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A Review of Histogram Equalization Based Image Contrast Enhancement Methods

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Abstract
Contrast enhancement is considered as one of the critical trademark in the field of image processing and histogram equalization is a straightforward and understood strategy for image contrast upgrade, this technique utilizes the histogram of image in its preparing. In spite of the fact that the ordinary histogram equalization technique is broadly acknowledged however this strategy experiences the drawback of "mean-shift" issue, i.e. mean brightness of processed image will always be the middle gray level regardless the mean brightness of the input image. So it is not considered as the best technique for balance improvement with brightness protection. A few other histogram equalization based techniques have been introduced to overcome the issue of mean shift problem. In this paper we will survey generally utilized histogram equalization strategies utilized for differentiation upgrade and brightness conservation.
Keywords: - *histogram equalization, contrast enhancement, brightness preservation.*

1- INTRODUCTION

In the field of advanced image preparing contrast enhancement is for the most part utilized as a part of computer vision and it is likewise utilized for development of pictorial data for human visual perception. It is generally used for medical image processing, speech recognition, texture synthesis and various other applications.A few techniques have been presented in the field of image contrast enhancement [2]-[10]. Let us review some of the important methods.

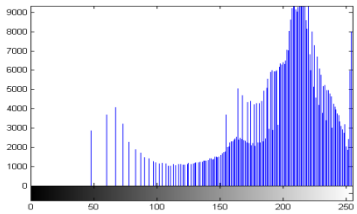
Low contrast advanced image investigation is a testing issue in computerized image preparing. Low differentiation computerized images decrease the capacity of observer to analyze the image. Histogram equalization (HE) is the one of the prominent strategy for image contrast improvement [1]. The histogram of the discrete dark level image speaks to the recurrence of event of every dim level in the image [5]. This technique is predominantly utilized on account of its straightforwardness of usage and computationally less cost than different strategies. In spite of the fact that the HE technique is broadly acknowledged however many time histogram equalization image experiences the "mean-shift" issue [5], i.e. it shifts the mean intensity value to the middle gray level of the intensity range. So this procedure is not helpful in circumstances, where mean brightness conservation is required. To defeat this issue various varieties of HE technique have been proposed. In this paper we will give a precise survey on generally utilized HE based techniques.

The organization of this work is as follows. After providing a brief introduction in section 1, in section 2 we will cover the histogram equalization method in detail. Section 3 covers in details all the widely used HE based algorithms. Finally section 4 concludes the entire context

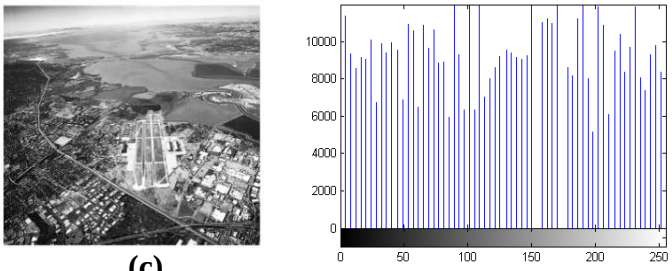
2- THE HISTOGRAM EQUALIZATION METHOD

Histogram equalization is an outstanding technique for image contrast improvement that utilizations histogram of image in its preparing. HE is a spatial space method in which alteration of pixels power qualities is done specifically which prompts upgrade of image.

(a)



(b)



(c) **(d)**

Fig. 1. (a) shows input image having low contrast, (b) shows histogram of input image, (c) shows histogram equalized image and (d) shows histogram of processed image.

3- HISTOGRAM EQUALIZATION BASED METHODS

A- Adaptive Histogram Equalization Method

Adaptive histogram equalization (AHE) [2] is a system of image differentiation upgrade utilized as a part of computerized image handling. It is not the same as ordinary histogram adjustment procedure in the way that the AHE figures different histogram balances freely, each of which has a place with various areas of images. The main advantage of AHE is that it can upgrade the nearby complexity of image and consequently, preserve more brightness.

Conventional histogram adjustment utilizes a similar change to change all pixels. HE demonstrates better in situations where pixels qualities are conveyed consistently in the image. Be that as it may, flops in situations where image comprises of various brighter and darker locals as it is not ready to improve the complexity of image. Therefore not able to protect splendor of brightness of image.

AHE conquers the downside of HE by improving nearby differentiation of image. AHE improve this change work by changing every pixel values. In light of the histogram of square, which is encompassed by pixel esteem every pixel esteem is changed as appeared in figure. The pixel estimation of neighborhood is corresponding for every change work and aggregate dispersion work. The customary histogram adjustment is like the change work got from every pixel esteem.

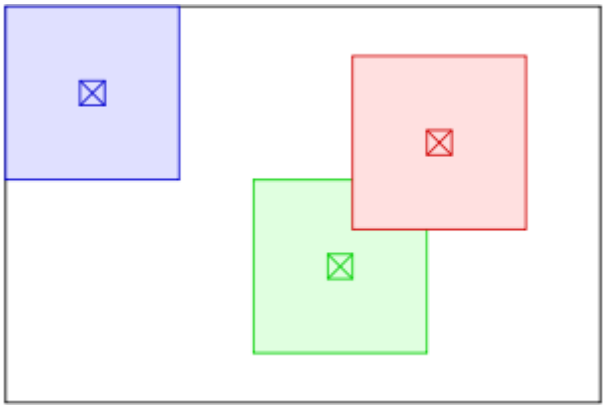


Fig. 2 Concept of Adaptive Histogram Equalization (ref [3]).

B- Contrast Limited Adaptive Histogram Equalization

Contrast Limited AHE (CLAHE) [4] encourages the contrast constraining usefulness that makes them not the same as adaptive HE. AHE can upgrade the local subtle elements just while contrast restricting usefulness of CLAHE can improve the global points of interest too. The fundamental favorable position of CLAHE is that it can forestall bends like commotion enhancement which is not in the event of AHE. The differentiation restricting usefulness of CLAHE is connected for each neighbor from whom we infer change work.

CLAHE performs noise enhancement by applying contrast constraining usefulness in AHE. The slope of change capacity decides the contrast intensification for each of the pixel esteem and the zone encompassed by pixel esteem. This is like the estimation of histogram for every pixel esteem. It is additionally like the slope of cumulative distribution function (CDF). CLAHE play out this intensification work by trimming the piece of histogram before applying the CDF which just prompts confine the incline of change. Contingent upon the standardization of this histogram, cut breaking point is the term characterized as the incentive through which histogram is trimmed.

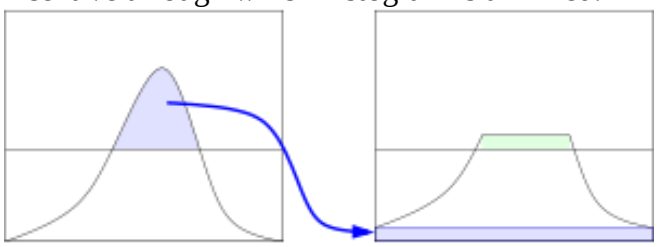


Fig. 3 Concept of Contrast Limited Adaptive Histogram Equalization (source [3]).

C- Brightness Preserving Bi-Histogram Equalization

The strategy was proposed by Kim [5]. This strategy beats the disadvantage of histogram adjustment. BBHE sections the image histogram into two sub-histograms: (in view of mean estimation of information image histogram) one from least dim level to the mean esteem and other from the mean an incentive to the most extreme dark level. After this the BBHE technique applies HE on each sub-histogram freely.

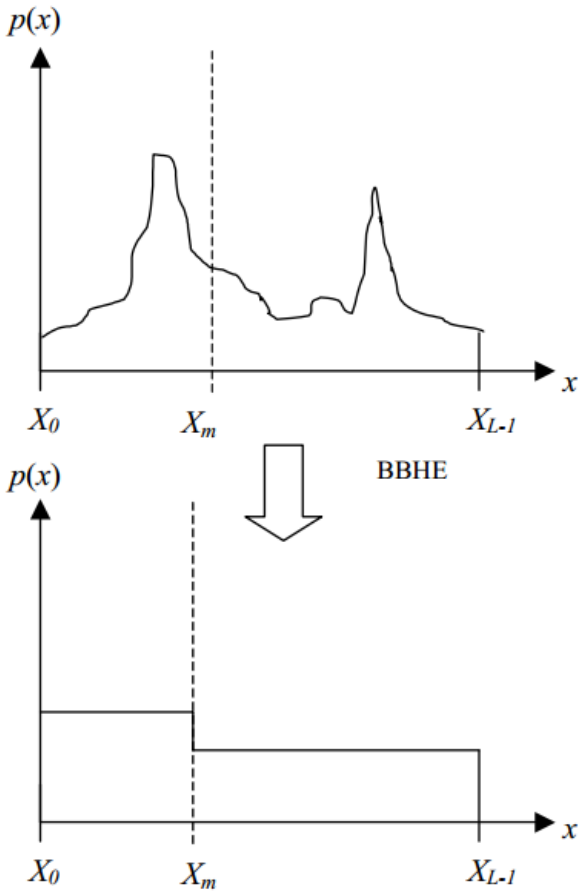


Fig. 4 shows the concept of BBHE, here the input image histogram is divided into two sub-histograms (source [7]).

D- Equal Area Dualistic Sub-Image Histogram Equalization

The BBHE technique solved the mean-shift issue up to some degree; however this strategy was not ready to protect fine subtle elements display in the information image. To take care of this issue Equal Area Dualistic Sub-Image Histogram Equalization (DSIHE) was proposed [6]. This strategy takes after an indistinguishable approach from that of the BBHE with the exception of DSIHE sections the image histogram in light of the median of the information image.

E- Recursive Mean Separate Histogram Equalization

This technique is an expansion of BBHE; the RMSHE [7] gives brighter preservation than BBHE. In BBHE the mean based division is preformed just once yet in RMSHE this division is performed more than once. This recursive nature of the RMSHE strategy infers adaptable conservation which is exceptionally valuable in purchaser electronic items.

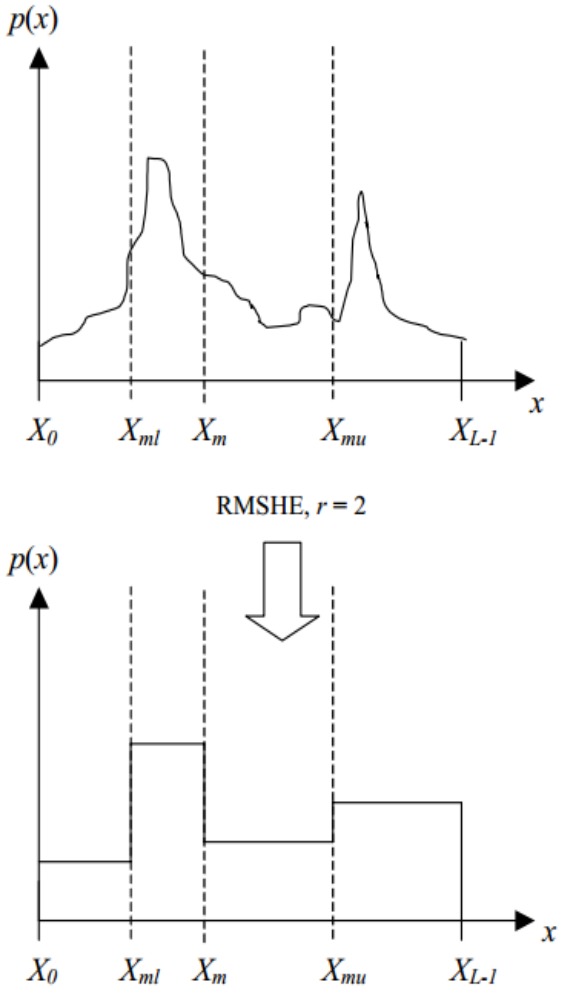


Fig. 5 shows the concept of RMSHE, here the input image histogram is divided into four sub-histograms (ref [7]).

F- Recursively Separated and Weighted Histogram Equalization

The basic thought of RSWHE [8] is to fragment an information histogram into at least two sub-histograms recursively, to alter the sub-histograms by methods for a weighting procedure in view of a normalized power law work, and to perform histogram equalization out on the weighted sub-histograms autonomously.

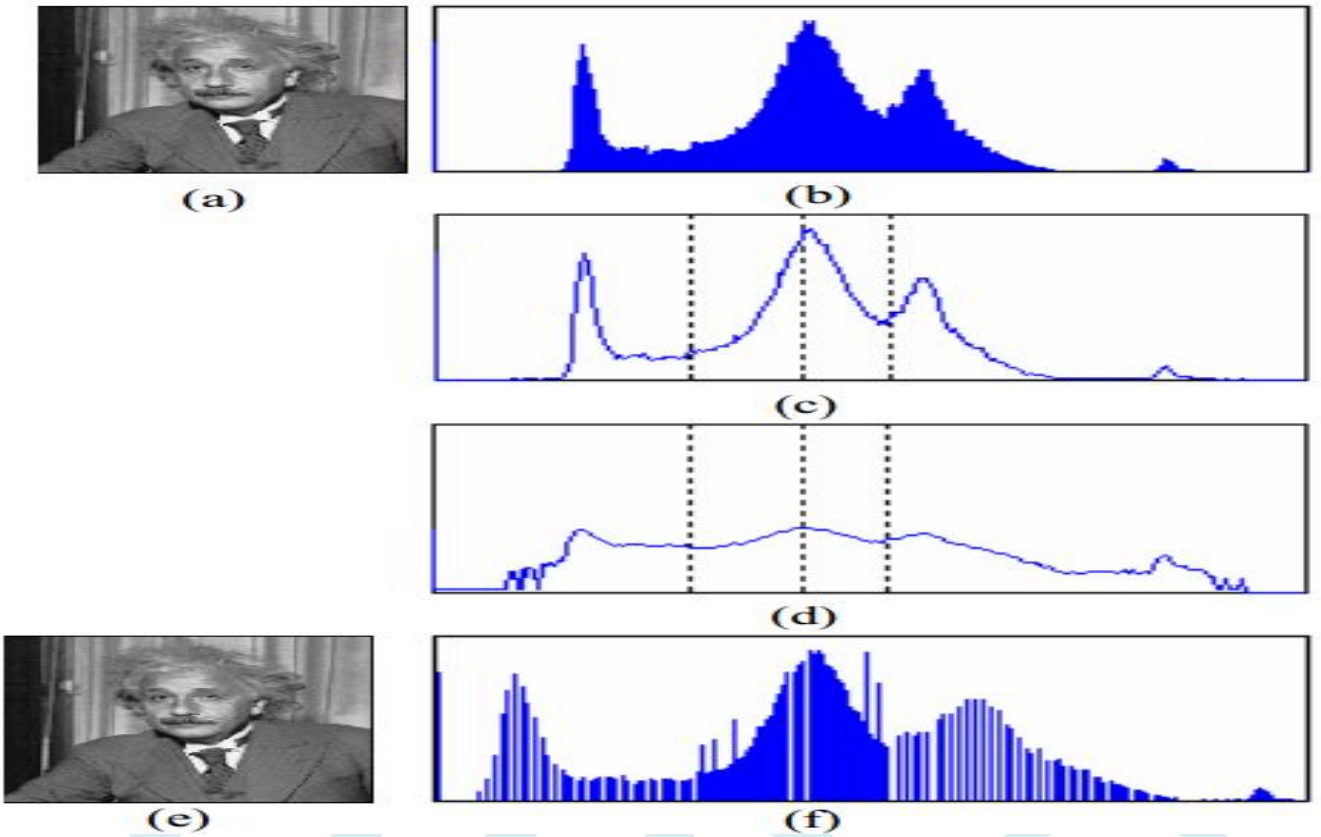


Fig. 6intermediate results of RSWHE: (a) input image, (b) input histogram, (c) segmented histogram, (d) weighted and normalized PDF, (e) output image, and (f) output histogram (ref [8]).

Next we show a tabular comparison of each method discussed in this work.

4- CONCLUSION

This paper gives the assessment of various histogram equalization strategies. The investigation of different histogram equalization strategies demonstrates that brightness is not protected productively by histogram equalization strategy. Different strategies like BBHE and DSIHE are acquainted which tries with expel the drawback of histogram equalization up to some degree. RMSHE conquers the downside of BBHE and DSIHE.

Table I Comparison of different methods

S.No.	Method	Advantage	Disadvantage
1	HE	The simplest method of contrast enhancement.	Suffers from the mean-shift problem.
2	AHE	Developed because HE was not able to deal with images having dark and bright regions.	Noise amplification.
3	CLAHE	Developed to solve the problem of noise amplification of AHE.	Depends on too many parameters.
4	BBHE	This method is able to deal with mean-shift problem.	Not able to preserve image fine details.
5	DSIHE	This method is able to deal with mean-shift problem.	Not good as it is not able to maintain more mean brightness in the processed image.
6	RMSHE	An extension of BBHE, this method perform histogram segmentation recursively.	More frequent grey levels are over-enhanced and less frequent grey levels are less enhanced.
7	RSWHE	An extension of RMSHE, the method was developed to overcome disadvantages of RMSHE method.	No disadvantage.

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