

Color Image Enhancement Using Histogram Modification

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Abstract

Image enhancement involves taking an image and improving it visually, typically by taking advantage of the human visual system's response. In this paper, we will enhance the color image that may be dark or light by using histogram modification such as histogram equalization, histogram stretch and histogram shrink. The objective of the histogram equalization is to map an input image to an output image such that its histogram is uniform after the mapping.

1. Introduction

The principle objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application [1]. Image enhancement approach fall into two broad categories: spatial domain and frequency domain. Spatial domain method refer to the image plane itself, and the approaches in this category are based directly manipulation of pixel in an image. Frequency domain process techniques are based on modified the Fourier Transform of an image [2]. Image enhancement processes consist of a collection of technique that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by human or machine [3].

2. Histogram Modification

The luminance histogram of a typical nature scene that has been linearly quantized is usually highly skewed toward the darker level; a majority of the pixel processes a luminance less than the average. In such image, detail in darker region is often not perceptible. One means of enhancing these types of images is a technique called histogram modification. The histogram equalization process for which the histogram of the enhanced image is forced to be uniform [3][4]

The gray level histogram of the image is the distribution of the gray levels in an image. In general, a histogram with a small spread has low contrast, and a histogram with a wide spread has high contrast, where as an image with its histogram clustered at the low end of the range is dark, and the histogram with the values clustered at the high end of the range correspond to bright image[1]

In this paper, we implement the histogram modification on a color image to each band (red, green, blue).

2.1 Histogram Equalization

Histogram equalization is a popular technique for improving the appearance of poor image. Its function is similar to that of a histogram stretch but often provide more visually pleasing result across a wider range of image. Histogram equalization is a technique where the histogram of the resultant image is as flat as possible (with histogram stretching the overall shape of the histogram remains the same) [1][2][5][6].

The histogram equalization only generates an approximation to a uniform histogram. In this paper we implement the histogram equalization on any band that has poor quality. As we shown in figure 1 the light image can be enhancement by histogram equalization to all

bands. The following algorithm used to implement the histogram equalization.

```
Algorithm 1: Histogram Equalization
Input: color image
Out put: Enhancement Image

Step1: Compute Histogram_red    // Histogram for red band
Step2: Compute Histogram_green  // Histogram for green band
Step3: Compute Histogram_blue   // Histogram for blue band
Step4: For i = 0 To max gray level value
        sum_r = sum_r + histogram_red(i)
        sum_g = sum_g + histogram_green(i)
        sum_b = sum_b + histogram_blue(i)
        Go to step 4
Step 5: For i = 0 To max gray level value
        div_r = (s + histogram_red(i)) / sum_r
        div_g = (s1 + histogram_green(i)) / sum_g
        div_b = (s2 + histogram_blue(i)) / sum_b
        new_histogram_red (i) = (div_r * 255)
        new_histogram_green(i) =(div_g * 255)
        new_histogram_blue(i) = (div_b * 255)
        s = s + histogram_red(i)
        s1 = s1 + histogram_green(i)
        s2 = s2 + histogram_blue(i)
        Go to step 5
Step 6: Map the new histogram with the old histogram one to one.
Step 7: end
```

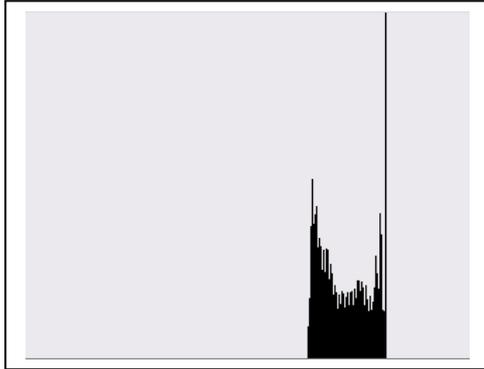
And we can implement the histogram equalization to any band as shown in the below. The figure 2 is has a problem in the green band and the figure 3 has a problem in the red band and the figure 4 has a problem in the blue band. In figure 2 we implement the histogram equalization on the green band only and in figure 3 we implement the histogram equalization on red band only and in figure 4 we implement the histogram equalization on blue band only.



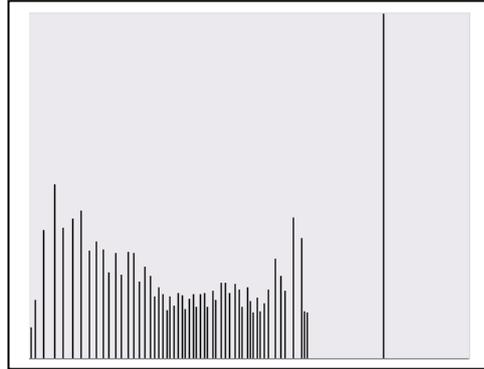
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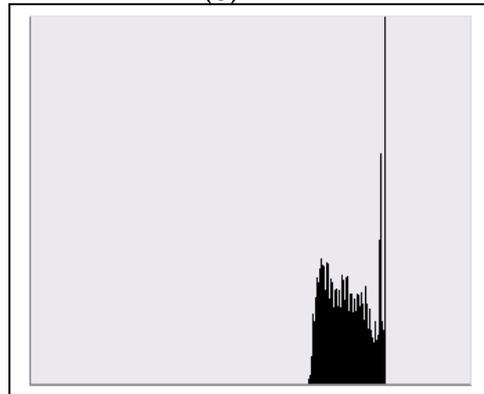
(b)



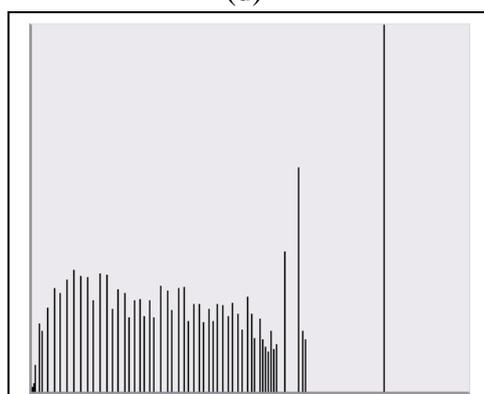
(c)



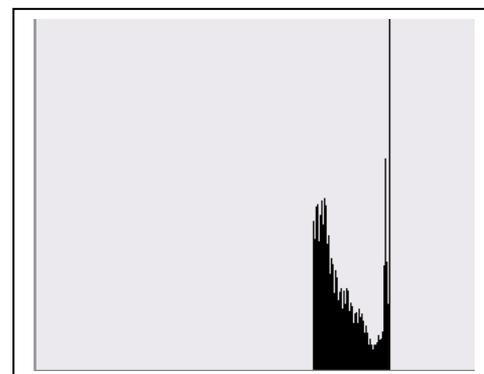
(d)



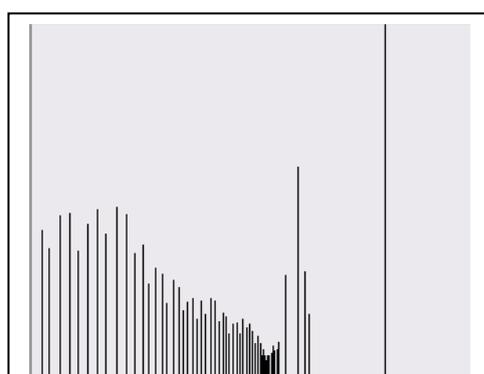
(e)



(f)



(g)



(h)

Figure 1

a: Original image, b: Enhanced image, c: Red band histogram for Original image, d: Red band histogram for Enhanced image, e: Green band histogram for Original image, f: Green band histogram for Enhanced image, g: Blue band histogram for Original image, h: Blue band histogram for Enhanced image.

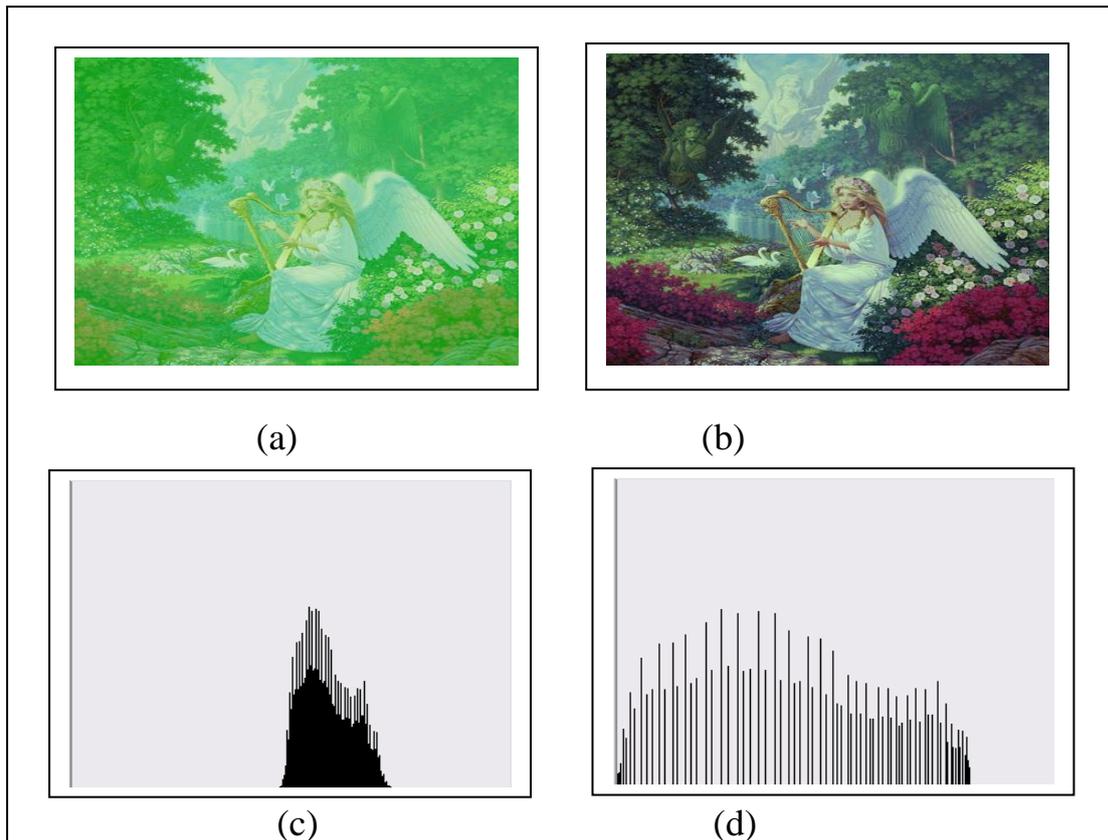


Figure 2
 a: Original Image, b: Enhanced image, c: Green band histogram for Original image, d: Green band histogram for Enhanced image

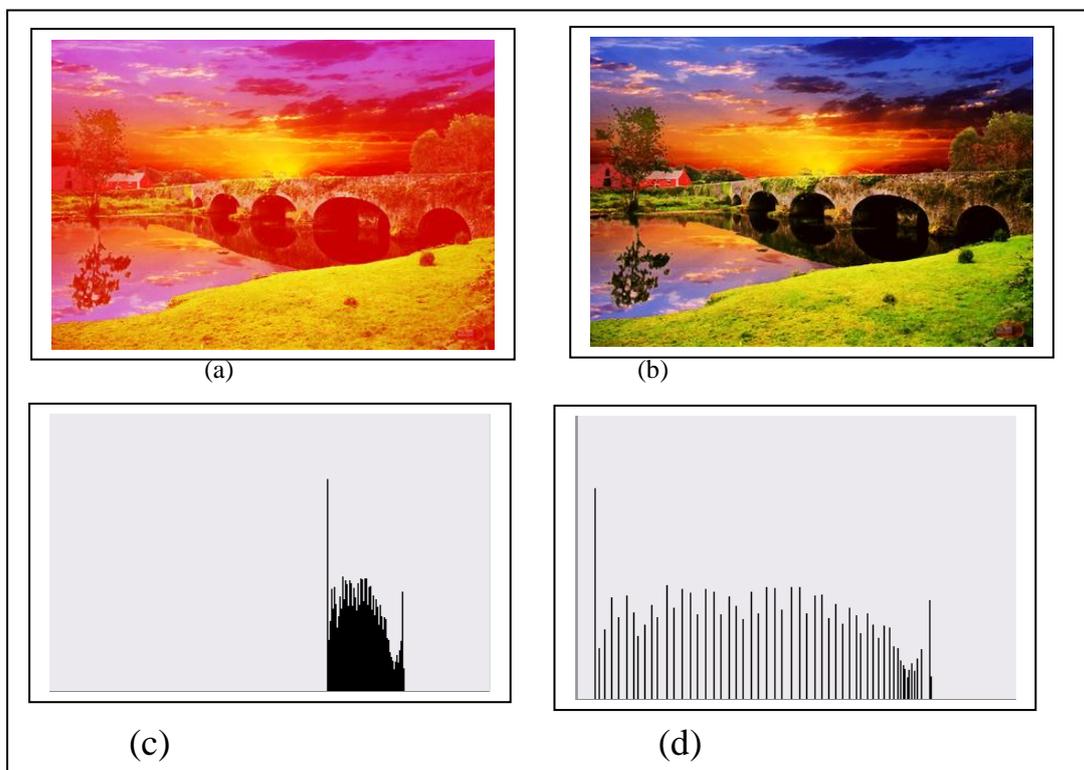


Figure 3
 a: Original Image, b: Enhanced image, c: Red band histogram for Original image, d: Red band histogram for Enhanced image

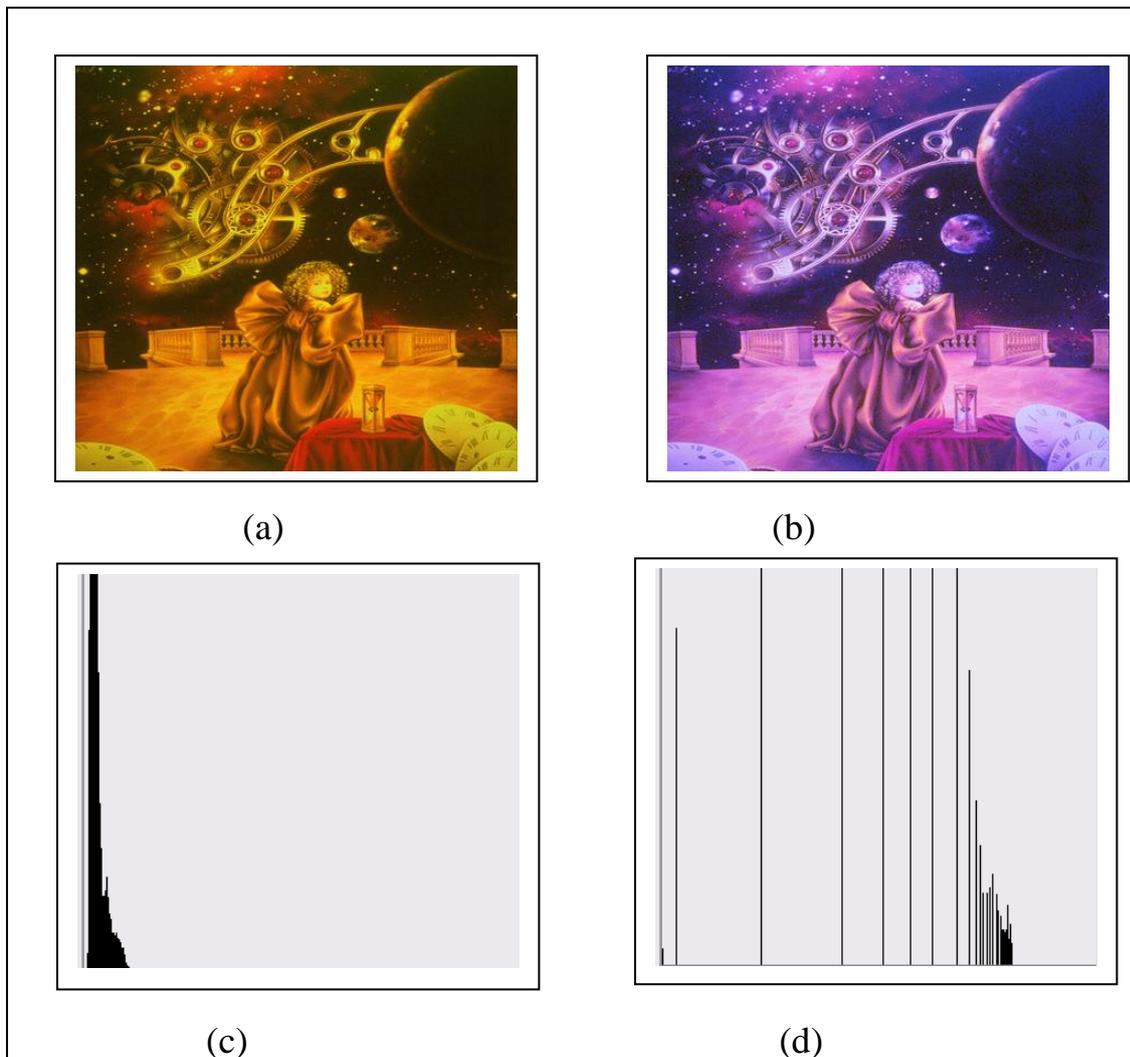


Figure 4
a: Original Image, b: Enhanced image, c: Blue band histogram for original image, d: Blue band histogram for Enhanced image

2.2 Histogram Stretch

The histogram can also be modified by a mapping function. The histogram stretch is a form of modification some time refers to as histogram scaling. The mapping function for histogram stretch can be found by the following equation:

$$Stretch(I(r,c)) = \left(\frac{I(r,c) - I(r,c)_{\min}}{I(r,c)_{\max} - I(r,c)_{\min}} \right) * (\max - \min) + \min \quad (1)$$

Where $I(r,c)_{\max}$ is the largest gray level value in the image $I(r,c)$, $I(r,c)_{\min}$ is the smallest gray level value in the image $I(r,c)$, max and min corresponding to the maximum and minimum gray level values.

This equation will take on the image and stretch the histogram across the entire gray level range which has the effect of increasing the contrast of a low contrast image. The following algorithm is used to implement the histogram stretch [1][7].

```

Input: Color Image, Max_histogram, Min_histogram
Output: Enhancement image
Step1: Compute Histogram_red // Histogram for red band
Step2: Compute Histogram_green // Histogram for green band
Step3: Compute Histogram_blue // Histogram for blue band
Step 4: Compute the max and min value in the histogram
Step 5: Compute new_Histogram for each band using equ. 1
Step6: Map the new_histogram with the old histogram one to one.
Step 7: end.

```

In this paper, we implement the histogram stretch on all bands or may be on one band only as show in the following figures. Figure 5 show the darkness image and the enhancement image and figure 6 show an image that has a problem in the blue band and the enhancement image and figure 7 show an image that has a problem in the green band and the enhancement image and figure 8 show an image that has a problem in the green band and the enhancement image.

2.3 Histogram Shrink

The histogram shrink is one of the histogram modification techniques. The opposite of the histogram stretch is a histogram shrink, which will decrease image contrast by compression the gray levels. The mapping function for a histogram shrink can be found by the following equation:

$$Shrink(I(r,c)) = \left[\frac{Shrink_{max} - Shrink_{min}}{I(r,c)_{max} - I(r,c)_{min}} \right] * [I(r,c) - I(r,c)_{min}] + Shrink_{min} \quad (2)$$

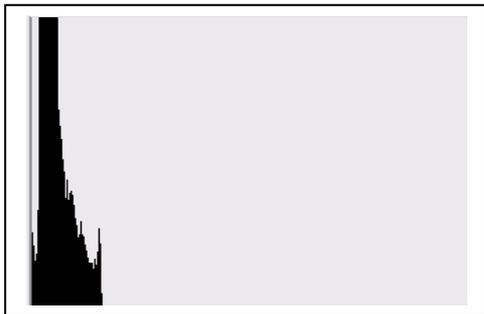
Where $I(r,c)_{max}$ is the largest gray level values, $I(r,c)_{min}$ is the smallest gray level values, $Shrink_{max}$ and $Shrink_{min}$ corresponding to the maximum and minimum desired in compressed histogram [1][8].



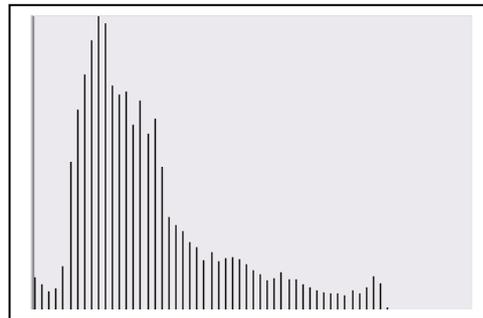
(a)



(b)



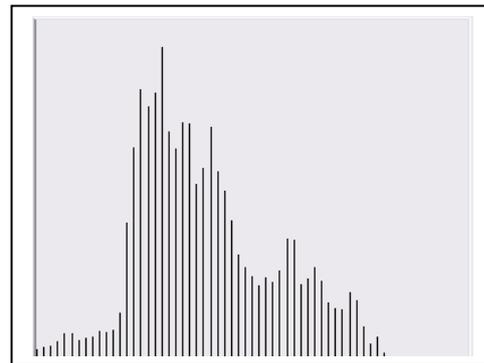
(c)



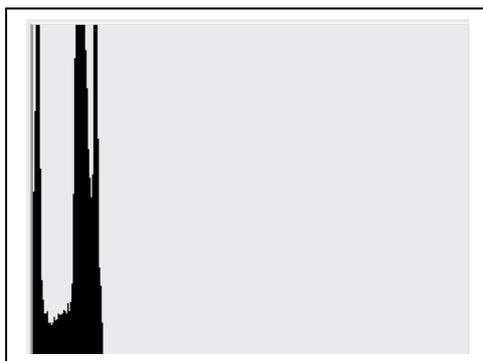
(d)



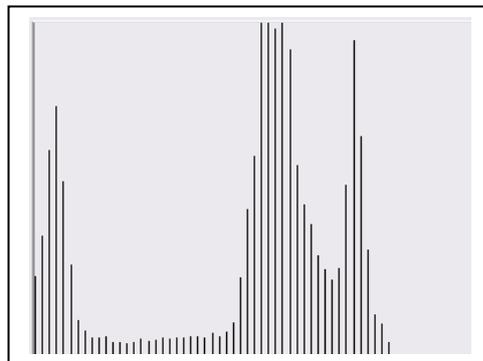
(e)



(f)



(g)



(h)

Figure 5

a: Original image, b: Enhanced image, c: Red band histogram for original image, d: Red band histogram for Enhanced image, e: Green band histogram for original image, f: Green band histogram for Enhanced image, g: Blue band histogram for original image, h: Blue band histogram for Enhanced image.

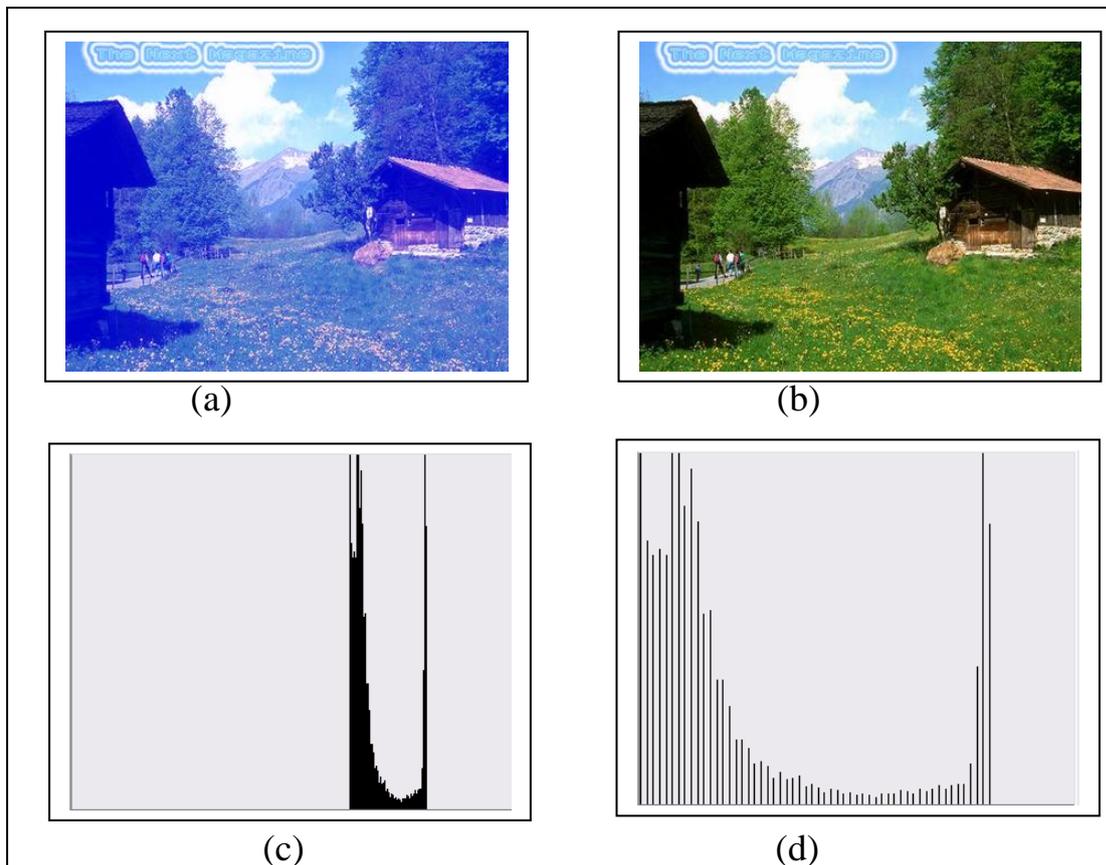


Figure 6
 a: Original Image, b: Enhanced image, c: Blue band histogram for original image, d: Blue band histogram for Enhanced image

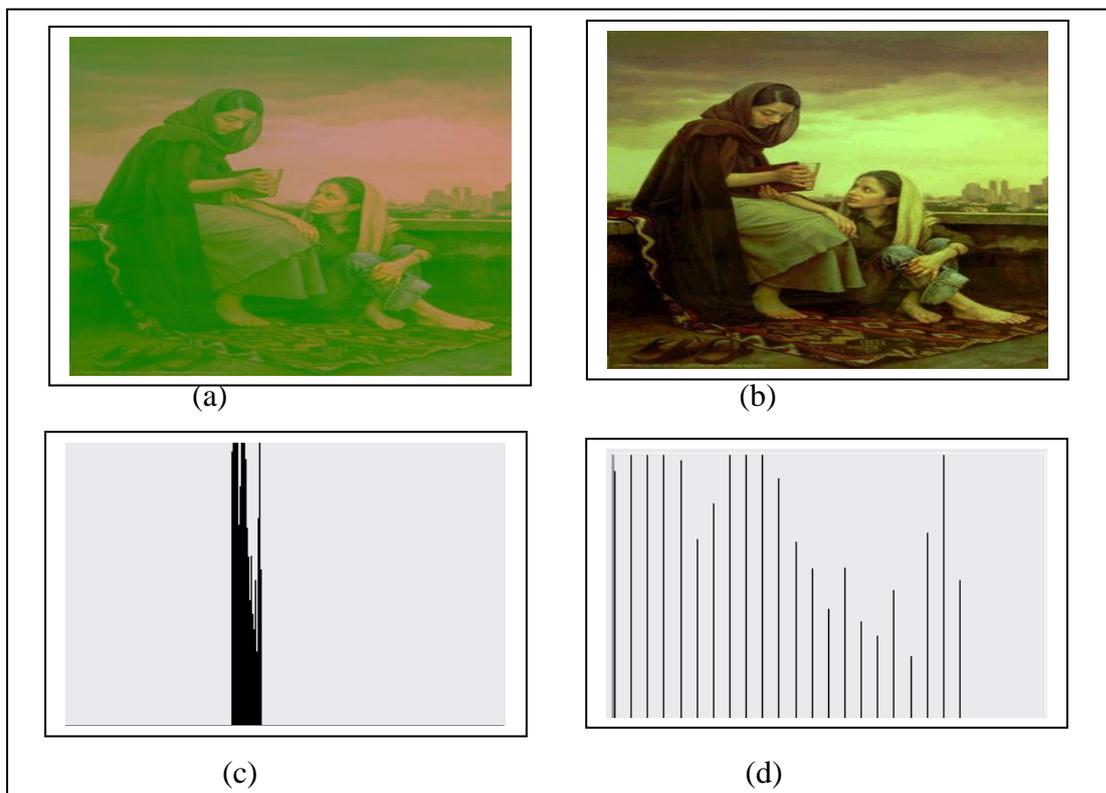


Figure 7
 a: Original Image, b: Enhanced image, c: Blue band histogram for original image, d: Blue band histogram for Enhanced image

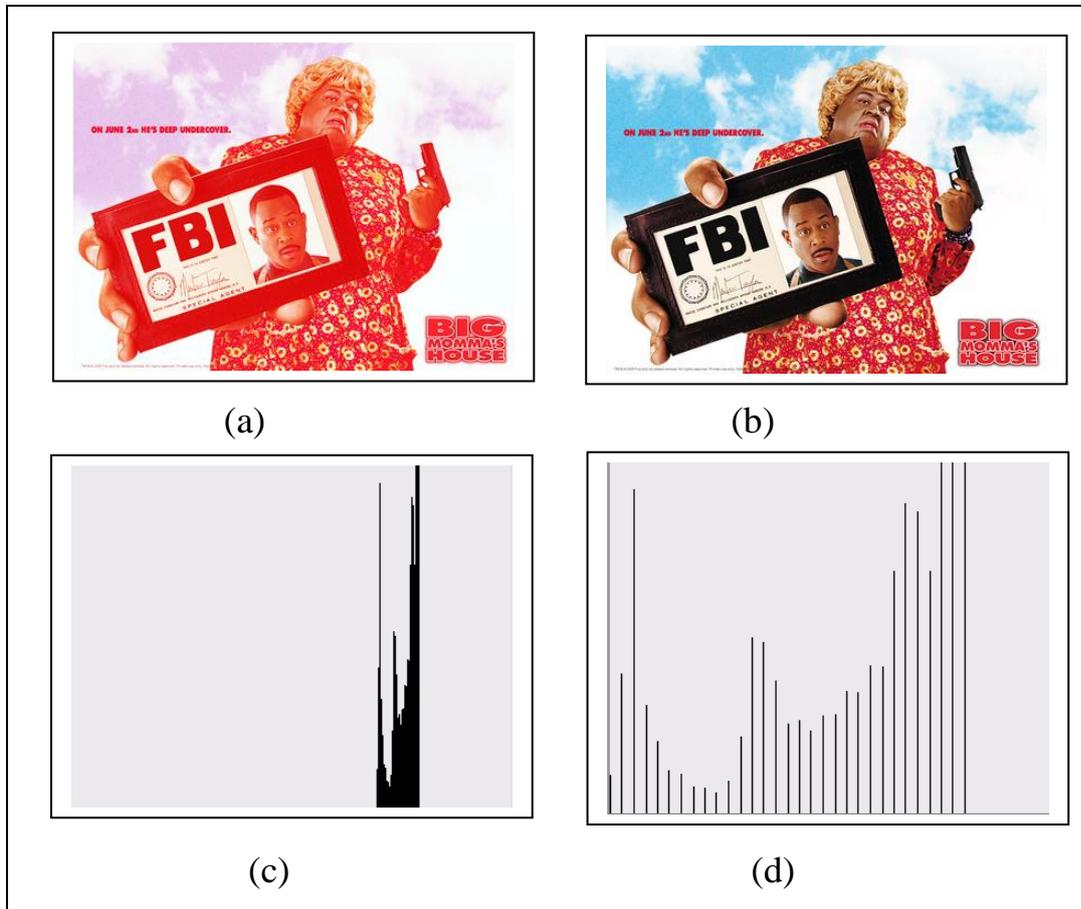


Figure 8
 a: Original Image, b: Enhanced image, c: Red band histogram for original image, d: Red band histogram for Enhanced image

The following algorithm is used to implement the histogram shrink. As show in figure 9 we implement the histogram shrink on all band and take the $shrink_{min}=10$ and $shrink_{max}=110$. And show figure 10 implement the histogram shrink on the blue band only and take $shrink_{min}=50$ and $shrink_{max}=130$.

```

Input: Color Image,  $shrink_{min}$ ,  $shrink_{max}$ .
Output: Enhancement image
Step1: Compute Histogram_red // Histogram for red band
Step2: Compute Histogram_green // Histogram for green band
Step3: Compute Histogram_blue // Histogram for blue band
Step 4: Compute the max and min value in the histogram
Step 5: Compute new_Histogram for each band using equ. 2
Step6: Map the new_histogram with the old histogram one to one.
Step 7: end.
  
```

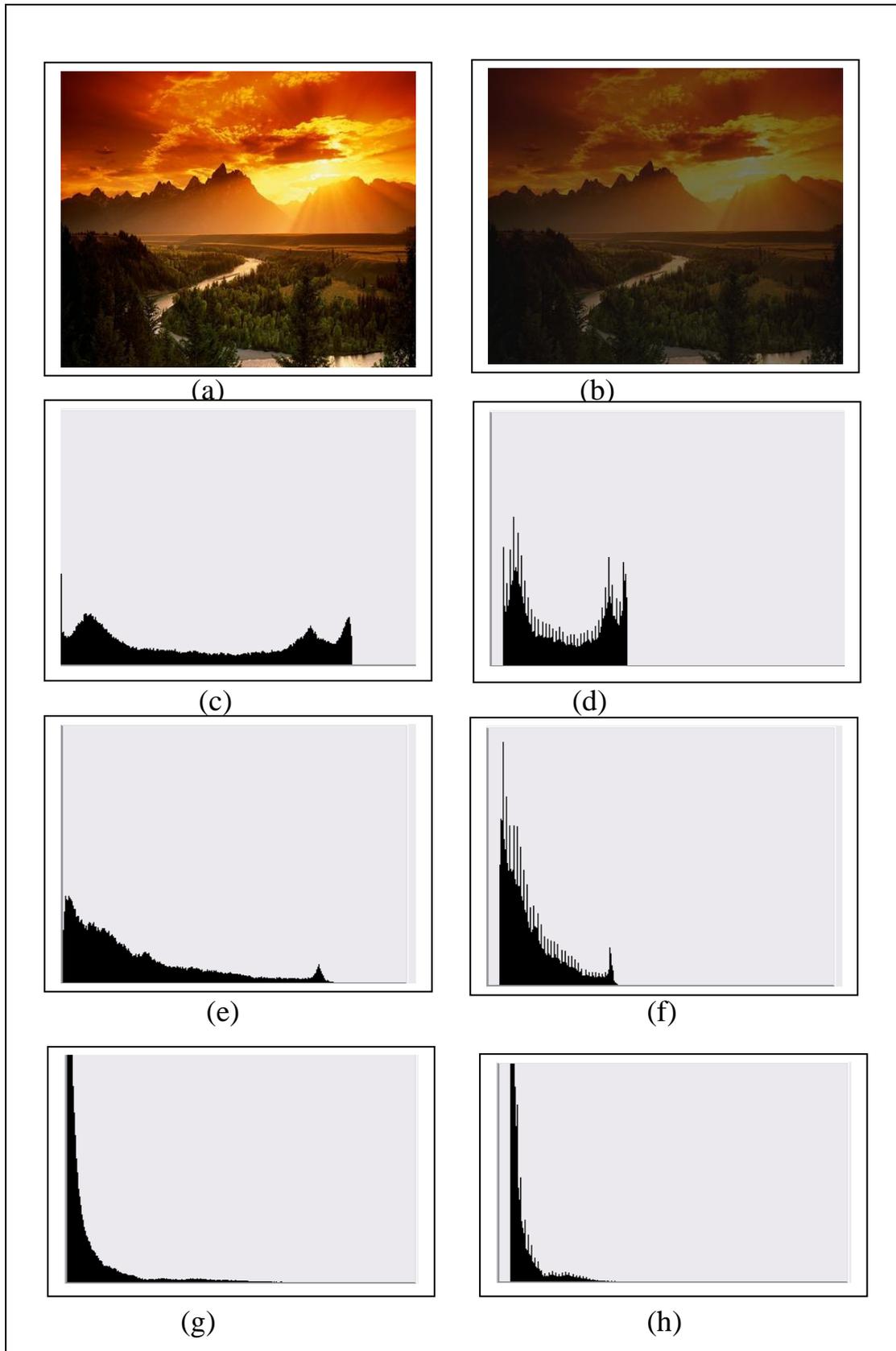


Figure 9

a: Original image, b: Enhanced image, c: Red band histogram for original image, d: Red band histogram for Enhanced image, e: Green band histogram for original image, f: Green band histogram for Enhanced image, g: Blue band histogram for original image, h: Blue band histogram for Enhanced image.

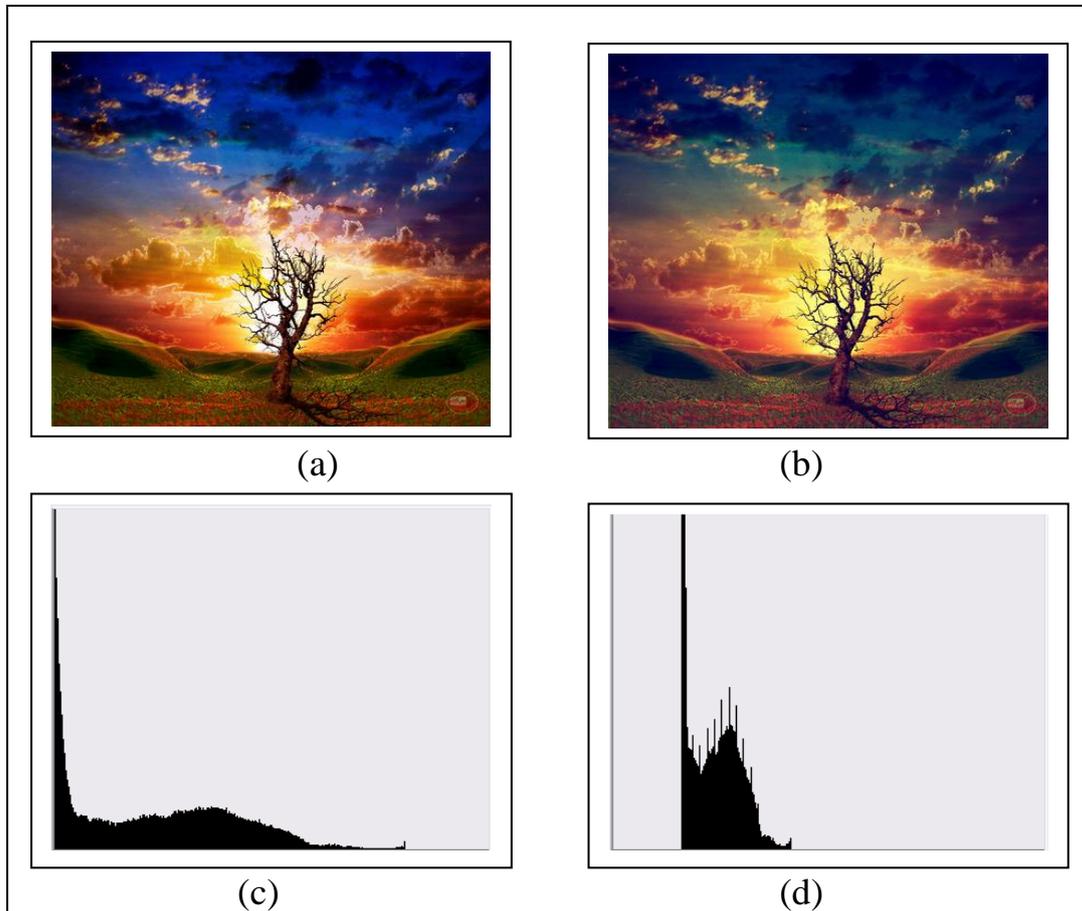


Figure 10
a: Original Image, b: Enhanced image, c: Blue band histogram for original image, d:
Blue band histogram for Enhanced image

3. Conclusions

In this paper, three methods of the histogram modification are proposed, which work on the distribution of the colors. The experimental result that shown the original image and enhanced image. These methods can be applied on the color image (on each band) or may be applied on the band that has a poor quality. The results that show the histogram equalization can solve the light image problem and may applied on one band and the results of the histogram stretch solve the darkness image problem and the histogram shrink solve the contrast of the image.

4. References

- [1] Scott E. Umbaugh, “Computer Vision and Image Processing”, Prentice hall, 1998.
- [2] Rafael C.Conzales, “digital image processing”, 2nd edition, Wesley, 1987.
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- [7] S.G. Hoggar, “Mathematics of digital Image”, Cambridge university press, 2006.
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تحسين الصورة
باستخدام
تعديل المدرج التكراري

علي محسن الجبوري /كلية علوم الحاسبات والرياضيات/ جامعة القادسية

الخلاصة

الهدف الرئيسي من تحسين الصورة هو معالجة الصورة للحصول على صورة اكثر وضوح من الصورة الاصلية. في هذا البحث تم تحسين الصورة باستخدام تعديل المدرج التكراري باستخدام ثلاث طرق هي مساواة المدرج الاحصائي و امداد المدرج التكراري و اكماش المدرج التكراري. في الطريقة الاولى تم تحسين الصورة الفاتحة و الطريقة الثانية تم تحسين الصورة الغامقة والطريقة الثالثة تم تحسين الصورة قليلة الوضوح. في هذا البحث تم تحسين الصورة الملونة بتطبيق الطرق الثلاثة على كل مستويات الالوان او ممكن تطبيق الطرق على مستوى واحد الذي يحتوي على مشاكل.