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Histogram Based Image Enhancement Techniques: A Survey

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***Abstract*—**Image enhancement is a digital processing technique which does its best to get a better image. It is a simple and most engaging range in image processing. Image enhancement is a process by which we got an improved and high-quality image through the low contrast and low-quality image. Image Contrast enhancement without disturbing other parameters of the image is one of the difficult tasks in image. This paper focused on several enhancement techniques that deal with contrast of image. Image enhancement dealt with improvement in the appearance and quality of the given image without losing the information of the image. This paper includes several approaches of image enhancement these approaches are used for improving the given image which incorporates manipulation of gray scale, Histogram Equalization (HE) and Filtering. HE is the basic method of image enhancement. All the techniques presented by this study is simulated on Intel I3 64 bit processor using MATLAB R2013b. For quality measurement of contrast enhanced image Peak to signal noise ratio and Mean Square Error parameter for each of the methods is additionally computed.

***Keywords*—**Image Enhancement, Histogram, Histogram Equalization, Brightness Preserving Bi Histogram Equalization, Brightness Preserving Dynamic Histogram Equalization.

I. INTRODUCTION

Digital Image processing is a procedure in which we input an image and output may be either an image or some characteristics. It has several applications like in medical science, earth science finger print identification, remote sensing. Captured image can be degraded by blurring, Noise incorrect colour balance and poor contrast, so this will lead image quality degradation. Image enhancement approaches can be put into 2 main classes:-

1. Spatial domain approach
2. Frequency domain approach

Spatial domain refers:-

Spatial domain strategy enhances an image by direct modification of pixels of an image. Huge numbers of systems have been concentrated on gray level image enhancement on spatial space. These techniques incorporate HE, low and high pass filtering and homomorphic filtering.

Frequency domain:-

Frequency domain processing techniques enhances an image by modifying the Fourier transform of an image [1]. Given image is improved by transforming the frequency substance of an image [2].

II. IMAGE ENHANCEMENT

The key idea behind enhancement of image is to enhance the quality of input image or basically to highlight the specific feature of the image. Through enhancement we improve the visual background of an image so looks better than original image improved image obtain through several contrast enhancement technique of image. It is simple and main essential idea in digital image processing and it can be executed by removal of noise or enhancement in contrast of image. Contrast of image is a visual difference of image that make the object is distinguishable to the background. The contrast of the image is improved than the original image as shown in figure.

III. IMAGE ENHANCEMENT TECHNIQUE

In image enhancement we only improve the image's quality it does not raise the image information content. HE is the simple and very useful technique of image enhancement

Histogram Equalization:-

An image's histogram is worried with the dark levels. Utilizing histogram to choose that given picture is whether a image is not bright or bright or low difference or high differentiation picture. Histogram Equalization which extends histogram to a picture. It is utilized to enhance the visual appearance of a picture. This method includes,

1) Dividing picture into sections.

2) Histogram is connected to discover the pixel power values for the dark levels and the picture have dim levels or powers in the range from 0 to 255.

3) Histogram Equalization is utilized to figure the power values and make them uniform appropriation of pixels to get an upgraded picture. In this way HE strategy is utilized to expand the dynamic scope of pixels for the presence of a picture.

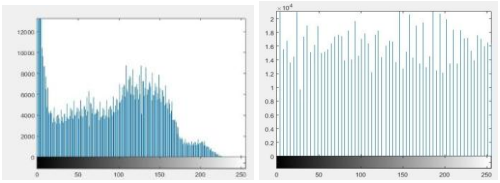


Figure 1: Histogram of original image and after histogram Equalization

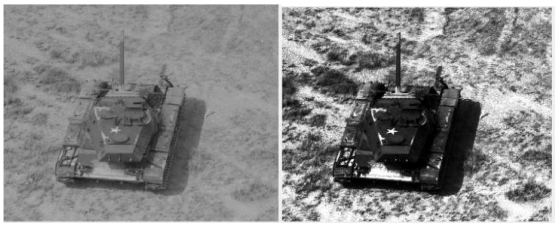
HE enhances the given gray levels by reconstructing given pixels of the image based on the PDF [3]. In general, we can classify this in two main categories that is Local and Global Histogram Equalization.

Global histogram equalization (GHE) uses the transformation function of the whole given image using the information of Histogram [4]. GHE method works better for over-all enhancement, but it fails to preserve the actual brightness of the given image. If there are some gray levels in the image normally dominate the higher frequency to the lower frequency.

Local Histogram Equalization (LHE) eliminates such drawback by using the small window that slides over each pixel of the given image sequence. In LHE small block of image pixel are fall in to the small window that equalise separately.

All mentioned enhancement approaches perform better on some of the images but they can create problems when sequence of images has to be enhanced, or when the histogram has points, or when a natural looking enhanced image in discipline manner required. Our main aim in this paper is to review all histogram based enhancement methods that has low computational complexity and works better with both gray and colour images [5]. To remove the mentioned stated drawback a new contrast enhancement technique that dealt with the histograms of both colour and depth image. In this approach the histograms of images are firstly separated into sub-images by the GMM [6]. The colour image histogram sections are then adjusted in such a manner so that the same intensity pixels and equal depth standards can fit in to the same section.

This method is commonly used as it is simplest and easy to execute. This can be used for contrast enhancement of all types of images. It executes histogram equalisation through the cumulative density function by widening range of the gray levels of an image. There are various most important application areas of histogram equalization in like medical field image-processing, radar image processing, etc. The biggest disadvantage of this method is it does not pre-serve brightness of an image. The brightness gets changed after histogram equalization. Hence preserve the initial brightness and contrast enhancement are important to avoid other side effects.



(a) (b)

Figure 2: (a) Original Image (b) HE Image

There are several modules in this paper. Part II explains the various global enhancement techniques and Section III describes several local enhancement techniques. The experimental work is done in part IV. Part V mentions conclusion with the future work scope followed by references.

GLOBAL ENHANCEMENT TECHNIQUES

Global enhancement methods are simple, fast are suitable for overall enhancement of the image. These methods cannot take care of local brightness features of the given image only global histogram uses information over the whole image [4]. Some global contrast enhancement techniques are BBHE, DSIHE, RMSHE, MMBEBHE etc. are explained in the following section.

1. Brightness Preserving Bi Histogram Equalization (BBHE)

BBHE technique parts the image's histogram into two freely evened out parts. This technique equalizes both the parts independently. Their separate histograms with a restriction that models in the first sub image plotted into the range from minimum gray level to given mean and models in the second sub image plotted into the range from mean to maximum gray level. The image generated by BBHE has the brightness value (gray-level mean) placed in the mid of the mean of the given image [8]. Through BBHE method Mean brightness of the image is preserved while improving the contrast of image. This is the main advantage of using this method. One disadvantage of the histogram levelling can be found on the way that the brilliance of a picture can be changed after the histogram evening out, which is for the most part because of the smoothing property of the histogram equalization [7]. The BBHE is expansion of histogram evening out to defeat such a downside of histogram adjustment. The substance of the calculation is to use free histogram adjustments independently more than two sub images got by breaking down the information picture in light of its mean with a limitation that the subsequent balanced sub images are limited by each other around the information

mean. It is demonstrated that the proposed calculation safeguards the mean splendour of a given picture essentially all around contrasted with run of the mill histogram evening out while upgrading the difference and gives a regular improvement that can be used in customer electronic items.

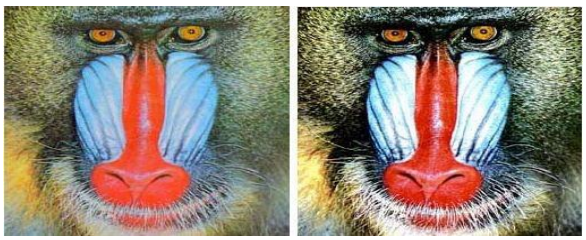


Figure 3: Original Image (b) BBHE image

Figure 3(a) depicts the original input image and 3(b) depict the contrast enhanced image through BBHE method. In this the computation unit counts and store the respective number of occurrences BBHE has an advantage that it preserves mean brightness of given image while enhancing contrast of image [8].

2. Dualistic Sub image Histogram Equalization (DSIHE)

DSIHE technique for enhancement in contrast of the image is partitioned into 2 equal part sub-images based on probability density function of specified image and these 2 sub-images fingered alone. Obtained image of DSIHE after the two equalized part, bright and dark will be again combine to get one image. DSIHE is like BBHE but one variation is that in this technique it divides the histogram through gray level with cumulative probability density rather than the mean which used in brightness preserving method, i.e. alternative of divide the given image through its mean value, the DSIHE method segments the image histogram at the maximize of the brightness of the produced image. The particular of the given image's gray level probability distribution is decomposed [10].

This is one of the histogram equalization technique in which the given image is partitions into 2 equal part sub-images based on gray level probability density function of input image. Then these two sub-images are going too equalized respectively. At last, a contrast enhanced image generated the equalised sub-images are combined into single image. This technique improves the visual information excellently and given images average luminance. This makes it possible to be applied in video directly [11].

3. Recursive Mean Separate Histogram Equalization (RMSHE)

This technique also work on image having low contrast Mean-separation means to separate an image on the premise of the mean of input image [8]. However, RMSHE technique is an extension of BBHE. In BBHE mean-separation was done only once. In this method the image is separated on the basis of mean of input image. The word recursive used in RMSHE suggested that in this approach instead of decomposing the given image only once, it splits down recursively up to a recursion level R, so that 2R sub images will be created and then these sub images are equalized by the histogram equalization technique. If recursion=0, that means no sub image splits down is done, i.e. it is equivalent to simple HE method. If r=1 that means it is equal to BBHE [4]. The main benefit of using this technique is that the level of brightness preservation will increase by increasing the number of recursive mean separations. Though it is recursive in nature, it also permits scalable preservation of brightness, which is very valuable in image processing. The main advantage of the recursive mean separate histogram equalization method is improving the brightness with the recursive level of giving break down an image.

4. Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE):

In this technique decomposition of an image into 2 sub image and equalization handle autonomously to the subsequent sub images which are like BBHE and DSIHE with exception of contrast is that this method looks for a threshold level [13].

This decomposition of the given image into 2 sub images in such a manner that the minimum brightness difference between the input and the output image is achieved. This is named Absolute Mean Brightness Error (AMBE). After this HE is applied to each sub image to produce output image. The steps taken in this process are as follows.

1. For each possible threshold level Absolute mean brightness error is calculated

2. Find a threshold value that yields low AMBE value.

3. Separate the given image histogram into 2 sub image's histograms based on threshold value found in Step 2 and equalizes both the histograms independently [12]. Main aim of this technique is to produce a method that is suitable for real-time applications.

5. Dynamic Histogram Equalization (DHE)

DHE technique enhances the image better than the basic HE method and it can improvement of the picture without change the image's property. This method partitions the given image's histogram into a various sub-histograms until it guarantees that no dominating segment is available in any of the recently formed sub-histograms.

Now at last, a separate transformation function is calculated for each sub histogram based on the traditional HE method and gray levels of input image are mapped to the produced image accordingly. The entire technique of DHE can be define by the following three parts – partitioning the histogram; allocating gray level ranges for each sub histogram

and apply equalization on all part of image. Therefore through DHE good contrast enhanced image is achieved with well-ordered dynamic range of gray levels and eliminating the possibility of the low histogram [14].

6. Brightness Preserving Dynamic Histogram Equalization (BPDHE)

The BPDHE technique is an extension to the basic HE method that can produce output image with the mean intensity that is almost equal to the mean intensity of input image. Thus BPDHE preserves the mean brightness of an image and hence overcomes the drawback of histogram equalization. This technique is actually an extension to the DHE. The BPDHE approach partitions the given histogram of image based on the local maximum. However, the BPDHE will also plot each partition to a new dynamic range, and after this histogram equalization performs. Through the change in range mean brightness of image also change. And the last step involves normalization of the output intensity. So, the intensity of resultant output image will be same as the given image. Hence, BPDHE verifies itself better in enhancement task as compared to traditional HE method, and better in preserving mean brightness when compared with DHE [15]

Local Enhancement Technique

Local Enhancement Technique enhances overall contrast more effectively than global techniques. Some local techniques for contrast enhancement like AHE, CLAHE etc. are explained in the following section

1. Adaptive Histogram Equalization (AHE)

It is a technique of contrast enhancement and it is different from simple image histogram equalization. In adaptive method, various histograms are processed where each histogram corresponds to a different part of an image and use them to rearrange the brightness values of the image [15]. Consequently, AHE enhances the image's local contrast and more points of interest can be observed. With this technique, information of all intensity ranges of an image can be viewed at same point of time. There are numerous ordinary display devices that are not able to delineate the full dynamic intensity range. This method conveys a solution for this issue. Different favourable circumstances incorporate that other advantages include that it is automatic (i.e., no manual intervention is required) and reproducible from study to study. In AHE technique, for each pixel in the given image, area centred about a pixel is allocated. This area is called relevant area (compute size of this region before assigning) [16]. The intensities values for this region are used to discover the histogram equalization mapping function and this mapping function is applied to the pixel being handled in the segment. The resultant image is delivered where each pixel is mapped in different way. Consequently the intensities are distributed locally and contrast is improved based on the local area rather than the entire image. Apart from these advantages of local enhancement, AHE method has few restrictions too. This technique works gradually on a general personal computer despite it works correctly. As enhancement is done in a neighbourhood, AHE tends to over enhance the noise in given image.

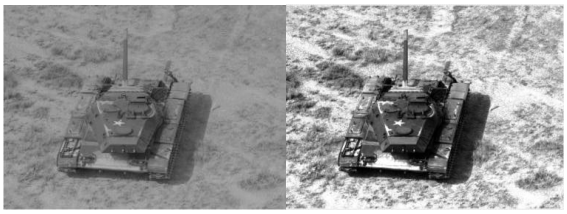


Figure 4: (a) Original Image (b) AHE Image

2. Contrast Limited Adaptive Histogram Equalization (CLAHE)

This is one of the techniques which is used for enhancement of image having low contrast. It can be different from basic histogram equalization with respect to the adaptive method because in this technique compute histogram corresponding to a different part of the given image, and after that applies histogram equalization to rearrange the brightness values of the image. In basic histogram equalization single histogram is use for the whole image. Consequently, for improving image's local contrast and bringing out more detail in the image adaptive histogram equalization is used. However, it may be produce significant noise in an image. A generalized form of AHE is called as contrast limited adaptive histogram equalization which is called CLAHE.

Figure 5: (a) Original Image (b) CLAHE Image

It was developed to overcome noise amplification problem. CLAHE not deal with entire image it dealt with tiles which are small regions in the image [2]. Each region contrast enhanced in such a way so that output region histogram almost matches the histogram stated by the Distribution parameter. The neighbour tiles are combined to remove artificially prompted boundaries by using Bilinear Interpolation [2]. With the help of contrast in homogeneous areas, it can be possible to avoid amplification of any unwanted noise that might be exist in the low contrast image.

The advantages of using CLAHE are that it is easy to use, uses simple calculation, and gives good output in local areas of the image. CLAHE has less noise and it can prevent brightness saturation that commonly happens in histogram equalization [5].

IV. RESULTS AND DISCUSSION

The image contrast enhancement methods are developed strikingly in the most recent decades. This paper gives comprehensive information and table 1 depicts comparison of different histogram equalization method. Here all these techniques are comparing by through Peak to signal noise ratio and Mean square error. In our paper 25 images have been tested but few results are shown to reduce the size of paper.

Table 1: Comparison of Image Contrast Enhancement Techniques

	PSNR	MSE
HE	13.5171	2.9159e+03
AHE	16.1420	1.5933e+03
BBHE	12.9909	3.2914e+03
RMSHE	13.5552	2.8904e+03
BPDHE	24.5463	230.6667

Table 1: PSNR and MSE

Table 1 depict the PSNR value and MSE value of the image through the table we can see that BPDHE technique performs well in contrast enhancement of image, High PSNR value indicates better enhancement of image and low MSE value indicates low error in enhanced image.

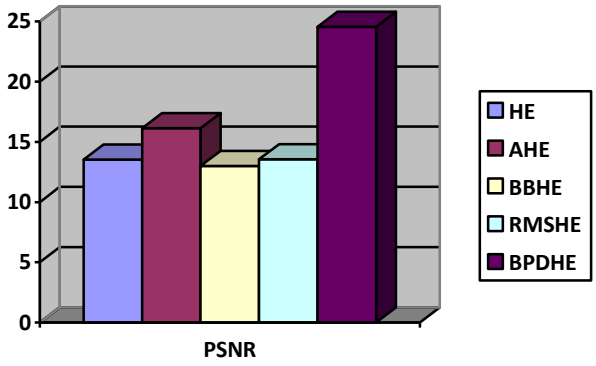


Figure 6: PSNR and MSE

Figure 6 shows the graph of PSNR values of HE, AHE, BBHE, RMSHE and BPDHE technique. In graph we can see the high PSNR value of BPDHE indicates the better enhancement of image.

Most of the image contrast enhancement techniques preserve the brightness and the actual appearance of the image each techniques advantage and disadvantage discussed in this paper. Out of above discussed Techniques BPDHE Techniques is useful for preserving brightness of the image.

V. CONCLUSION AND FUTURE SCOPE

This paper gives a survey on image enhancement based on the Histogram Equalization has been presented. Many image enhancement schemes like AHE, BBHE, DSIHE, RMSHE, MMBEBHE and BPDHE has been studied. Different histogram equalization method concludes that brightness preservation is not handled well by HE, DSIHE and BBHE but it is handled properly by RMSHE and MMBEBHE. In BPDHE technique error rate is very low this leads to good PSNR value.

In this paper, first segment gives a brief introduction to the image enhancement, the second segment contains a brief writing about the past work done in field of image contrast enhancement and the third segment contains analysis and comparative study of enhancement technique.

Through the result analysis table 1 depict that BPDHE have maximum PSNR value so it is well suited technique for contrast enhancement technique. In future we can use Discrete Wavelet Transform and decomposes the image into 4 sub bands and use this BPDHE technique and then decomposes the BPDHE contrast enhanced image and then use Singular value decomposition for further improvement in contrast.

VI. REFERENCE

[1] R. C. Gonzalez, and R. E. Woods "Digital Image Processing" Second Edition Prentice Hall.2002.
[2] S Jayaraman, S Esakkirajan, and T Veerakumar "Digital Image Processing" Tata McGraw- Hill Education Pvt.Ltd.
[3] V.A. Kotkar and S. S. Gharde., "review of various image contrast enhancement techniques" International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, July 2013.
[4] M. Kaur, J. Kaur, J. Kaur, "Survey of Contrast Enhancement Techniques based on Histogram Equalization", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 7, 2011.
[5] J.Y. Kim, L. K., and Hwang, S. "An advanced contrast enhancement using partially overlapped sub-block histogram equalization", IEEE Transactions on Circuits and Systems for Video Technology, 475–484, 2001
[6] Celik, T., and Tjahjadi, T. "Automatic image equalization and contrast enhancement using Gaussian mixture modeling", IEEE Trans. Image Process. Vol. 21, no 1, pp. 145–156, 2012.
[7] Kim Y., "contrast enhancement using brightness preserving Bi-Histogram equalization", IEEE Trans. Consumer Electronics, vol. 43, no. 1, pp. 1-8, Feb. 1997.
[8] S.-D. Chen, A. Ramli, "Contrast enhancement using recursive mean separate histogram equalization for scalable brightness preservation," IEEE Trans. On Consumer Electronics, vol. 49, no. 4, pp. 1301-1309, Nov 2003.

[9] S. Gupta, Y. Kaur, "Review of Different Histogram Equalization Based Contrast Enhancement Techniques" international Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 7, July 2014.
[10] Rajesh K., Harish S., and Suman, "Comparative Study of CLAHE, DSIHE & DHE Schemes", international journal of research in management, science & technology vol.1, issue no. 1.
[11] Y. Wang, Q. C., and Zhang, B. "Image enhancement based on equal area dualistic sub-image histogram equalization method", IEEE Transactions on Consumer Electronics Vol 45, no.1, pp. 68–75, 1999.
[12] M. Kaur, V. L., "Study of Image Enhancement Techniques: A Review", International Journal of Advanced Research in Computer Science and Software Engineering, Vol 3, Issue 4, April 2013.
[13] Chen, S. D., and Rahman Ramli. "Minimum Mean Brightness Error Bi-Histogram Equalization in Contrast Enhancement", IEEE Transactions on Consumer Electronics vol 49, no 4, pp 1310–1319 2003.
[14] M. Abdullah-Al-Wadud, Md. Hasanul K., M. Dewan A. A., and Chae O., "A dynamic histogram equalization for image contrast enhancement" IEEE Trans. Consumer Electron., vol. 53, no. 2, pp. 593- 600, May 2007.
[15] H. Ibrahim, Nicholas Sia Pik Kong "Brightness Preserving Dynamic Histogram Equalization for Image Contrast Enhancement", IEEE Transactions on Consumer Electronics, Vol. 53, No. 4, Nov 2007 October 14, 2007 IEEE 1752.
[16] Rashmi Choudhary, Sushopti Gawade, "Survey on Image Contrast Enhancement Techniques" International Journal of Innovative Studies in Sciences and Engineering Technology (IJISSET) Vol. 2 Issue 3, March 2016.
[17] J. Alex Stark, "Adaptive Image Contrast Enhancement Using Generalizations of Histogram Equalization" IEEE transactions on image processing, vol. 9, no. 5, may 2000.
[18] S. Gupta, Y. Kaur, "Review of Different Histogram Equalization Based Contrast Enhancement Techniques" International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 7, July 2014.
[19] Kumar, V., and Himani Bansal. "Performance Evaluationof Contrast Enhancement Techniques for Digital Images", International Journal of Computer Science and Technology Vol. 2, no. 1, pp. 23–27, 2011.
[20] O. Patel, Yogendra P. S. Maravi and Sharma S., "A comparative study of histogram equalization based image enhancement techniques for brightness preservation and contrast enhancement", Signal & Image Processing: An International Journal Vol.4, No.5, October 2013.
[21] T. Arici, D. S., and Y., A. "A histogram modification framework and its application for image contrast Enhancement". IEEE Trans. Image Process. Vol. 18, no. 9, pp. 1921-1935, 2009.
[22] Y. Wang, Q. C., and Zhang, B. "Image enhancement based on equal area dualistic sub-image histogram equalization method", IEEE Transactions on Consumer Electronics Vol. 45, no. 1, pp. 68–75, 1999.
[23] M. Kim and M. G. Chung, "Recursively Separated and Weighted Histogram Equalization for Brightness Preservation and Contrast Enhancement" IEEE Transactions on Consumer Electronics, vol. no. 54, no. 3, Aug 2008.
[24] S.S. Bedi, R. Khandelwal "Various Image Enhancement Techniques- A Critical Review". International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 3, March 2013.
[25] Agarwal, T.K., "Modified Histogram based contrast enhancement using Homomorphic Filtering for medical images", Advance Computing Conference (IACC), IEEE International on 1-22 Feb. 2014.
[26] S.S. Chong et al. F, "Modified HL Contrast Enhancement Technique for Breast Mr Image", 2013 IEEE International Conference on Signal and Image Processing Applications 2013.
[27] T. Mahashwari, A. Asthana. "Image Enhancement Using Fuzzy Technique". Ijrrest International Journal of Research Review in Engineering Science & Technology Vol.2, Issue 2, June-2013.
[28] A. Polesel, G. Ramponi, and V. John Mathews. "Image Enhancement via Adaptive unsharp masking" IEEE Transaction on Image Processing March 2000.
[29] Manvi, R. S. Chauhan, M. Singh. "Image Contrast Enhancement Using Histogram Equalization". International Journal of Computing & Business Research. 2012.
[30] A. Pareyani, A. Mishra, "Low Contrast Image Enhancement Using Adaptive Filter and DWT: A Literature Review" Indian Journal of Computer Science and Engineering (IJCSE) Vol. 6 No.3 Jun-Jul 2015.

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