International Journal of Research in Science and Technology http://www.ijrst.com

(IJRST) 2018, Vol. No. 8, Issue No. I, Jan-Mar **e-ISSN: 2249-0604, p-ISSN: 2454-180X**

ENHANCEMENT OF IMAGES USING HISTOGRAM TECHNIQUES

***Gunjan Bansal, **Dr. Sachin Yadav**

**Research Scholar, Dept of Computer Science and Engineering, Calorx Teachers' University, Ahmedabad*
***Professor, Dept of Computer Science and Engineering, G L Bajaj Institute of Technology & Management, Greater Noida, UP*

INTRODUCTION

Image enhancement approaches adopting histogram equalization can be broadly categorized into classes of global and local equalization implementation. The former method conducts equalization over all image pixels concurrently. In a canonical implementation, the resultant image has a histogram resembling a linear transformation or stretching from its original image histogram. In spatial relationships between neighboring pixels were taken into consideration.

On the other hand, local equalization tackles image enhancement by dividing the image into multiple sectors and equalizing them independently. In the work by Stark, the generation of a desired target histogram is made dependent on the characteristics of local windows. For this, a predetermined scheme can be applied to divide the image into subblocks, where each block is equalized independently. In this context, a local histogram equalization scheme was proposed. In the input images were subdivided, independently equalized, and finally fused to produce a contrast-enhanced image. This approach was further developed in Kim et al., where the original image is divided into overlapping subblocks and equalized according to the pixel characteristics within the block. In the image histogram is matched to a distribution determined from a windowed and filtered version of the original histogram. Manipulations on the histograms were also frequently suggested by researchers. These include specific considerations in minimizing the mean brightness error between the input and output images. In the maximum entropy or information content criterion was invoked in contrast enhancement.

Image enhancement is a process of changing the pixels intensity of the input image; to make the output image subjectively look better Contrast enhancement is an important area in image processing for both human and computer vision. It is widely used for medical image processing and as a pre-processing step in speech recognition, texture synthesis, and many other image/video processing applications. Contrast is created by the difference in luminance reflectance from two adjacent surfaces. In our visual perception, contrast is determined by the difference in the color and brightness of an object with other objects. If the contrast of an image is highly concentrated on a specific range, the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to enhance the contrast of an image in order to represent all the information in the input image. Brightness preserving methods are in very high demand to the consumer electronic products. Numerous histogram equalization (HE) based brightness preserving methods tend to produce unwanted artefacts.

LITERATURE REVIEW

Kim and Paik, et.al 2008 introduced a new contrast enhancement method for controlling noise amplification as well as preserving the original brightness of the image named as Gain-Controllable Clipped Histogram Equalization (GC-CHE). It is an interpretation of BBHE and RMSHE methods. Based on clipping level, histogram of the image is clipped and the clipped portion is then re-distributed to the entire dynamic range by locally regulating the clipping gain. While enhancing the contrast of a low light-level image, the contrast elevation ration is adjusted to solve the noise amplification problem according to the input image and compensate contrast using the gain control method.

Ooi *et al.*, 2009, proposed Bi-Histogram Equalization Plateau Limit (BHEPL) as the fusion of the BBHE and clipped histogram equalization. Similar to BBHE, the BHEPL decomposes the input image into two sub-images by using mean brightness of the image. Then, these sub-histograms are clipped by using the plateau limit as the mean of the number of intensity occurrence and the decomposed sub-histograms are equalized independently. BHEPL method avoids excessive enhancement and over amplification of noise in the image.

Ooi *et al.*, 2010 introduced clipping based Quadrants Dynamic Histogram equalization (QDHE), which separates the histogram into four sub-histograms based on the median of the input image. Then, the resultant sub-histograms are clipped according to the mean of intensity occurrence of the input image before new dynamic range is assigned to each sub-histogram and are equalized individually. QDHE is most robust method to extract the details of the low contrast images.

Liang *et al.*, 2012, proposed Double Plateaus Histogram Equalization (DPHE) for infrared image enhancement. In this method, upper and lower threshold values could be calculated by searching local maximum and predicting minimum gray interval and be updated in real time. The value of upper threshold is set to be 20-30% of the total pixels, while the lower threshold value is set to be 5-10% of it. The upper threshold is utilized in the algorithm for preventing over-enhancement of background noise with typical gray levels, and the lower threshold is set for protecting detailed information with fewer pixels from being combined.

X. Fang et al. proposed a method to improve the enhancement result with image fusion method with evaluation on sharpness. Image enhancement can improve the perception of information.

HISTOGRAM EQUALIZATION BASED TECHNIQUES

Histogram equalization is a simple and an effective contrast enhancement technique which distributes pixel values uniformly such that enhanced image have linear cumulative histogram and is a global operation. Hence, it does not preserve the image brightness. To overcome these drawbacks and increase contrast enhancement and brightness preserving many HE-based techniques have been proposed.

1. Bi-Histogram Equalization Methods

Bi-histogram equalization methods divide the histogram into two sub-histograms based on different dividing points. Later, each sub-histogram is equalized individually based on histogram equalization. These methods can preserve image brightness more, when compared to Histogram Equalization method.

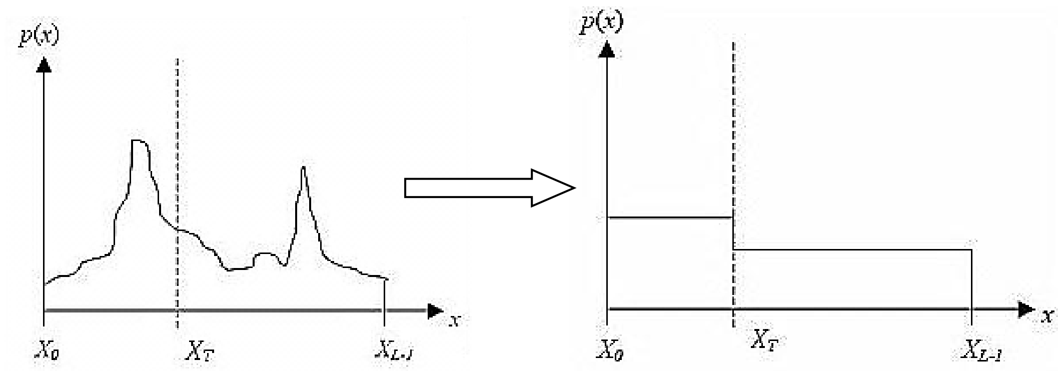


Figure 1: Bi-histogram Equalization Method
(a) Input Histogram Divides into Two sub-histograms (b) Equalized Sub-histograms

First Mean based separation technique, Brightness Preserving Bi-Histogram Equalization (BBHE) has been proposed by Kim in 1997 to preserve the mean brightness of a given image while contrast is enhanced and it preserves the brightness of image at some extent and shown better result than HE. Similar to BBHE, Wang et al. in 1999 proposed Dualistic Sub-Image Histogram Equalization (DSIHE), but this method used median value instead of mean to separate the input histogram and shown better brightness preserving than BBHE and HE. DSIHE is the best processing technique to preserve the original image brightness and also enhance the image information effectively. BBHE and DSIHE are not much suitable for images requiring higher degree of brightness preservation to avoid annoying artefacts.

For higher degree of preservation Chen and Ramli in 2003 proposed Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE) an extended method of BBHE and the separation based on threshold level, which would yield minimum Absolute Mean Brightness Error (AMBE). The ultimate goal behind this method is to allow maximum level of brightness preservation in Bi-Histogram Equalization to avoid unpleasant artefacts and unnatural enhancement due to excessive equalization, and also to formulate an efficient, recursive and integer-based solution to approximate the output mean as a function of threshold level. Simulated results, MMBEBHE clearly indicates that it has preserved better brightness and yielded a more natural enhancement. BBHE and MMBEBHE have a better preservation and enhancement levels compared to HE and DSIHE. But, MMBEBHE shows poor brightness preservation and enhancement, where the images that require far more brightness preservation it fails to control the over enhancement of the image.

Range Limited Bi-Histogram Equalization (RLBHE) has been proposed by Zuo *et al.*, in 2012, which divides the input histogram into two independent sub-histograms by a threshold that minimizes the intra-class variance. This was carried out to effectively separate the objects from the background. This method achieves visually a more pleasing contrast enhancement while maintaining the input brightness and it is easy to implement in real-time processing.

2. Multi Histogram Equalization Methods

In order to enhance contrast, preserving brightness and improve natural looking of the images, multi-histogram equalization technique decomposes the input image into several sub-images, and then applies the classical histogram equalization process to each of sub-histogram. Image processed by Multi-HE methods preserves the image brightness and prevent introduction of undesirable artefacts but not significantly enhance the contrast.

Recursive Mean-Separate Histogram Equalization (RMSHE) has been proposed by Chen and Ramli in 2003, is to divide the input histogram into two, based on its mean before equalizing them independently. This separation is done one time in BBHE, but in this method new histograms (separated) were further divided based on their mean value. It has been analysed mathematically that the output image’s mean brightness would converge to the input image’s mean brightness as the number of recursive mean separations increases. In order to achieve higher brightness preservation, this model is proposed to perform the mean separation recursively and separate the resulting histograms again based on their respective means. Similar to RMSHE, Recursive Sub-Image Histogram Equalization (RSIHE) is proposed by Sim *et al.* in 2007 and it separates the input histogram based on a gray level with median, but RMSHE uses mean-separation and both the methods share the same characteristics in equalizing the sub-histograms. Both methods shown good brightness preserving because of multi separation of histogram, but for bright images these methods lead to over enhancement.

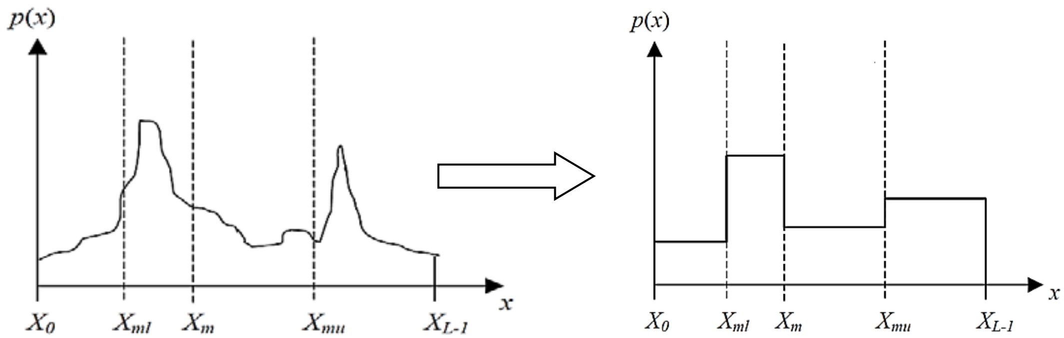


Figure 2: Recursive Mean-Separate Histogram Equalization (RMSHE)
(a) Separated Histogram (b) Equalized Histogram (r=2)

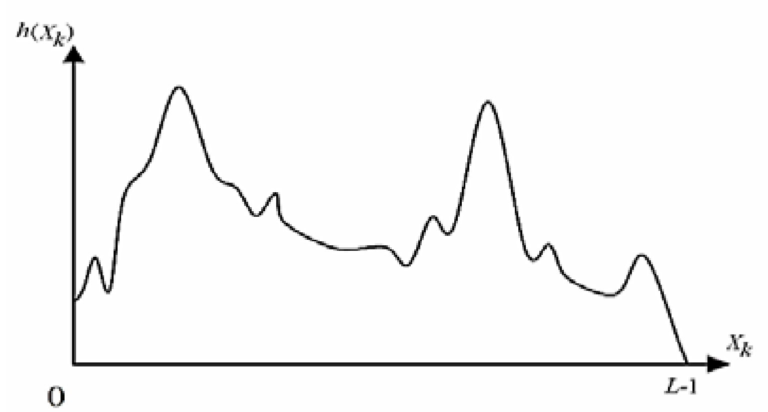
Dynamic Histogram Equalization (DHE) has been introduced to overcome the drawback of the DHE, Brightness Preserving Dynamic Histogram Equalization (BPDHE) has been proposed by Ibrahim and Kong in 2007, an extension method of the DHE and Multi Peak Histogram Equalization with Brightness Preserving (MPHEBP) and divides the input histogram based on local maximum value. BPDHE shown better contrast enhancement compared to MPHEBP and mean brightness preserving compared to DHE.

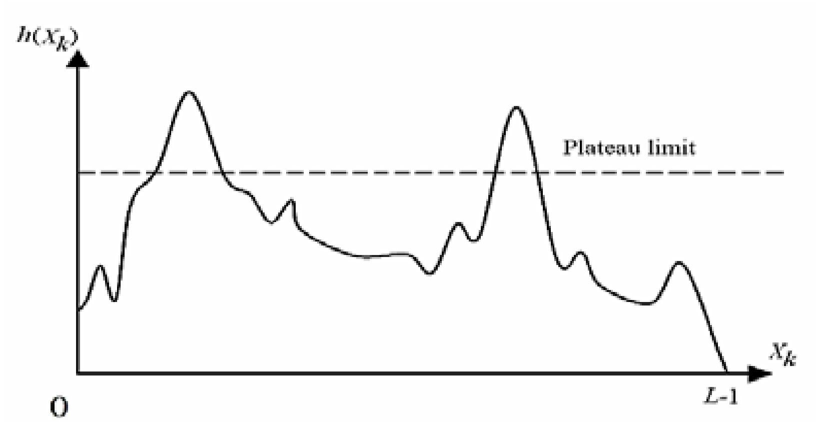
MMLSEMHE is more computationally complex because it estimates the optimal number of sub-histograms from all possible sub-histograms to minimize certain discrepancy functions. Both the methods preserves the brightness to a maximum extent but the contrast enhancement is less intensive.

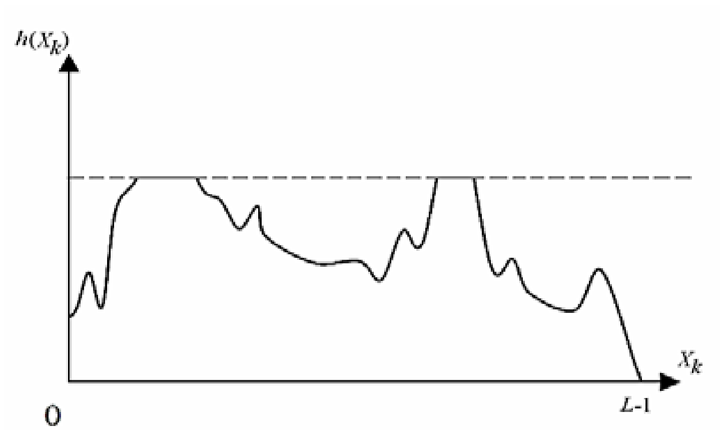
RSWHE-M and RSWHE-D are two different implementations of RSWHE: that is, RSWHE-M performs the mean-based segmentation and RSWHE-D performs the median-based segmentation. From the experimental results, the RSWHE-M method is found to be better than the RSWHE-D for brightness preserving and contrast enhancement.

3. Clipped Histogram Equalization Methods

Generally, histogram equalization stretches the contrast of the high histogram regions, and compresses the contrast of the low histogram regions. As a result, when the object of interest in an image only occupies a small portion of the image, this object will not be successfully enhanced by histogram equalization and this method also extremely pushes the intensities towards the right or the left side of the histogram, causing level saturation effects. To overcome these problems, Clipped Histogram Equalization (CHE) methods are used to restrict the enhancement rate. CHE modifies the shape of the input histogram by reducing or increasing the value in the histogram's bins based on a threshold limit before the equalization is taking place. This threshold limit is also known as the clipping limit, or the plateau level of the histogram. The histogram will be clipped based on this threshold value. In some cases clipped portion will be redistributed back to the histogram and then histogram equalization is carried out. Clipped Histogram Equalization (CHE) is far more effective for contrast enhancement than the existing HE-based methods.







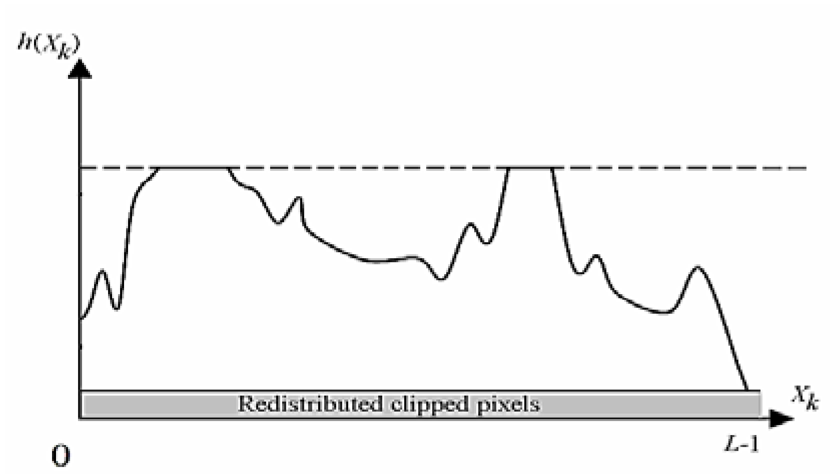


Figure 3: Clipped Histogram Equalization (CHE) Method
(a). The Original Input Histogram (b). The Settings of the Plateau Limit (c). Clipping the Histogram based on the Plateau Limit (d). Redistribution of Clipped Portion Back into the Modified Histogram

The major drawbacks of CHE method are those methods require manual setting of the plateau level of the histogram which are not suitable for automatic systems and some of the methods put weight to the modified histogram. The weight factor is also dependent to the user.

Bi-HE methods enhance the image contrast significantly and may preserve the brightness to some extent, but it introduces undesirable artefacts. Decomposition of image histogram into several sub-histograms, Multi-HE methods shown better brightness preservation and prevent introduction of undesirable artefacts but may not significantly enhance the contrast. CHE methods provide well brightness preservation without any artefacts by clipping the histograms using threshold values and are not shown significant contrast enhancement. Methods like GC-CHE sacrificed the amount of contrast for controlling noise and for preserving the original intensity level.

IMAGE QUALITY MEASUREMENT TOOLS

The present section describes the image quality measurement tools used to evaluate the ability of the enhancement techniques to maintain the mean brightness preserving and contrast enhancement.

1. Absolute Mean Brightness Error (AMBE)

An objective measurement is proposed to rate the performance in preserving the original brightness. It is stated as Absolute Mean Brightness Error (AMBE). It is defined as the absolute difference between the mean of the input and the output images and is proposed to rate the performance in preserving the original brightness.

$AMBE=|(\boldsymbol{X})-E(\boldsymbol{Y})|$ (1)

X and Y denotes the input and output image, respectively, and E (.) denotes the expected value, *i.e.*, the statistical mean. Lower AMBE indicates the better brightness preservation of the image. Equation (1) clearly shows that AMBE is designed to detect one of the distortions-excessive brightness changes.

2. Peak Signal-to-Noise Ratio (PSNR)

Let, X(i,j) is a source image that contains M by N pixels and a reconstructed image Y(i,j), where Y is reconstructed by decoding the encoded version of X(i,j). In this method, errors are computed only on the luminance signal; so, the pixel values X(i,j) range between black (0) and white (255). First, the mean squared error (MSE) of the reconstructed image is calculated as;

$$MSE = \frac{\Sigma_{i=1}^{M}\Sigma_{j=1}^{M}[X(i,j)-Y(i,j)]^2}{M\times N} \quad (2)$$

The root mean square error is computed from root of MSE. Then the PSNR in decibels (dB) is computed as;

$$PSNR = 20log_{10}\left(\frac{Max(Y(i,j))}{RMSE}\right) \quad (3)$$

Greater the value of PSNR better the contrast enhancement of the image.

CONCLUSIONS

The present paper gives the review of existing histogram-based contrast enhancement techniques for brightness preserving and contrast enhancement. Bi-histogram equalization methods such as BBHE, DSIHE and MMBEBHE, Multi-histogram equalization methods such as RMSHE, RSIHE, DHE, BPDHE and RSWHE and Clipped Histogram equalization methods such as GC-CHE and BHEPL techniques are compared with Image Quality Measurement (IQM) tools such as absolute mean brightness error (AMBE) and peak signal-to-noise ratio (PSNR).All the techniques have overcome the drawbacks of histogram equalization and have shown a better brightness preserving and contrast enhancement than HE. For BBHE, DSIHE, MMBEBHE, RMSHE, RSIHE and RSWHE methods, the contrast of the images is improved, but the problem of the intensity saturation occurs in some regions of the image as well and also presented stimulated amplification of noise in the output image. All these techniques show brightness preserving, but show a less brightness preservation for bright images like Pirate, Lenna and Cygnusloop. MMBEBHE, the extension method of BBHE has shown a better brightness preserving. But it could not control over-enhancement of the image. Due to over-enhancement in MMBEBHE, RMSHE and RSIHE, there is a loss of information in the output image. RSIHE technique has also shown more over-enhancement than MMBEBHE and RMSHE. RSWHE and DHE methods have shown good brightness preserving as well as a controlled over-enhancement, but introduced annoying noise in the output image. BHEPL technique has also shown good brightness preserving except bright images like Cameraman, Face, Hurricane Andrew, Pirate and Lenna. BPDHE technique has given very less value of AMBE, and is almost zero (0.0067 to 0.0911) indicating good brightness preserving and high values of PSNR shows better contrast enhancement. GC-CHE method has also shown less values of AMBE (0 to 0.1827) and high values of PSNR (34.1527 to 61.6174). The output images of BPDHE and GC-CHE are very clear without any noise and there is no loss of information. BPDHE and GC-CHE techniques are more suitable for consumer electronic products where preserving the original brightness is essential.

REFERENCES

[01] M. A. A. Wadud, M. H. Kabir and O. Chae, "A Spatially Controlled Histogram Equalization for Image Enhancement", 23rd International Symposium on Computer and Information Sciences, ISCIS '08, **(2008)**.

[02] D. Sheet, H. Garud, A. Suveer, M. Mahadevappa and J. Chatterjee, "Brightness Preserving Dynamic Fuzzy Histogram Equalization", IEEE Transactions on Consumer Electronics, vol. 56, no. 4, **(2010)** November, pp. 2475-2480.

[03] M. Khan, E. Khan, and Z. A. Abbasi, "Weighted average multi segment histogram equalization for brightness preserving contrast enhancement", IEEE International Conference on Signal Processing, Computer and Control, ISPCC, **(2012)**.

[04] Y.-T. Kim, "Contrast enhancement using brightness preserving bi histogram equalization," IEEE Trans. On Consumer Electronics, vol. 43, no. 1, pp. 1-8, Feb. 1997

[05] Y. Wang, Q. Chen, and B. Zhang, "Image enhancement based on equal area dualistic sub-image histogram equalization method," IEEE Trans. on Consumer Electronics, vol. 45, no. 1, pp. 68-75, Feb. 1999.

[06] C. Wang and Z. Ye, "Brightness preserving histogram equalization with maximum entropy: A variational perspective," IEEE Trans. On Consumer Electronics, vol. 51, no. 4, pp. 1326-1334, Nov. 2005.

[07] C. Shannon, "A mathematical theory of communication," Bell Syst. Tech. J., vol. 27, pp. 379-423, 1948.

[08] M. Luessi, M. Eichmann, G. Schuster, and A. Katsaggelos, "New results on efficient optimal multilevel image thresholding," in IEEE International Conference on Image Processing, 2006, pp. 773-776.

[09] David Menotti, Laurent Najman, Jacques Facon, and Arnaldo de A. Araújo "Multi-Histogram Equalization Methods for Contrast Enhancement and Brightness Preserving"

[10]. G. Turk, "Generating textures on arbitrary surfaces using reaction diffusion," *Comput. Graph.* 25, 289-298 (1991).

[11]. D. J. Heeger and J. R. Bergen, "Pyramid-based texture analysis/synthesis," in *Proc. Computer Graphics*, pp. 229-238, Los Angles, CA, August 6-11 (1995).

[12]. J. P. Rolland, A. Goon, and L. Yu, "Synthesis of textured complex backgrounds," *Opt. Eng.* 37(7), 2055-2063 (1998).

[13]. J. P. Rolland and R. Strickland, "An approach to the synthesis of biological tissue," *Opt. Express* 1(13), 414:423 (1997).