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A Review Of Widely Used Histogram Equalization Based Image Enhancement Methods

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Abstract
In the field of Digital Image Processing, contrast upgrade is the critical element which can improve the complexity of image dealing applications successfully. Histogram Equalization is the straightforward and generally known procedure for improving contrast of image that prompts the presence of image brighter. Histogram Equalization is not known as the best strategy for contrast improvement as it experiences the advantage of "mean-shift" issue i.e. Rather than mean brightness of input image, mean brightness is dependably in the center dark level. Different strategies are created that by one means or another tries to defeat the disadvantage of customary Histogram Equalization, for example, BBHE, DSIHE, and RSIHE. This paper gives survey of these distinctive procedures.
***Keywords: -** Histogram Equalization, Contrast Enhancement, Brightness preservation.*

1- INTRODUCTION

Histogram improvement is considered as imperative trademark in the field of digital image processing. It is basically utilized for medicinal image preparing, discourse acknowledgment, surface amalgamation and different applications [1].

Histogram equalization is eminent and prominent method for image Histogram updates that usages histogram of image in its planning. Histogram conformity encounters drawback of "mean-shift" issue i.e. mean brightness is reliably in the inside dim level instead of mean sparkle of data image. This technique changes the brightness of data image inside and out. Along these lines, this method is not sensible in circumstances where brightness preservation is the basic component. Distinctive procedures have been made like BHE, DSIHE, and RSIHE in the field of image processing shift up to overcome the issue of Histogram Equalization. Let us discuss a part of the crucial techniques.

BHE procedure is created that overcomes the issue of standard histogram alteration by segregating the data image into two sub images in perspective of mean estimation of data image and a short time later just histogram adjust is associated unreservedly on sub image. Along these lines, BHE can spare sparkle of image. DSIHE resembles BHE beside that it disengages the information sources image in light of center estimation of data image. RMSHE is the extension of BBHE in which input image is confined recursively in light of mean estimation of data image. This methodology can secure more brightness as each sub histogram is separated recursively.

The generalized used HE based strategy can be thoroughly detached into five classes which are

1. The traditional HE technique.
2. Bi-HE methodologies.
3. Recursive division based HE strategies.

The relationship of this work is according to the accompanying. In the wake of giving a short introduction in fragment 1, in section 2 we will cover the standard histogram equalization procedure in detail. Portion 3 covers in unpretentious components all the comprehensively used adaptable HE based counts. Portion 4 covers in purposes of intrigue all the by and large used Bi-HE based computations. Zone 5 covers in unpretentious components all the for the most part used recursive division HE based estimations. Portion 6 covers in detail all the by and large used component division based histogram conformity systems. Finally territory 6 completes the entire setting.

Histogram equalization is a well known and straightforward strategy for image contrast upgrade that utilizations histogram of image while preparing [1]. Histogram adjustment is utilized as a part of various zones like restorative image handling, discourse acknowledgment and so forth. Histogram adjustment bombs in situations where splendor protection is important component as it experiences the downside of "mean-shift" issue It is notable that in the wake of applying HE technique the resultant handled image will have uniform foundation. On the off chance that Y is the prepared image then

$$pdf(y) = \frac{1}{(X_{L-1} - X_0)} \quad (1)$$

Now mean brightness of histogram equlized image is given as:

$$E(Y) = \int_{X_0}^{X_{L-1}} y.pdf(y)dy \quad (2)$$

$$E(Y) = \int_{X_0}^{X_{L-1}} \frac{y}{(X_{L-1} - X_0)} dy \quad (3)$$

$$E(Y) = \frac{(X_0 + X_{L-1})}{2} \quad (4)$$

2- THE HISTOGRAM EQUALIZATION METHOD

Histogram equalization is eminent and conspicuous method for image Histogram updates that usages histogram of image in its planning. Histogram conformity encounters drawback of "mean-shift" issue i.e. mean brightness is reliably in the inside dim level instead of mean sparkle of data image. This technique changes the brightness of data image inside and out. Along these lines, this method is not sensible in circumstances where brightness preservation is the basic component. Distinctive procedures have been made like BHE, DSIHE, RSIHE in the field of image processing shift up to overcome the issue of Histogram Equalization. Let us discuss a part of the crucial techniques.

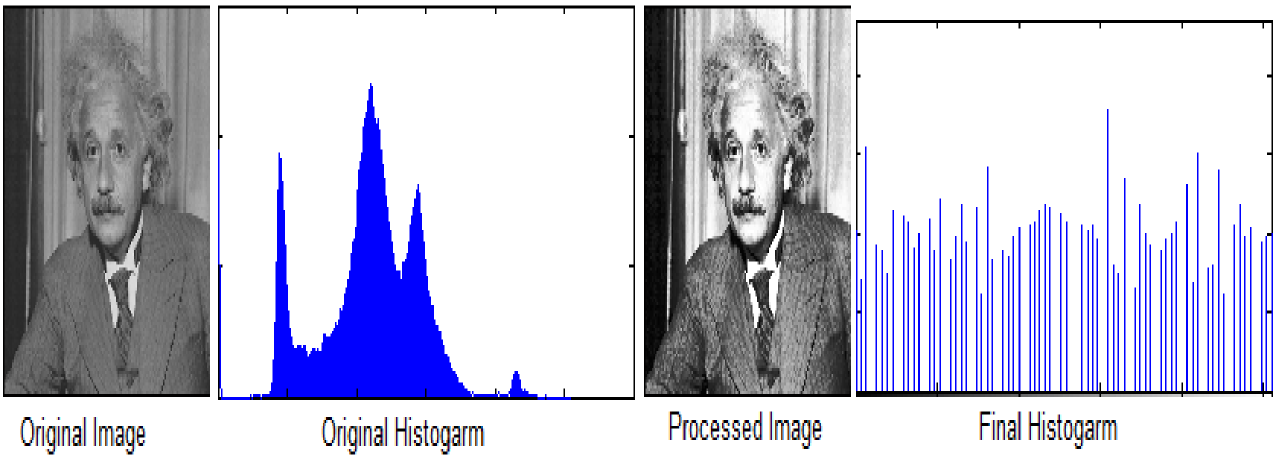

Fig. 1 Results of the conventional histogram equalization method.

Brightness Changed by the Histogram Equaliztaoin Method:

It is well known that after applying HE method the resultant processed image will have uniform background. If Y is the processed image then:

$$pdf(y) = \frac{1}{(X_{L-1} - X_0)} \quad (5)$$

Now mean brightness of histogram equlized image is given as:

$$E(Y) = \int_{X_0}^{X_{L-1}} y.pdf(y)dy \quad (6)$$

$$E(Y) = \int_{X_0}^{X_{L-1}} \frac{y}{(X_{L-1} - X_0)} dy \quad (7)$$

$$E(Y) = \frac{(X_0 + X_{L-1})}{2} \quad (8)$$

This is known as the mean shift problem. In other words mean brightness of histogram equalized image is middly grey level.

3- BI-HISTOGRAM EQUALIZATION BASED METHODS

A- Brightness Preserving BI-Histogram Equalization BBHE

BBHE is presented by Chen and Ramli [5] to defeat the disadvantage of histogram equalization which can't save brightness of image. BBHE separates the information image histogram into two sub-images histograms in light of mean estimation of information image and apply histogram equalization on each sub-histogram autonomously. BBHE is fit for performing mean partition before equalization is performed autonomously. Subsequently, ready to safeguard splendor which is not if there should arise an occurrence of histogram evening out. Now let input image X is decomposed into two sub-histograms namely X_L and X_U by using the input mean X_m, where $X_m \in \{X_0, X_1, X_2 \ldots X_{L-1}\}$. Now it is clear that $X_L = [X_0, X_m]$ and $X_H = [X_m, X_{L-1}]$.

Brightness Changed by the BBHE Method:

Let Y is the processed image after applying BBHE. Then

$$E(Y) = E(Y \mid X \le X_m)\Pr(X \le X_m) + E(Y|X > X_m)P_r(X > X_m) \quad (9)$$

$$= \frac{1}{2}\{E(Y|X \ge X_m) + E(Y|X > X_m)\} \quad (10)$$

since

$$E(Y \mid X \le X_m) = (X_0 + X_m)/2 \quad (11)$$

and

$$E(Y \mid X > X_m) = (X_m + X_{L-1})/2 \quad (12)$$

$$E(Y) = \frac{1}{2}(X_m + X_G) \ , \quad (13)$$

where $X_G = (X_0 + X_{L-1})/2$

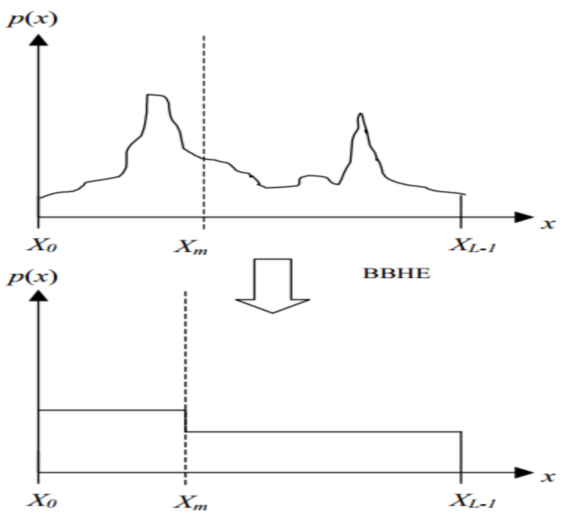

Fig. 2 The concept of BBHE, here the input image histogram is divided into two sub-histograms (source [8]).

B- Minimum Mean Brightness Error BI-Histogram Equalization MMBEBHE

MMBEBHE [6] is the augmentation of BBHE. MMBEBHE is a technique that isolates the input image histogram in light of limit estimation of information image which limits absolute mean brightness error in the handled image.

The accompanying 3 stages are performed while performing MMBEBHE:

1: Firstly, for every limit level, estimation of AMBE is done.

2: Therefore, figuring of least edge level Xt is finished by this technique which prompts minimum MBE.

3: Finally, base Xd on Xt of step 2 MMBEBHE separates the input histogram and after then apply histogram equalization on each of sub histogram freely.

Brightness Changed by the MMBEBHE Method:

$$E(Y) = E(Y \mid X \le X_T)\Pr(X \le X_T) + E(Y|X > X_T)P_r(X > X_T)$$

$$= \frac{1}{2}\{E(Y|X \ge X_T) + E(Y|X > X_T)\}$$

$$E(Y \mid X \le X_T) = (X_0 + X_T)/2$$

$$E(Y \mid X > X_T) = (X_T + X_{L-1})/2$$

$$E(Y) = \frac{1}{2}(X_T + X_G)$$

$$X_G = X_0 + X_{L-1}/2 \quad (14)$$

C- Equal Area Dulastic Sub-Image Histogram Equalization

DSIHE is proposed by Wan et al. [9]. DSIHE is like BBHE aside from that in BBHE input image histogram is partitioned into sub-image histogram in light of mean estimation of input image while in the event of DSIHE information image is isolated into sub-images in view of middle estimation of input image and after that apply histogram equalization autonomously on these sub-images

Let input image X is decomposed into two sub-histograms namely X_L and X_U by using the input median X_D, where $X_D \in \{X_0, X_1, \ldots, X_{L-1}\}$. Now it is clear that $X_{Low} = [X_0, X_D]$ and $X_{High} = [X_{D+1}, X_{L-1}]$.

Brightness Changed by the DSIHE Method:

$$E(Y) = E(Y|X < X_e) + E(Y|X \geq X_e)$$
$$E(Y|X < X_e) = (X_0 + X_{e-1})/4$$
$$E(Y|X \geq X_e) = (X_e + X_{L-1})/4$$
$$E(Y) = (X_0 + X_{e-1})/4 + (X_e + X_{L-1})/4$$
$$= (X_e + (X_{L-1} + X_0)/2)/2)$$

4- RECURSIVE SEGMENTAION BASED METHODS

A- Recursive Sub-Image Histogram Equalization

RSIHE takes after the comparative trademark as that of RMSHE in isolating the info image and afterward equalizing it. The distinction emerges between RSIHE [8] and RMSHE is that RMSHE takes after mean detachment approach for brightness conservation and RSIHE isolates the image histogram with middle qualities utilizing cumulative probability density function.

Brightness Changed by the RSIHE Method:

$$E(Y) = E(Y|X \leq X_{ml})\Pr(X \leq X_m)$$
$$E(Y|X_{ml} < X \leq X_m)\Pr(X_{ml} < X \leq X_m)$$
$$+ E(Y|X_m < X \leq X_{mu})\Pr(X_m X < X_{mu})$$
$$+ E(Y|X > X_{mu})\Pr(X > X_{mu})$$
$$= \frac{1}{4}\{E(Y|X \leq X_{ml}) + E(Y|X_{ml} < X \leq X_m)$$
$$+ E(Y|X_m < X \leq X_{mu}) + E(Y|X > X_{mu})\}$$
$$E(Y) = \frac{1}{4}\{[(X_0 + X_{ml})/2] + [X_{ml} + X_m)/2]$$
$$+ [(X_m + X_{mu})/2] + [X_{mu} + X_{L-1})/2]\}$$
$$\frac{1}{4}\{[X_0 + X_{L-1})/2] + [2(X_{ml} + X_{mu})/2] + X_m\}$$
$$= \frac{1}{4}\{X_G + 2X_m + X_m\}$$
$$= \frac{1}{4}\{X_G + 3X_m\} \quad (15)$$

B- Recursively Separated and Weighted Histogram Equalization

The fundamental thought of RSWHE [11] is to portion an info histogram into at least two sub-histograms recursively, to adjust the sub-histograms by methods for a weighting procedure in view of a normalized power law function, and to perform histogram equalization on the weighted sub-histograms freely.

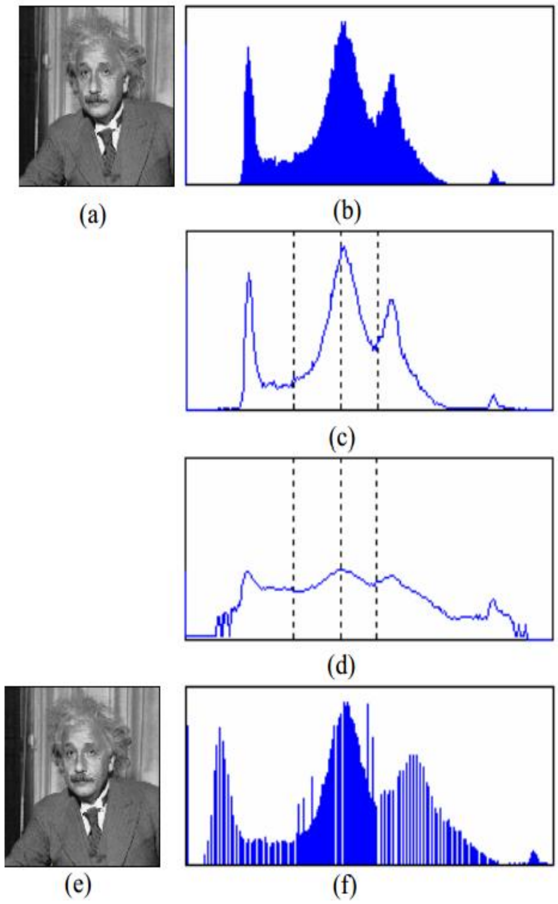

Fig.3. Intermediate results of RSWHE: (a) input image, (b) input histogram, (c) segmented histogram, (d) weighted and normalized PDF, (e) output image, and (f) output histogram (source [12]).

5- CONCLUSION

This paper demonstrates review of various Histogram Equalization techniques. After investigation of various techniques it is observed that brightness preservation is not taken care of well by contrast improvement strategies, for example, HE, BBHE, DSIHE. Be that as it may, it can be taken care of well up to some degree by strategies like RSIHE and RSWHE. When contrasted with different techniques, RSWHE-M offers better brightness preservation and contrast upgrade. The RSWHE likewise turns out to be better contrast upgrade component as a result of its recursive nature

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