Proceedings of
National Conference on Innovative Trends in Computer Science Engineering (ITCSE-2015)
held at BRCMCET, Bahal on 4th April 2015

Comparative Study of Image Enhancement Using Histogram Equalization Based Processing Techniques

Sonia , Mukta Goel , Rohit Goel
M.Tech Scholar , Assistant Professor , Assistant Professor
Department of CE, Department of ECE
TIT&S, Bhiwani (Haryana)
[1]soniasharma962@gmail.com

Abstract: Various enhancement schemes are used for enhancing an image which includes gray scale manipulation, filtering and Histogram Equalization (HE). Histogram equalization is one of the well known image enhancement became a popular technique for contrast enhancement because this method is simple and effective. But HE can change the brightness of the image.So different techniques is to be used for contrast enhancement.The aim is to use these techniques to preserve the input mean rightness so that the image looks natural in appearance.
Keywords:Histogram Equalization,enhancement

I.INTRODUCTION

Image enhancement is an important area in digital image processing. The aim is to use these enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. It is important to keep in mind that enhancement is a very subjective area of image processing. Improvement in quality of these degraded images can be achieved by using application of enhancement techniques.There are many techniques use for contrast enhancement process but the most common one is histogram equalization(HE). The HE technique remaps gray levels of image based on probability distribution function (PDF) of the input image gray levels. HE flattens the histogram and stretches dynamic range of gray levels to perform overall contrast enhancement. However, histogram equalization has some disadvantages that are often observed when HE is used. First, histogram equalization transforms the histogram of original input image into a flat histogram where mean value lies somewhere in middle of gray level range. That means it does not take into account mean brightness of the input image. Second, the HE method performs enhancement based on global content, it's only enhances borders and edges among objects in the image. Third, HE may result in over enhancement due to stretching of the gray levels of input image over the full gray level range. Brightness is also included in it. So some other brightness preserving techniques as an improvement in the traditional histogram equalization process. Brightness Preserving Bi-HE (BBHE), Dualistic Subimage Histogram Equalization (DSIHE), Recursive Mean Separate Histogram Equalization (RMSHE), Minimum Mean Brightness Error Bi-HE (MMBEBHE), Recursive Separated and Weighted Histogram Equalization (RSWHE), Dynamic HE (DHE), Brightness preserving Dynamic HE (BPDHE) etc. are some of the techniques that aim to preserve the brightness of the image.

II.HISTOGRAM EQUALIZATION

Histogram equalization (HE) is a widely used technique for contrast enhancement because it is simple to use and gives better performance for all type of images. It is most commonly used in the areas like medical image processing, radar signal processing ,robotics etc. Histogram Equalization is a technique that generates a gray map which changes the histogram of an image and redistributing all pixels values to be as close as possible to a user –specified desired histogram. Histogram equalization automatically determines a transformation function seeking to produce an output image with a uniform Histogram.The algorithm for histogram equalization is:

For a given image X = {X(i, j)}, composed of L discrete gray levels denoted as $\{X_0X_{1\ldots}.X_{L-1}\}$, where X (i, j) represents an intensity of image at the spatial location (i, j) and X (i, j) { $X_0X_1\ldots.X_{L-1}$}. For image X , probability density function ( ) K p X is defined as:

$$P(Xk)=nr/n$$

for k= 0,1,...,L=1 , where n^k represents number of times X_k appears in input image X and n is total number of samples in input image.Here ( ) K p X is associated with histogram of input image which represents number of pixels having specific intensity k X . A plot of n^k vs. X_k is known as histogram of X . The cumulative density function (CDF) c(x) is defined on the bases of PDF,

$$c(x) = \sum_{j=0}^{k} p(X_j)$$

where X =x k , for k =0,1,...,L -1. Here c(X_{l-1})=1by definition. HE is a scheme which maps input image into the entire dynamic range, (X_0,X_{l-1}) by using CDF as a transform function

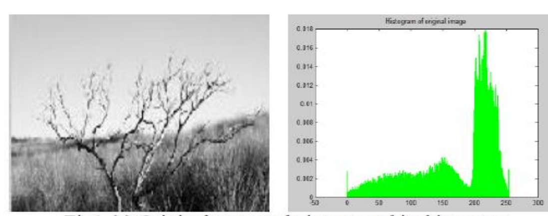
Fig1 (a) Original gray scale image and its histogram

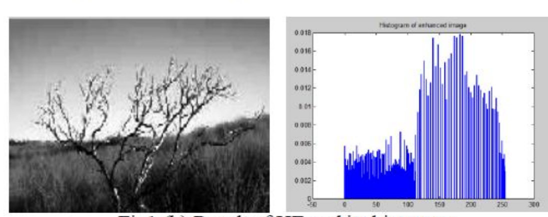
Fig1 (b) Result of HE and its histogram

HE works by flattening the histogram of input image and stretches dynamic range of gray levels by using cumulative density function (CDF) of the image. A Histogram represents relative frequency of occurrence of gray levels to preserve mean brightness of the input image. The HE method re-maps the gray levels of input image by re-assigning intensity values of pixels to make a uniform intensity distribution. The following figures show how HE enhances the gray scale image.

III.BRIGHTNESS PRESERVING BI-HISTOGRAM EQUALIZATION METHODS (BPBHE)

The BPBHE firstly breaks an input image into two sub images based on the mean brightness value of the input image. One of the sub images is the set of samples less than or equal to the mean whereas the other one is the set of samples greater than the mean. Then the BBPHE equalizes the sub images independently based on their respective histograms.

X = XL U XU

Where Xm be the mean of the image X, the sub-image XL is composed of {X0, X1….Xm} and the
other image XU is composed of {Xm+1, Xm+2… XL-1 }.
Xm= (X0 + XL-1) / 2

BBHE has an advantage that it preserves mean brightness of the image while enhancing the contrast and, thus,provides much natural enhancement that can be utilized in consumer electronic products.

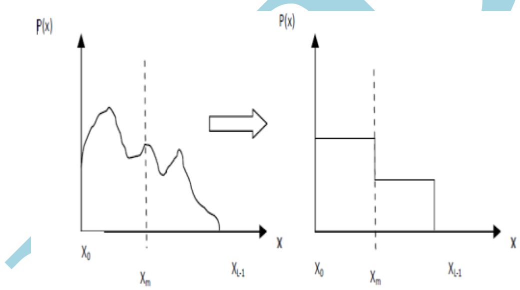

Figure 2: BI-histogram Equalization Method

Dualistic Subimage Histogram Equalization (DSIHE):

The basic idea used in the DSIHE method is similar to by the BBHE method. Dividing the input image into two sub-images and equalizes the histograms of the those differently. Instead of dividing the image based on its mean gray level, the DSIHE method divides the image based on equal area property , both the sub images contain the equal number of pixels, being one dark and one bright. Finally, result of enhancement provides an enhanced image with its original luminance that makes it possible to be used in the video system directly.

Recursive Mean-Separate Histogram Equalization (RMSHE):

RMSHE technique is an extension of BBHE (where mean-separation was done only once). In RMSHE, instead of decomposing the input image only once, it is decomposed recursively up to a recursion level r, therefore 2r sub images will be generated. Each subimage is then equalized independently with histogram equalization method. If r=0, that means no subimage decomposition is done, i.e. it is equivalent to HE method only . When one mean separation is done before equalization, i.e. r=1, this is equivalent to BBHE . This increases a level of brightness preservation. Similarly, two mean-separations before equalization will result in much higher level of brightness preservation as compared to r=0 and r=1 levels . The above discussion concludes that the level of brightness preservation will increase with the increase of number of recursive eanseparations.This technique aims to bring more extends of brightness preservation than HE and BBHE techniques

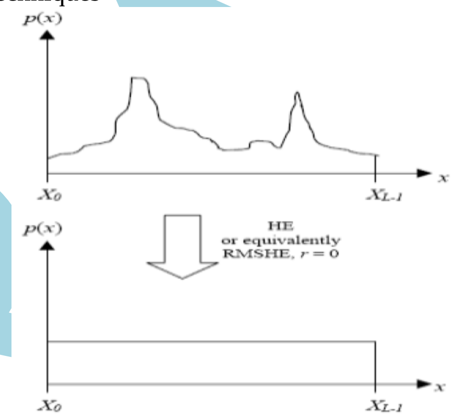

Fig3 (a) Histogram before and after HE or equivalently RMSHE, r = 0

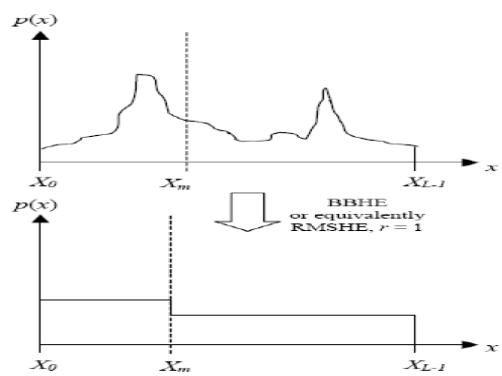

Fig3 (b) Histogram before and after HE or equivalently RMSHE, r = 1

Recursive Separated and Weighted Histogram Equalization (RSWHE):

The main difference between RSWHE and other histogram equalization techniques is that RSWHE first modifies the input histogram and then runs the equalization procedure.
This technique works in three modules:
i) Histogram segmentation module It takes the input image, computes the input histogram. The input histogram is decomposed recursively into two or more sub histograms based on the mean and median value.
ii) Histogram weighting module In this module, sub histograms computed in step 1 are modified through histogram weighting process using a normalized power law function.

iii) Histogram equalization module In this, histogram equalization process is individually applied over each of the weighted sub-histograms that were modified in step 2.
Recursive sub-image histogram equalization (RSIHE) and recursive mean separate histogram equalization (RMSHE) are some methods that are similar to RSWHE, but weighting process is not carried out in RSIHE and RMSHE.

Minimum Mean Brightness Error Bi-HE (MMBEBHE):
This technique searches for a threshold level lt, which decomposes input image into two sub-images in such a way that the minimum brightness difference between the input and the output image is achieved. This is called absolute mean brightness error (AMBE) After decomposing input image by the threshold level, each of the two sub-images undergo histogram equalization process to generate the output image.

Dynamic Histogram Equalization (DHE):
It employs a partitioning operation over the input histogram to chop it into some sub histograms so that they have no dominating component in them. Then each subhistogram goes through HE and is allowed to occupy a specified gray level range in the enhanced output image. Thus, a better overall contrast enhancement is gained by DHE with controlled dynamic range of gray levels and eliminating the possibility of the low histogram components being compressed that may cause some part of the image to have washed out appearance.

Brightness Preserving Dynamic Histogram Equalization (BPDHE)
BPDHE maintains the mean brightness of the image and hence overcomes the limitation of histogram equalization . This method is actually an extension to the DHE. The BPDHE method partitions the input histogram based on the local maximums of the smoothed histogram. However,before the histogram equalization has taken place, the BPDHE will map each partition to a new dynamic range, similar to DHE. The change in the dynamic range will cause the change in mean brightness. And the final step involves normalization of the output intensity. So, the
average intensity of resultant output image will be same as the input image. Hence, BPDHE proves itself better in performing enhancement task as compared to traditional HE method, and better in preserving mean brightness when compared with DHE.

IV.CONCLUSION

Histogram equalization is a simple and effective technique that can be used for image contrast enhancement. Various other brightness preserving contrast enhancement techniques are used. BBHE and DSIHE divide the input image into two different sub-images based on the mean value and median value respectively. RMSHE handles higher brightness preservation than traditional HE, BBHE and DSIHE techniques. MMBEBHE is an extended version of BBHE technique and provides maximal brightness preservation comparatively These methods perform good contrast enhancement, but also cause annoying side effects. The main aim of all these contrast enhancement techniques is to produce the output images in which mean brightness is preserved and the image looks better in appearance.

REFERENCES

[1] Kotkar V. A. and Gharde S. S., “review of various image contrast enhancement techniques” International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, July 2013.
[2] Rafael C. Gonzalez, and Richard E. Woods, “Digital Image Processing”, 2nd edition, Prentice Hall, 2002.
[3] Ibrahim H., and Kong N. S. P., “Brightness preserving dynamic histogram equalization for image contrast enhancement”, IEEE Trans. Consumer Electronics, vol. 53, no. 4, pp. 1752 - 1758, November 2007.
[4] Wang, Y., Chen, Q., and Zhang, B.(1999): ‘Image enhancement based on equal area dualistic subimagehistogram equalization method’, IEEE Trans. Consumer Electronics., 45, (1), pp. 68–75
[5] D. Menotti, L. Najman, J. Facon, A.A. Araujo,”Multi –Histogram Equalization Methods for Contrast Enhancement and Brightness Preserving”, IEEE Trans. On Consumer Electronics, vol. 53, No. 3, Aug. 2007.
[6] Review of Different Histogram Equalization Based Contrast Enhancement Techniques by Er. Shefali Gupta1, Er. Yadwinder Kaur2