

The resulted enhancement images from applying M.R.W algorithms for the captured images under low lightness by the SM-Cam and SN-Cam demonstrated in figs. (8, and 9) for the two images (test color chart image and flower image). Where can be noted that the images and improved in its appearance (contrast and illumination), but the enhancement results for SN-Cam images are always better than that of SM-Cam images. By comparing the resulted enhancement images with the original captured images with good lightness, can be seen that the enhancement process are given good quality images, but not reached to the quality of original good images.

The enhanced images by using (M.R.W) for the images that captured by the two types camera (SM-Cam and SN-Cam), can be seen visually the resulted images for SM-Cam are so good with respect to the resulted images for SN-Cam. The aspect of mathematical result enhanced images for (SN-Cam) is better also than the result of the enhanced images for (SM-Cam) according by methods image quality assessment used in this study. Where the colors dark owns satiated little affected more distortion resulting from a low lightness while light colored have high satiation shall be affected by lower, for that reason be best result when enhancement.

From the above results can be comparing between the three enhancement methods, where noted that the modify algorithm (M.R.W) is better than other methods (R) then (H.E.) because it has enabled to restore and achieved a balance in colors, increase the lightness strongly, resolution and contrast in images wonderfully. Where the basic and secondary color appear true, this is a good indicator at enhancement the images debilitating and low lightness. In addition, the quantitative comparisons and assess of quality will be explained later.



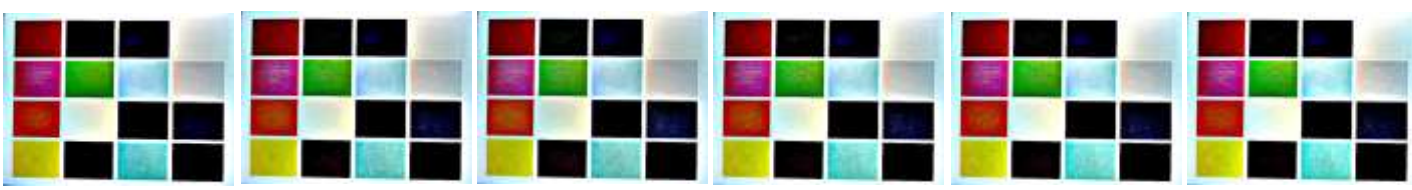
L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5 Lux L=6 Lux

(b)

Figure (8): The enhanced images by (W.R) algorithm for captured images by SM-Cam under low lightness values. (a) Test color chart enhancement image, (b) Flowers enhanced Images



L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5Lux L=6 Lux

(a)

L=1 Lux L=2 Lux L=3 Lux L=4 Lux L=5 Lux L=6 Lux

(b)

Figure (9): The enhanced images by (W.R) algorithm for captured images by SN-Cam under low lightness values. (a) Test color chart enhancement image, (b) Flowers enhanced Images

8. Image Quality Assessments Results

In this study, have been used many examination of quality measures to estimate of enhancement images. Firstly used structural similarity index (SSIM) assessment measure, secondly Quality Factor (QF) measure, and finally the Mean of locally (μ, σ) model measure.

8.1 Structural Similarity (SSIM) Assessment

Fig. (10) shown the relationship between (SSIM) and different lightness (L) for original (color charts and flowers) images captured by SM-Cam and SN-Cam.

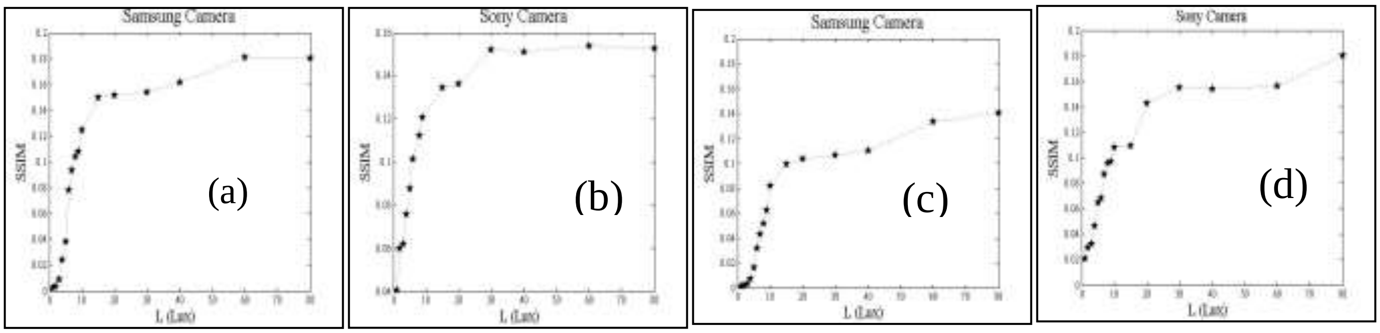


Figure (10): The quality assessment measure SSIM as function of lightness for original image. (a) chart color image captured by SM-Cam, (b) flowers image captured by SM-Cam, and original flower image(c) chart color image captured by SN-Cam, (d) flowers image captured by SN-Cam.

8.2 Quality Factor (QF) Assessment

Fig. (11) show the relation of QF results with different lightness (L) for (test color chart image, and the flowers images) captured by SM-Cam and SN-Cam for original image and the enhanced images by the three method (H.E., R, and M.R.W) Through results, it is obviously most enhancement algorithms have produced good quality when compared to the original images degraded. The comparison between the enhancements method it is observed that (M.R.W) algorithms better than others because of that this method based on colors restoration and largely increase the luminance for the dark pixels.

Also can be noted that (QF) for enhanced images by (M.R.W and R) is increased with the increase the lightness (L) to reach (20 lux) and then very slightly increased long range of L- values. While (QF) for enhanced images by (H.E) is fixed straight line horizontal with the increase in (L) where the best method to image enhancement under low lightness according to (QF) is (M.R.W) then (R), and (H.E).

The comparison between QF for SM -Cam image and SN-Cam image, can be noted that (SN-Cam) give better quality factor value, where seen from (QF) figure (11).

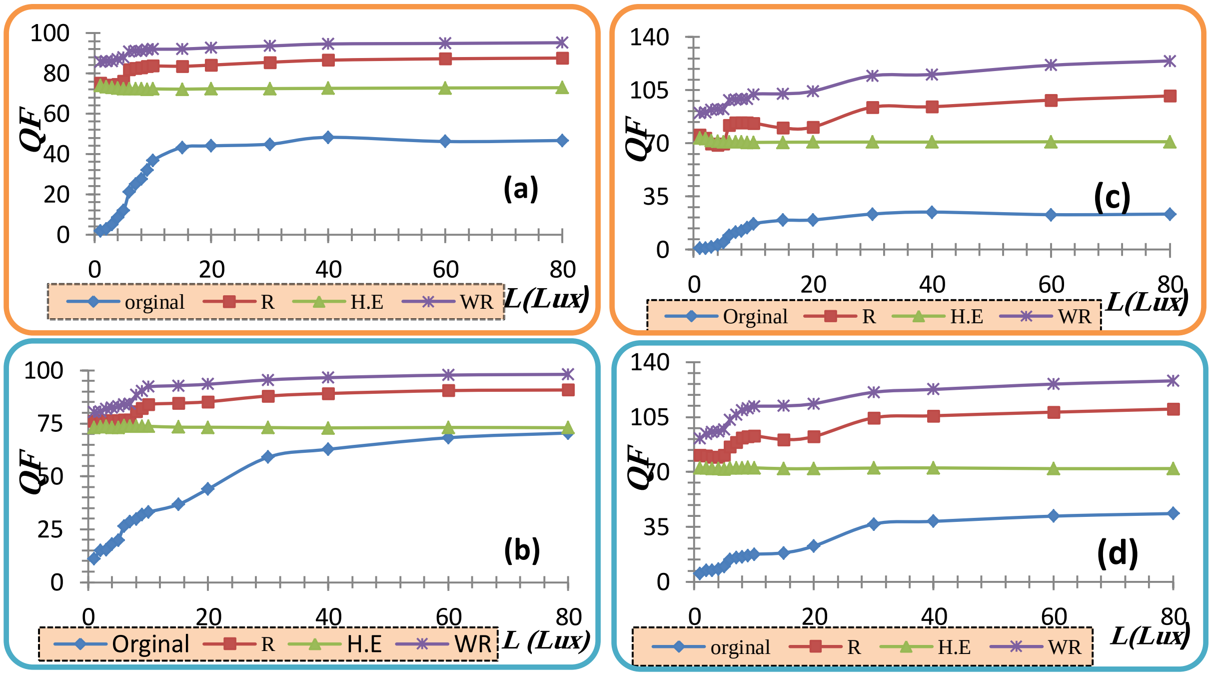


Fig (11): Shows the relationship between (QF) and (L) for enhance test colored image chart image that captured by: (a) SM-Cam (b) SN-Cam and flowers images that captured by: (c) SM-Cam (d) SN-Cam.

8.3 Mean of Locally (μ, σ) Model

Mean of locally (μ, σ) measure model results for the original images and enhancement images by the three algorithm (H.E., R., and M.R.W) for the two images (color test chart image and flowers image) for two types camera (SM-Cam and SN-Cam) as a function of lightness (L). Shown in figs. (12) - (13) respectively. From these figures can be seen that the relationship between mean of local standard deviation and mean for image are illustrated in figs. (14) - (15). One can illation that the (M.R.W) are good methods to enhanced low lightness color image in terms of lighting and contrast (tend to visual ideal region).

Through the figs. (12) - (15) noted that the best results for the enhanced images by methods is the suggested method (M.R.W), Where the ($\bar{\mu}$, and $\bar{\sigma}$) values is higher than the (R and H.E). Where the resulted enhanced images by (M.R.W) method is in the perfect position as in figs.((12) - (15)) followed by (R) gives a better way than (H.E).

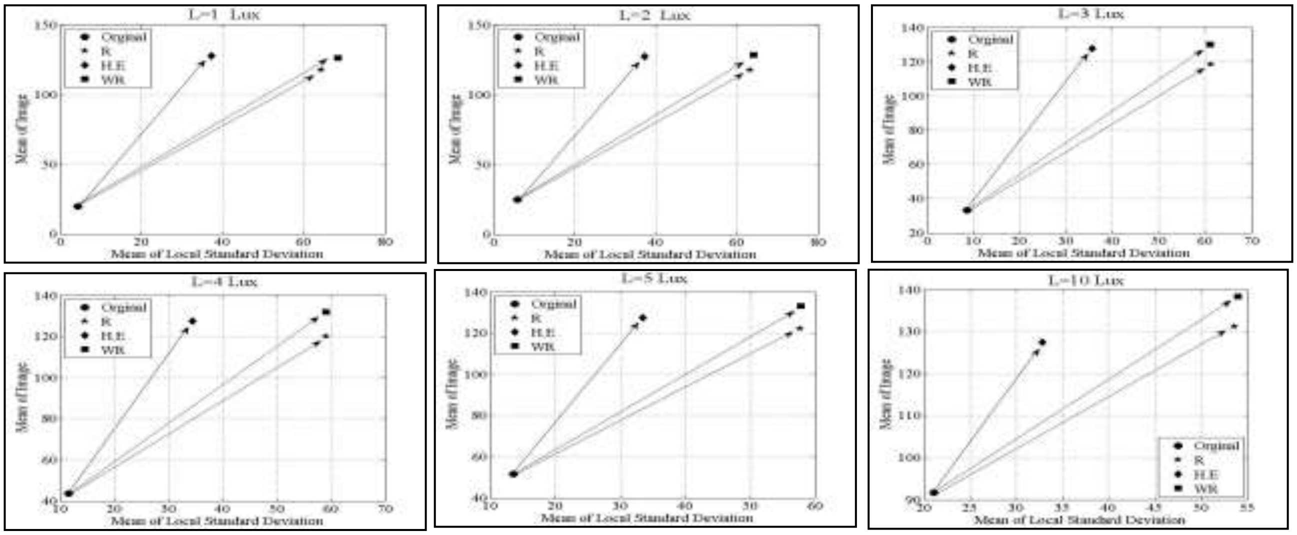


Figure (12): Shows the Mean of locally (μ, σ) model for original and enhanced images for test color chart image by captured by SM-Cam at different lightness.

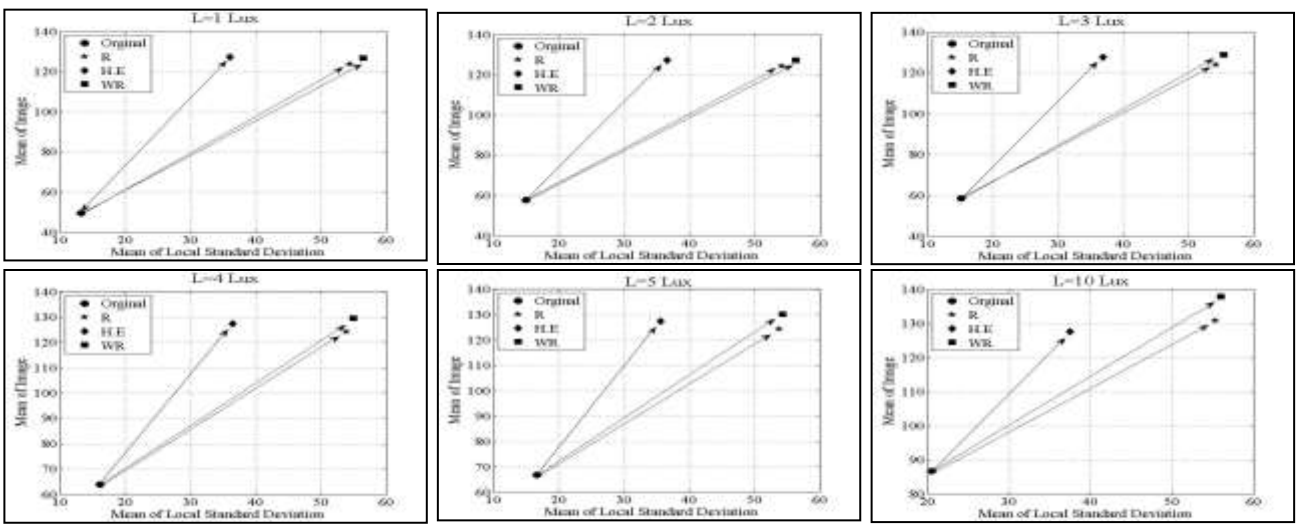


Figure (13): Shows the Mean of locally (μ, σ) model for original and enhanced images for test color chart image by captured by SN-Cam at different lightness.

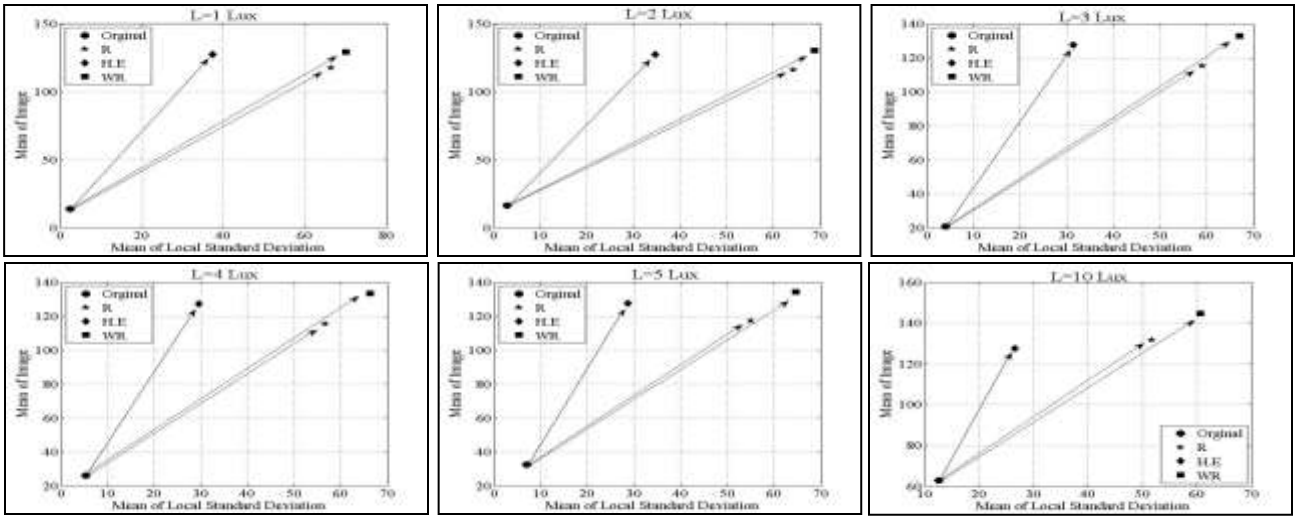


__Figure (14): Shows the Mean of locally (μ, σ) model for original and enhanced images for color flower image by captured by SM-Cam at different lightness.__

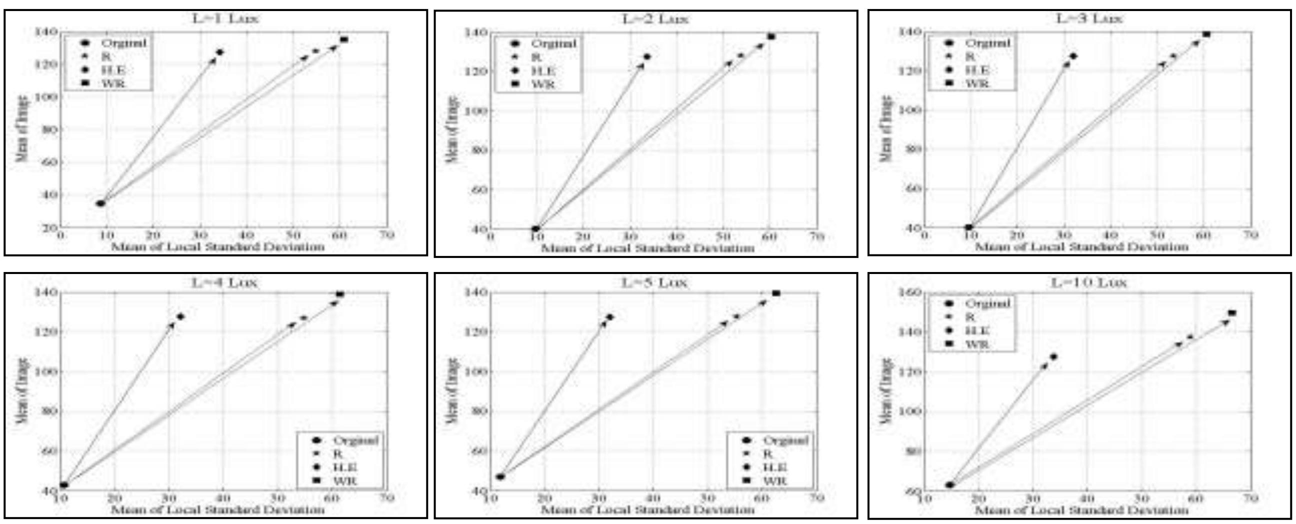


__Figure (15): Shows the Mean of locally (μ, σ) model for original and enhanced images for color flower image by captured by SN-Cam at different lightness.__

9. Image Noise Filter Results

After enhanced images that captured under low lightness, which is not good appearance (low quality images). These images are always noisy. This leads to lose its original color, features, and information. Image enhancement by filters is an important part to improve the optical properties by computer aided. In this work, two algorithms (mean and, median) have been used to smooth the colored images with different lightness. Where using captured images under lightness (L = 1, 3,5,7,9,10,20,40 and, 60) Lux by two camera types (SM-Cam and SN-Cam). Images were used color test chart image. The captured images by two cameras have been smoothed by two ways (mean and, median), also it been calculate the statistical properties of images the mean (μ) and the standard deviation (σ) before and after applying filters for each extracted homogeneous block from the 12 image target, the results demonstrated by the following subsections.

9.1 Mean and Median Filters Results

From table (1) can be notice that the standard deviation (σ) values of at least after applied the filter and the standard deviation (σ) values for mean filter less than the standard deviation (σ) values for median filter, this means that the efficiency of mean filter is better than the efficiency of median filter. While when comparing between the two cameras (SM-Cam and, SN-Cam), it can be noticed that the captured image by SN-Cam better than the captured image by SM-Cam.

Table (1): *Values (μ and σ) for the two types of filters for several targets of the (SM-Cam and, SN-Cam)*

		SM-Cam						SN-Cam					
CHARTS		L=1		L=3		L=5		L=1		L=3		L=5	
		μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ
RED CHART	OR	44.5	17.6	55.1	15.	56.6	10.4	64.5	4.6	64.3	5.0	64.3	4.2
	MN-F	44.5	6.4	55.2	7.0	56.5	5.8	64.6	2.5	64.5	2.9	64.6	3.0
	MD-F	43.2	6.9	54.6	7.6	56.2	6.0	64.5	2.1	64.2	2.4	64.5	2.5
GREEN CHART	OR	29.9	16.2	30.0	12.4	34.6	8.0	34.5	4.2	35.2	3.4	36	3.3
	MN-F	30	6	29.9	6.5	34.6	4.6	34.5	2.9	35.3	2.1	36	2.3
	MD-F	29.2	6.8	29.8	6.7	34.5	4.6	34.5	3.0	35.2	2.1	36	2.3
BLUE CHART	OR	29.8	16.6	29.2	13.0	45.8	10.6	38.6	3.9	39.8	3.7	40	4.2
	MN-F	29.9	5.0	29.4	4.8	45.8	4.4	38.5	3.2	39.8	3.3	40	3.5
	MD-F	27.\9	5.9	28.7	5.1	45.5	4.7	38.5	3.2	39.8	3.3	40	3.5
WHITE CHART	OR	240	11.1	264	5.9	249	4.1	208	14.0	227	12.8	237	9.0
	MN-F	240	5.2	246	3.1	249	2.4	208	9.0	227	7.6	237	6.3
	MD-F	241	5.4	246	3.2	249	2.5	208	9.4	227	7.8	237	6.3
PINK CHART	OR	99.0	13.3	102	10.9	113	7.8	114	3.5	114	3.5	111	4.8
	MN-F	99.0	6.3	102	6.8	113	5.3	114	2.6	114	2.4	111	4.1
	MD-F	99.3	6.5	102	6.9	113	5.5	114	2.6	114	2.5	111	3.7
GREEN LIGHT CHART	OR	94.8	13.3	92.6	8.2	92.6	6.6	90.9	3.1	92.1	3.3	92	4.0
	MN-F	94.8	6.3	92.7	3.8	92.5	4.3	90.9	2.4	92.	2.4	92	2.5
	MD-F	94.7	6.5	92.4	4.0	92.5	4.4	90.8	2.2	92.2	2.2	92	2.4
BLUE LIGHT CHART	OR	168	14.4	163	11.4	169	10.7	140	5.3	141	5.6	144	4.3
	MN-F	168	6.1	163	7.2	169	8.6	140	4.4	141	4.8	144	3.7
	MD-F	168	6.2	163	7.2	169	8.7	140	4.4	141	4.9	144	3.8
GRAY LIHJY CHART	OR	192	18.7	185	12.4	194	9.7	148	4.1	149	3.6	151	4.7
	MN-F	192	9.4	185	6.0	194	6.2	148	3.0	149	2.7	151	3.7
	MD-F	192	9.6	185	6.3	194	6.4	148	3.1	149	2.8	151	3.8
ORANG CHART	OR	96.9	14.2	94.9	12.2	93	10.1	105	6.8	100	4.2	99	4.2
	MN-F	96.9	6.9	94.9	7.1	93	7.3	105	4.5	100	2.9	99	3.0
	MD-F	97.3	7.1	95.1	7.4	93	7.5	105	4.4	100	2.6	99	2.9
GRAY CHART	OR	66.1	15.9	70	9.5	77	7.0	75	4.2	74.5	4.2	73	4.4
	MN-F	66.1	6.2	70	4.8	77	4.8	75	3.4	74.5	3.4	73	3.7
	MD-F	66.5	6.4	70	4.9	77	4.9	75	3.5	74.5	3.5	73	3.8
YELLOW CHART	OR	108	14.9	110	10.6	90	8.8	134	8.6	126	12.2	107	7.5
	MN-F	108	8.2	110	6.6	90	7.5	134	6.4	126	9.2	107	6.5
	MD-F	107	8.4	110	6.7	90	7.6	134	6.5	126	9.4	107	6.4
BLACK CHART	OR	19.2	12.7	10.6	7.2	5.4	4.0	8.7	2.8	7.7	3.1	7.2	2.3
	MN-F	19.3	3.6	10.5	2.9	5.4	2.4	8.7	1.3	7.6	1.5	7.2	1.4
	MD-F	17.1	3.8	9.6	2.9	4.9	2.4	8.7	1.3	7.4	1.8	7.1	1.5

10.Conclusion

This study will present the most important conclusions that have been reached at in this study. From the results of the present study, the following points are concluded:

1) From enhancement results can be conclude the following points:

a) The introduced hybrid method (wavelet and retnx) for enhancement gives better efficiency depending on QF and local mean of (μ, σ) rather than histogram equalization and Retenix.

b) The best method to enhancement image based on lightness and contrast change is the introduced method in this study (M.R.W)

c) The QF is robust method to assessment the quality of images with different lightness levels.

d) The mean of locally (μ, σ) model is good measure to determine the quality of images with different lightness levels: low, moderate and high.

2) The best filter found in this study to be is the mean filter Compared with the median filter.

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