Enhance Video Film using Retnix method

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Abstract. An enhancement technique used to improve the studied video quality. Algorithms like mean and standard deviation are used as a criterion within this paper, and it applied for each video clip that divided into 80 images. The studied filming environment has different light intensity (315, 566, and 644Lux). This different environment gives similar reality to the outdoor filming. The outputs of the suggested algorithm are compared with the results before applying it. This method is applied into two ways: first, it is applied for the full video clip to get the enhanced film; second, it is applied for every individual image to get the enhanced image then compiler them to get the enhanced film. This paper shows that the enhancement technique gives good quality video film depending on a statistical method, and it is recommended to use it in different application.

Keywords: enhancement, video frame enhancement, image quality, video processing.

1. Introduction

Image enhancement techniques (IET) used to enhance the quality of an image as seeming by a human. IET techniques are most useful because a lot of satellite images when studied on a color display, they provide insufficient information of image interpretation. Image enhancement used to correct geometric and radiometric deformities. Image enhancement ways are applied separately to each band of a multispectral image. Digital enhancing techniques considered one of the most satisfactory method compared with the photographic technique, because of the accuracy and wide different of digital processes [1, 2]. Methods of image enhancement mostly can be categorizing into two groups: Frequency Domain Methods, and Spatial Domain Methods. Some of contrast and lightness enhancement algorithms are used such as Histogram Equalization, Multi Scale Retinex algorithm and Contrast enhancement that depend on the physical contrast of simple images to enhance color images from any type of distortion such as noise, color shift, inverse transform for any operation and lightness change. Therefore, many efforts in image enhancement used sinusoidal screen, or a solitary patch of light on an unchanging background, which is well defined and approves with the recognized contrast [3]. Non-uniform lighting conditions and the night scenes have been studied depending on nonlinear transform [4]. While using Structural Similarity Index Metric (SSIM)
requires two images (optimal and original image) and evaluation of three different measures like luminance, contrast, and structure comparison which make this process difficult and slow [5]. Histogram modification technique used to enhance intensity contrast and brightness error [6]. A criterion called Quality Factor (QF) suggested to determine color image quality based on changing lightness and contrast with analyzing image by using methods depending on image quality assessments like, mean of locally (μ and σ) model, which suggest introduced two methods named Modified Retinex (MR) and Adaptive Histogram Equalization (AHE) to enhance color images based on changing lightness and contrasts [7]. Methods like Histogram Equalization, Retinex, and a combined between Retinex and wavelet are introduced to study the effect of the low lightness on the captured images using two types of camera [8].

In this study, we introduced famous method which called Multi Scale Retinex algorithm to be used as video enhancement.

2. Retinex Method

Image enhancement in general refining the explainable or observation of data within images for any watchers and giving improved input for other computerized image processing techniques. Image lighting consider interested parameter features in digital image processing. Lighting enhancement is commonly lead to focused problems in digital image processing [9].

Retinex method is bridging the gap between images and the human observation of scene. Retinex could achieve compensation for the blurring introduced by image development process, make efficient output as brightness change and functional range compression. Retinex Techniques divided into [9]:

1. Single Scale Retinex (SR)
2. Multi Scale Retinex (MR)
3. Multi Scale Retinex Color Restoration (MSRCR).

Multi Scale Retinex (MSR) is extended from Single Scale Retinex (SSR) where [10, 11]:

\[ R_i(x, y, c) = \log[I_i(x, y)] - \log[F(x, y, c) \otimes I_i(x, y)] \]  \tag{1}

meaning of \( R_i(x, y, c) \) is the Gaussian shaped surrounding space constant of the production of channel \( i \) (\( i \in \{R, G, B\} \)) at location \( x, y, c \). \( I_i(x, y) \) is the value of image pixel for channel \( I \), and character \( \otimes \) is convolution. Function \( F(x, y, c) \) is Gaussian surrounds function which is written as [10, 11]:

\[ F(x, y, c) = k \, e^{-\frac{x^2 + y^2}{c^2}} \]  \tag{2}

\( k \) is normalization constant [10]:

\[ \iint F(x, y, c) \, dx \, dy = 1 \]  \tag{3}

The output of MSR is then simply a weighted sum of all different SSR outputs [10, 11]:

\[ R_{MSR}(x, y, w, c) = \sum_{n=1}^{N} W_n \, R_i(x, y, c_n) \]  \tag{4}

where \( N \) is the number of scales, \( R_i(x, y, c_n) \) the \( i \)th component of the \( n \)th scale, \( R_{MSR}(x, y, w, c) \) the \( i \)th spectral element of the MSR output, and \( W_n \) is the weight related with the \( n \)th scale. It assumed that \( \sum W_n = 1 \).

The above processing will deal with both negative and positive RGB values as a result, and the histogram will usually have big tails. Therefore, a final gain-offset is used as stated and discussed in additional details underneath. This method can lead that color within image becomes gray color, therefore an extra processing stage is anticipated [10, 11]:
\[ R = I_{MSR} \cdot L(x, y) \] (5)

where \( L \) can be written as

\[ L(x, y) = b \log [1 + a \frac{I_i(x, y)}{\sum_{i=1}^3 I_i(x, y)}] \] (6)

where the permission uses the form \( \log (1+x) \) instead of \( \log (x) \) to make sure to get a positive result. The values of \( a = 125 \) and \( b = 100 \) are suggested for a specific test images.

\[ I_{pi}(x, y) = g(L(x, y) + h) \] (7)

In equation (7), The values of the gain offset \( g = 0.35 \) and \( h = 0.56 \) respectively [7]; \( I_{pi} \) is output image. In this paper, the value that used are \( w_1 = w_2 = w_3 = 1/3 \) and \( c_1 = 250, c_2 = 80, c_3 = 15 \) [10, 11].

3. Video frames enhancement

The recording process was recorded indoor using fixed camera, where the artificial light intensity controlled and measured by luxmeter with values (315, 644 and 566 Lux). The MR algorithm is used to enhance video frames that captured in different intensities. Moreover, \( \sigma \) and \( \mu \) are computed for each image after and before the enhancement process. The algorithm that used is the same algorithm (1) except step (1) should be replaced to clip frames. The procedure analysis and enhancement steps as follow:

**Algorithm (1) color frames lighting enhancement**

**Input:** color frame image \( I() \) OR clip frames.

**Outputs:**
- computed \( (\mu, \sigma) \) to each color frame images before and after the enhancement process.

**Start Algorithm**

1-Open color frame image frame \( I_i() \), i= r, g, b OR clip frames.

2- Calculate Gaussian surrounds function

\[ F(x, y, c_n) = (k) \exp \left( \frac{-(x^2 + y^2)}{c_n^2} \right) \]

\( k \) is constant normalization, \( c_n, n=3, \{c_1=250, c_2=120, c_3=80\} \) [7].

3-Compute SSR using: \( R_i(x, y, c) = \log[I_i(x, y)] - \log[F(x, y, c_n) \otimes I_i(x, y)] \)

4-Compute MSR using:

\[ R_{MSR}(x, y, w, c) = \sum_{n=1}^N W_n R_i(x, y, c_n) \]

Where \( N=3, \{w_1=w_2=w_3=1/3\} \).

5-Calculate MSR with color repair by

\[ I_{i}^{'}(x, y) = b \log [1 + a \frac{I_i(x, y)}{\sum_{i=1}^3 I_i(x, y)}], b = 100, a = 125. \]

6- color image enhancement is gotten form gain offset using \( IE_i(x, y) = 0.35(I_{i}^{'}(x, y) + 0.56). \)
4. Results of lighting Enhancement of Color Video Clips Frame

4.1 Images of the colored target
These images are homogeneous in intensity and color, with size of (1080x1820) pixel. They are captured under different light conditions. Figure 1 shows these images with colored target.

Figure 1. Images of the colored target light intensity (a) 64.4 Lux, (b) 315 Lux, and (c) 566 Lux.
4.2 Results of Enhancement using Retinex technique

The enhancement process is implanted by using algorithm (1). The results show that the enhanced regions are the high contrast regions (edges) which is a prove that this algorithm works properly. Moreover, enhanced the background and object color. The enhancement process is used for the recorded video with 80 frames, and it used for each frame individually as shown in figure 2.

Figure 2. Images enhancement using Retinex technique for 80 frames individually
(a) Light Intensity = 64.4Lux (b) light Intensity = 315ux and (c) Light Intensity = 566 Lux.
Mean ($\mu$) and standard deviation ($\sigma$) are computed individually as shown in figure 3. Mean curve has higher values at low light conditions and it is decay with frame image time at high light condition. While at mid light condition, $\mu$ have stable behavior. Standard deviation (represent the small details within the image) behavior is increases for the three light conditions. The best increase is at low light conditions. In the legend, (-O) denoted to the original images while (-E) for the enhanced images.
(b)
Figure 3. Values of $\sigma$ & $\mu$ as a function to the number of frames of images enhancement individually where light intensity in (a) 64.4 Lux, (b) 316 Lux and (c) 566 Lux.
Figure 4 shows the results of using enhancement method to a recorded video with 80 frames as one process, which means that the loop in algorithm (1) takes the clip as one loop. It is the same behavior for the individual frame process where the mean curve has higher values at low light conditions and it is decay with frame image time at high light condition. While at mid light condition, $\mu$ have stable behavior. Therefore, it is recommended to use this algorithm. In the legend, (-O) denoted to the original images while (-E) for the enhanced images.
Figure 4. Values of $\sigma$ & $\mu$ as a function to the number of frames for images enhancement of a recorded video with 80 frames where light intensity in (a) 64.4 Lux (b) 316 Lux and (c) 566 Lux.
As a summary, the behaviour of $\sigma$ and $\mu$ as a function of frame number, in both ways as taken as a package (clip frames) or individually (one frame), is the same because the area of the background in the image is bigger than the target. Which means that $\sigma$ and $\mu$ for the target does not have an effect on the $\sigma$ and $\mu$ for the image when Retinex apply on the frame. Therefore, the enhancement is matching in both cases.

5. Conclusions
The value of $\sigma$ and $\mu$ for the video frames before and after enhancement are computed. The enhancement results are obvious depending on $\sigma$ values because image contrast for the enhancement images is increased, and $\sigma$ values are increased for all type of light conditions. While $\mu$ values didn’t show any response at high light conditions.

The process of enhancement the video images of the two methods (continuous and separate) gave identical results, so we recommend using the continuous method of execution speed.

Retinex enhancement technique is adapted and applied on the video frames, where it showed good responds in enhancing the brightness and contrast of video images, especially at the moderate and middle light intensity.

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