Colour image Enhancement using Background Brightness Preserving Histogram Equalization

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Abstract: Histogram Equalization (HE) is generally used to upgrade the image contrast yet it has a tendency to over enhance the image background brightness. BBHE (Bi Histogram Equalization) has broken down and proposed scientifically that it may be preserved original brightness to a certain limit. On the other hand, still cases are not handled well by the BBHE, as they are requiring preservation of higher degree. Particular paper has proposed novel augmentation of BBHE, which alluded to as the MMBEBHE (Minimum Mean Brightness Error Bi Histogram Equalization) to give maximum brightness preservation. BBHE isolates the input image's histogram into two in depend on input mean before leveling with them freely. Enhancement schemes have been presented with minimum defects of the conventional HE, yet the over enhance of the background brightness is still self-evident. A novel methodology of nonlinear HE is displayed, which has the capacity to enhance the image contrast, while preserving the background brightness for images with very much characterized background brightness.

Keywords: *Histogram modification, histogram specification, contrast enhancement, Histogram equalization*.

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I. INTRODUCTION

Among different image upgrade techniques, histogram equalization (HE) is broadly used to improve image contrast, by essentially extending the dynamic range of the image [1]. Consider an input image A is having pixels n and K gray levels. The input probability density function (PDF), $p(X_k)$, is characterized as,

$$p(X_k) = n_k \;/\; n \quad [2] \qquad (1)$$

For k= 0,1,,………k-1 ,

Where

N_k= total pixels for X_k level

$X_k \in (X_0, X_1, \ldots\ldots\ldots X_{k-1})$.

$$C(Xk) = \; = \sum_{r=0}^{k} p(Xr) \qquad (2)$$

By the definition, $c(X_{K-1})=1$. Transform function obtained from input CDF,

$$f(X_k) = X_0 + (X_{k-1} - X_0)c(X_k) \qquad (3)$$

The output image of the HE, B, can then be expressed as

$$B= f(X_k) \qquad (4)$$

For a normal grayscale image, K=256 and k=0, 1,..........255.

For processing, an image is constantly normalized into the range [0, 1]. Thus, the transform function is the input CDF, and the conventional HE (CHE) is only a mapping function of an input level X_k by its CDF [3]. In this manner, the CHE extends to higher density gray levels more than lower density gray levels. Most images oblige to just object improvement while holding the background, particularly when these two parts are all around isolated. As the background is constantly over-enhanced attributable to a great degree of high density when contrasted with the objects, and in this manner objects are efficiently upgraded [4]. The Brightness Preserving Bi-Histogram Equalization (BBHE) was proposed to preserve the image brightness by splitting the image into two in view of the input mean [5]. The sub-images are then freely evened out and consolidated into the output image. In the interim, Wang Et Al. proposed the dualistic sub-image histogram equalization (DSHIE) to portion the image into two of CDF of 0.5 rather than the mean value so that the output image can yield the highest entropy in view of information theory [6]. The BBHE is enhanced by MMBEBHE (Minimum Mean-Brightness Error Bi Histogram Equalization) [7], where the image is disintegrated in the view of gray level that yields minimum absolute mean error between the input and output images. The shift of background brightness is still clear for these systems. In this letter, system is utilizing nonlinear histogram equalization, in particular Background Brightness Preserving Histogram Equalization (BBPHE) [8], is proposed to upgrade the image contrast, as well as to preserve the background brightness.

BBPHE: The possibility behind the BBPHE is that the density of background levels is ordinarily much higher than alternate levels, particularly for plain images, the aggregate density of background levels can be more than half of the aggregate pixels. In this manner, BBPHE splits the input image into sub-images of the background levels and non-background levels range [9]. After that, every sub-image is balanced autonomously, and afterward it consolidated into the last output image. Along these lines, the background levels are just extended inside of the original range, henceforth, the over upgrade can be evaded. Additionally, other sub images contain just similarly low density gray levels; BBPHE has the capacity to grow them into a more extensive territory because of normalization. Henceforth, this will give a satisfactory upgrade on the image.

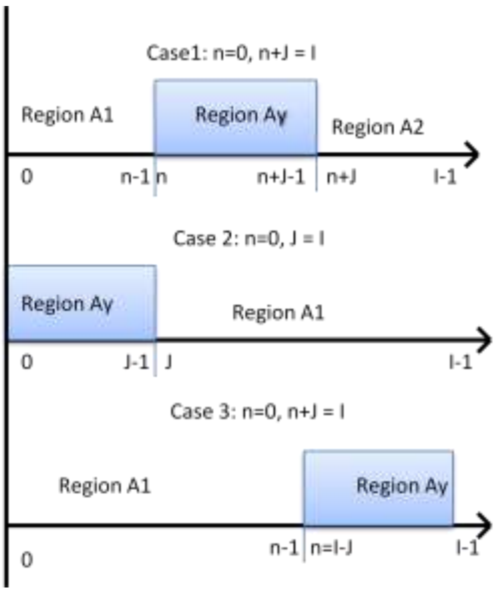

Fig. 1 Decomposition of an image into the sub images which based on the background levels for the different cases

II. THE HISTOGRAM EQUALIZATION AND VARIANTS

Assume global background of input image A is in the continuous J-gray level range in between input I gray-levels. Also, J,I and m-levels are there before background level. Hence, there are I 2 n 2 J –levels after final background level Xm+J −1. Assume background level is Xb and images will be divided into three sub images A1,A2 and A_y as the,

$$A = A1 \cup A_y \cup A2 \ \ [10] \tag{5}$$

Where

$$A1=\{X \le X_{n-1}\},$$
$$A_y = \{X_n \le X \le X_{n+J-1}\},$$
$$A2=\{X_{n+J} \le X \le X_{I-1}\}, n \neq 0, n+J = I, \text{ and}$$
$$X_b \, \varepsilon [\{X_n, X_{n+1}, \ldots, X_{n+J-1}\}.$$

A1 & A2 are sub images of non background levels, and the A_y is sub image of the background-levels. The PDFs of sub images A1, A2, &A_y are defined,

$$p_1(X_k) = m_k / m1 \tag{6}$$

for I= 0 ,1 , …. n-1 ,

$$p_b(X_k) = m_k / m_b \tag{7}$$

for I= n, n+1 ,n+J-1 and

$$p_2(X_k) = m_k / m_2 \tag{8}$$

for k=n+J , n+J+1,…. , I−1, where m_k is the respective total of the pixels at X_k gray-level in every sub image, and m_1,m_2, and m_b are respective total of the pixels in A1,A2, and A_y. Respective CDFs are obtained,

$$c_1(X_k) = \ = \sum_{r=0}^{k} p1(Xr) \tag{9}$$
$$c_b(X_k) = \ = \sum_{r=0}^{k} pb(Xr) \tag{10}$$
$$c_2(X_k) = \ = \sum_{r=0}^{k} p2(Xr) \tag{11}$$

In fact $c_1(X_{n-1}) = c_b(X_{n+j-1}) = c2(X_{k-1}) = 1$, Similar to CHE , transform function of A1 , A2 & S_b may be then separately defined ,

$$f_1(X_k) = X_0 + (X_{n-1} - X_0)c_1(X_k) \tag{12}$$
$$f_b(X_k) = X_n + (X_{n+j-1} - X_n)c_b(X_k) \tag{13}$$
$$f_2(X_k) = X_{n+J} + (X_{I-1} - X_{n+J})c_2(X_k) \tag{14}$$

The output image B can be expressed as

$$B = f_1 \cup f_b \cup f_2 \tag{15}$$

In above case 1 calculation background-levels lie within full gray-level range. As well, there are the two special type cases where, background-level are starting from X_0 and ends at the X_{I-1} and after that Input-image is split into the two sub images A1& A_y instead of the three. Output-image B=f_1 U f_b is then obtained by the similar-steps too.

Case-1 but with the different boundary-conditions as in following:

Case 2 : A= S_b U A1 , where $S_b = \{X \le X_{J-1}\}$, A1 = $\{X_J \le X \le X_{k-1}\}$,n= 0,J ≠ I , and X_b starts from X_0 , hence , $X_b \, \varepsilon \{X_0, X_1, \ldots, X_{j-1}\}$

Case 3 : A= A1 U A_y , where A1 = $\{X \le X_{n-1}\}$,$A_y = \{X_n \le X \le X_{n+j-1}\}$,n ≠ 0, n + J = I , and X_b ends at X_{I-1} , hence , $X_b \, \varepsilon \{X_n, X_n+_1, \ldots, X_{n+j-1}\}$

III. PROCEDURE

BBPHE description for all the three cases is then shown in the Fig. No.1. BBPHE may be extended for the image with several-continuous ranges of a background-level. Let, A be input -image with the g numbers of a separate background-level ranges and the h-numbers of a non background level-ranges, and B be output-image, then

$$A \neq (A1 \cup A2 \cup \ldots\ldots A_y) \cup (A_{y1} \cup A_{y2} \cup \ldots\ldots\ldots\ldots A_{yg}) \tag{16}$$

$$B = (f_1 \cup f_2 \cup \ldots\ldots \cup f_b) \cup (f_{b1} \cup f_{b2} \ \ldots\ldots\ldots \cup f_{bg}) \tag{17}$$

As indicated by the mechanism of histogram equalization and histogram specification, an image with a large upper boundary value (and in this manner PDF) of the backing of the histogram will result in washed-out appearances after equalizing histogram. Then again, one with an expansive lower boundary value (and in this way PDF) of in the backing of the histogram will show up patchiness effects in equalizing histogram [11]. One or both of these impacts might also occur in the plan of histogram redistribution methods, for example, GLG. In this area, we should propose a basic histogram modification scheme to uproot these effects.

The methodology of the scheme is outlined as takes after:
1. Locate the initial two and last two values of the support of the histogram.
2. Set the first value to be zero and supplant the last one with the minimum between the last two values.
3. Perform histogram equalization.

IV. RESULTS

The BBPHE is contrasted with the CHE, BBHE, DSIHE and MMBEBHE for evaluation. The output histograms are inspected as well. Fig. 2 shows these HE methods on a cell image and the separate histograms. For BBPHE, the input image is fragmented and is taking into account of three intervals showed in the input histogram in Fig. 2 b. The images in Fig. 1 demonstrate that the objects in the input image are improved by every one of the routines. In any case, BBPHE beats the other four where the background brightness are very much preserved. This can be seen by looking at the histograms, where the background levels in Fig. 2 are unnecessarily extended in the other four techniques, bringing about over improvement. Therefore, the non-background levels are insufficiently stretched. The proposed BBPHE tackles this issue by keeping up the background levels in the same intervals, and henceforth has the capacity satisfactorily extend the non-background levels. The color results are shown by image 2 and the hue preservance is given by fig 4.

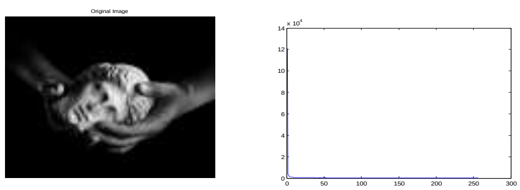

Fig 2 (a) Original Image and its histogram

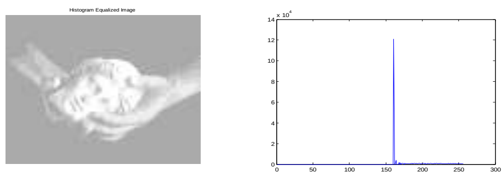

Fig 2 (b) Histogram equalized Image and its histogram

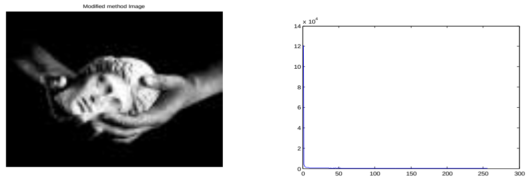

Fig 2 (c) Modified Image and its histogram

TABLE 1. COMPARISONS ON CELL

	Mean	Entropy
Original Image	86.4346	-
Histogram Equilized Image	45.8642	3.3595

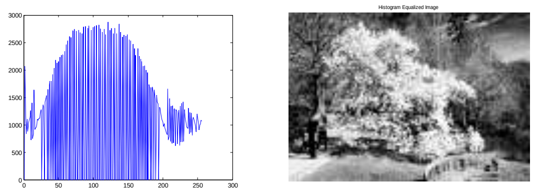

Fig 3 (a) Histogram Equalized Image

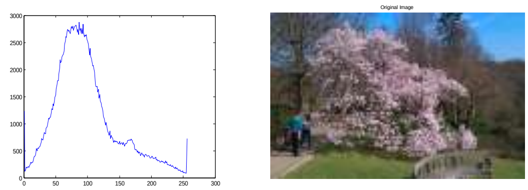

Fig 3 (b) Original Image and its histogram

Fig 3 (c) Final colored Image

Fig 4 (a) Results of Hue Preservance

TABLE 2. COLOUR IMAGE RESULTS

	Mean	Entropy	Hue preservance Mean
R component	123.6701	7.2093	101.6654
G component	110.9212	7.3152	102.7670
B component	132.1814	7.4396	104.3695

V. CONCLUSION

The primary targets of difference upgrade incorporate improving the items while at the same time keeping up the foundation splendor. In this paper, another histogram adjustment strategy by disintegrating the information picture in view of the foundation and non-background levels is presented. The displayed system is equipped for enhancing the items while saving the foundation splendor. The exploratory results demonstrate that this technique beats the other existing strategies.

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