International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 2 (2018) pp. 1165-1170

A Study of Histogram Equalization Techniques for Image Enhancement

Bogy Oktavianto[1] and Tito Waluyo Purboyo[2]

[1, 2] Department of Computer Engineering, Faculty of Electrical Engineering, Telkom University, Bandung, West Java, Indonesia

Orcid : [1]0000-0003-4846-3306, [2]0000-0001-9817-3185

Abstract

The use of digital images is increasing because of the advantages possessed by digital images, among others, in the picture, reproduce images, image processing and others. But not all digital images have a visual appearance that satisfies the human eye. Dissatisfaction can arise due to noise, lack of illumination quality in the images where it either too dark or too bright. So we need methods to enhance the quality of digital images. To enhance the image quality from the red color side we can give care to the histogram. The treatment referred to in this article is an image equalization histogram at the gray level (grayscale). A good picture histogram when it involves all possible levels or levels on a gray level. Of course the goal to be able to display the detail on the image for easy observation. One method to improve digital images is to use the equalization of histogram method, where the level or gray in the image can the spread evenly across all levels of gray**.**

Keywords: image processing, histogram equalization, digital image

INTRODUCTION

Histogram equalization applications are commonly implemented for image processing in medical use, voice recognition, synthesizing textures and more. Recently, the implementation of the histogram equalization method to enhance image has been an interesting topic. A technique that has been develop where images manipulated from its pixel intensity to create an image that visually greater, called Image enhancement [1]. The purpose are to enhance images for human visually by improving the interpretation of information contained in it, or also the result can be used as a high quality input for more image processing use. From many proposed image enhancement method over years, equalization of histogram has become the most popular image enhancement used. The method mostly implemented in image enhancement process because of its ease of use, a higher performance and output with almost all kind of image. With the manipulation the level of gray based on the distribution probability, an image can be improved. That changes and improve the level of contrast of the images by manipulating dynamic range from the histogram, where its stretches and flatten based on the method [1]. The equalization of histogram (HE) has become the common used technique in image contrast enhancement [2]. And also become the most popular process because of its ease of use and higher quality output and performance. Histogram equalization method is by recapping image's level of gray according to the input gray level probability distribution [2].

However, it is well known that traditional HE methods suffer

of the following deficiencies [3]:

1) Has no mechanism that adjusts the rate of improvement and sometimes it can't reach a balance on many aspect of the image, for example, the balance between image detail and the background.
2) Sometimes causing an increasing level of noise, undesirable visual artifacts like clipping or level saturation, over enhancement, and imbalance between many aspects.
3) May changes a lot of things, and can dramatically affect the image, like different average of illumination from the image with the result.

Due to the side effect pointed above, equalization of histogram become rarely implemented on its normal form. Since then, years and years improvement, manipulation, development and changes result in new type of HE methods that have been proposed. Image contrast enhancement technique is popular method to use in image or video processing to gain a very dynamic and wider range. The most common algorithm which can be implemented to gain the most dynamic range is the Histogram based algorithm.

METHODS

A. Histogram Equalization

The image histogram provides information about the intensity distribution of the pixels in the image. For example, images that are too light or too dark have a narrow histogram [24]. Equalization of histogram has been widely applied and developed, multi-histogram equalization used to improve image contrast and brightness. A dynamic equalization histogram can produce an image output with an average image intensity equal to the average intensity of the input image. Not only in the picture, histogram equalization method can also be applied to the video which can also produce a bright image output. Improved image quality is a process done to get certain conditions on the image [8]. The process is carried out using a variety of methods depending on the expected conditions on the image, such as sharpening certain parts of

the image, removing noise or interference, contrast manipulation and gray scale, etc.

Noise is the points in the image that are not actually part of the image, but are mixed in the image for a reason. Noise arises usually as a result of poorly muted (noise sensors, photographic gain noise) [27]. The disorder is generally a variation in the intensity of a pixel that does not correlate with neighboring pixels. Visually, the disorder is easily seen by the eye as it looks different from its neighboring pixels. Pixels with disturbances generally have high frequency [30]. Components of low frequency images generally have a constant pixel value or change very slowly [14].

The image enhancement process is: image brightness, contrast stretching, histogram equalization, image smoothing, sharpening edge, pseudocolouring, , geometric changes[30]. Generally, image quality improvement is done through image histogram representation through histogram equalization method [23]. This method works by describing the distribution of pixels in a histogram by changing the gray level value of certain pixels regardless of its location in a picture. The histogram image is a value that allows to be used as an overview of the intensity of a image [17].

In the image repair process, we will use the imhist and histeq functions, using the same image, where the original image is a color image that has been converted into a black-and-white image. Image before comparison histogram and image after histogram on two images that have the same color image in figure 1 the following :

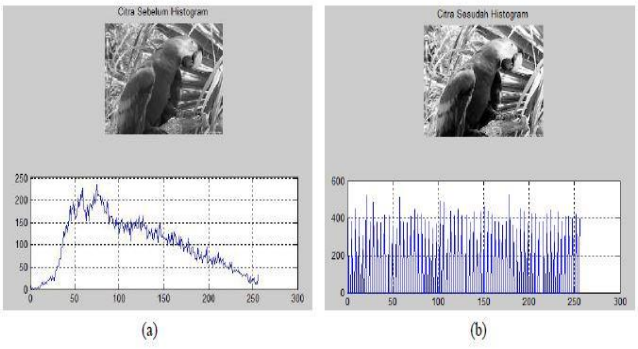

Figure 1: (a) Histogram Citra Input, (b) Histogram Citra Output

From Figure 1 explain about that the output image of histogram distribution is much more evenly than the input image, with a more evenly distributed histogram will increase the spread of grayscale value so that the output image will seem brighter and more visible [5]. Impaired image image will reduce its quality. Thus, the image with disturbance is improved by removing noise by using the median filter. The results of the process in Figure 2 below:

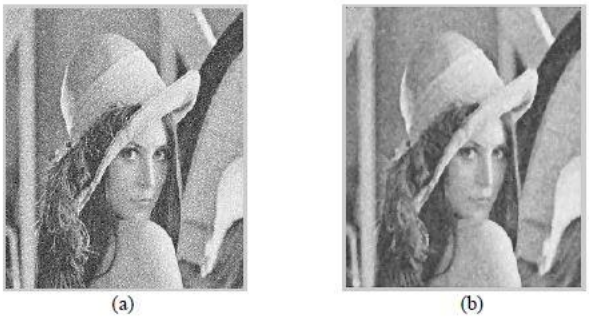

Figure 2: (a) Before median screening, (b) after median screening

Figure 2 above the difference in image quality before filtering the median value and after median value screening. After going through the process of eliminating noise, then the image can be done histogram process. The results of the median screening can be seen in Figure 2 (b) where the image appears to be deficient in noise or disturbance.

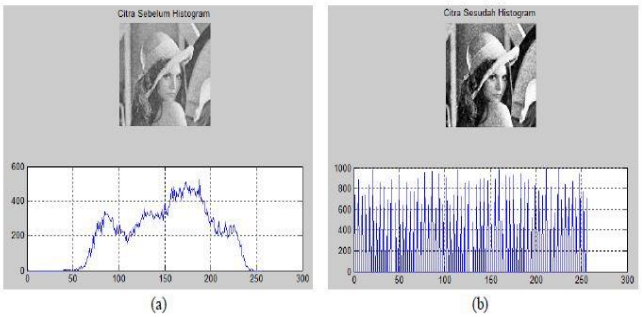

Figure 3: (a) Histogram Citra Input, (b) Histogram Citra Output

In Figure 3 the lena image histogram, pixels representing flax are on the right side of the histogram, different than the input histogram in Figure 1 (a). This can be due to several things, including image quality and large image size.

Certain contrast image sizes are presented in this paper for quality improvement [19]. Stretch contrast is a method to create an image that has a brighter part for brighter and darker parts dark [9]. Image contrast is a distribution of light and dark pixels. The low-contrast image of grayscale will look too dark, too bright or too gray. Histogram image with low contrast, all pixels will be concentrated in left, right or center. All pixels will be grouped tightly on one side and use a fraction of all possible pixel values [8].

B. Contrast Stretching

A certain contrast image size is presented in this paper for quality improvement. The contrast image is a loosened field that has a lower and upper threshold. This is an intensity of contrasting cintra bases the method of increasing the image at the distance between pixels in the form of the function I0 (x=y) = f (I(x, y)), and the original image I (x, y), and the output is I0 (x, y) after the increase contrast, and f is a

transformation function [9]. Stretch contrast is a method of making the image that has the light become lighter and the dark becomes darker [9]. Grayscale images with low contrast will then look too dark, too bright or too gray. The image histogram with low contrast, all pixels will be concentrated on the left, right or center. All pixels will be clustered tightly on a particular side and use a fraction of all possible pixel values [8].

C. Method HE-Recursive Mean-Separate HE (RMSHE)

The RMSHE method suggests recursive image decomposition, until the scale value on r produces 2 sub-images. Then these two sub-drawings are individually enhanced using the CHE method. Note that if the value of r = 0 then no sub-image is produced and if the value r = 1 then this method is the same as CHE and BBHE method. This implies brightness level of a resulting picture is better maintained or enhanced because the r value will increase.

RESULTS OF REVIEW PAPER

Number in Reference	Authors	Method	Conclusion
[1]	Haidi I, NSP Kong	Brightness Preserving Dynamic Histogram Equalization (BPDHE*)*	This paper discusses BPDHE as a continuation of MPHEBP and DHE. Both MPHEBP and BPDHE can split the histogram and is almost identical in dynamic range intervals terms with DHE. The difference is, the use of a brightness normalization in order to maintain input intensity by BPDHE. Also, BPDHE advantages is the absence of parameters that need to be regulated. From experiments and results have been concluded that BPDHE can improve images without first knowing the unwanted artifacts. With this we can conclude that, BPDHE can be implemented in real system, easy to use and very effective.
[2]	MA Al-Wadud, MH Kabir, MAA Dewan, and O Chae	Dynamic Histogram Equalization (DHE)	We have proposed a dynamic approach for contrast enhancement of low contrast images. DHE improves image without reducing image detail. However, if the user is not satisfied, he or she can control the upgrade rate (i.e., the amount of lost details he / she is ready to accept) by simply adjusting one parameter.
[3]	Q Wang, RK Ward	Weighted Thresholded Histogram Equalization (WTHE)	The experimental results show that the proposed WTHE is able to achieve a visually pleasing enhancement effect. That over-enhancement and saturation levels of artifacts are effectively avoided. Compared to many other global HEbased enhancement methods, enhanced images using the WTHE method show enhanced contrast and small artifacts, while looking natural. Importantly, the control mechanism in WTHE is convenient and smooth, especially adjusting the power factor r.
[5]	YEONG TM	Preserving Bi-Histogram Equalization (PBHE)	This paper discusses the development of a contrast enhancement algorithm called dengahn BBHE. BBHE is a novel addition of a typical histogram equalization. BBHE uses more than two subimages obtained by reducing the input image with reference to the mean value. The purpose of BBHE is to improve and maintain the average brightness in the image.
[7]	M Kim and MG Chung	Recursively Separated and Weighted Histogram Equalization (RSWHE)	The problem with Histogram Equalization is the difference between the original and result images brightness which very visible. In this journal, there is a new method of histogram distribution method called RSWHE (Separate and

Number in Reference	Authors	Method	Conclusion
			Recursive Histogram Equation) to effectively solve the problem of average shift. The main reason for RSWHE made was just to enhance image contrast and keep the image bright.
[9]	H Yeganeh, A Ziaei, A Rezaie	Bi Histogram Equalization (BHE)	This journal discuss the new technique that can be used to enhance contrast of images for better perception. The method that being suggested is based on the previous histogram processing before the histogram equalization implemented. The result has a better method efficiency than other ordinary methods for contrast enhancement
[12]	JH Han, S Yang, and BU Lee	Grayscale and RGB Histogram Equalization (GRHE)	In this paper discusses comparison of the performance of histogram color equalization method in gray. Because images contrast is worse after converting. So this paper suggests a 3 dimensional method of color that results in the same distribution on a gray scale histogram. The performance of Menotti algorithm also discusses on this paper, on its performance that depends on color component. With this, we have a conclusion that the method presented improves the contrast of the lighting effectively by generating the same pdf on a gray scale.
[13]	D Menotti, L Najman, J Facon, and AA Araújo	Multi-Histogram Equalization (MHE)	MHE is the new test method which can enhance brightness and contrast for images, and also control that produces images with a natural look. From the experimental results obtained the conclusion that brightness of a picture being processed is better to be maintained with this method since it is providing output images with a very good view.
[15]	JY Kim, LS Kim, and SH Hwang	Partially Overlapped Sub-block Histogram-Equalization (POSHE)	POSHE is a so-called new contrast enhancement algorithm is the main topic on this paper. It is more effective and much closer than local histogram equalization. POSHE has a very important feature that is the ow-pass mask-shaped filter gain function density probability sub-region which has the conclusion that the image size can vary. The global equity histogram method is not used because POSHE has an increase in brightness contrast to very large images and causes a preventive effect

CONCLUSION

A digital image processing software has been successfully constructed. The software can do image contrast enhancement with histogram equalization method. The results given by the method equalizaton histogram can improve image quality, so that information in the image more clearly visible.

REFERENCES

[1] Ibrahim, Haidi, and Nicholas Sia Pik Kong. "Brightness preserving dynamic histogram equalization for image contrast enhancement." *IEEE Transactions on Consumer Electronics*53.4 (2007).

[2] Abdullah-Al-Wadud, Mohammad, et al. "A dynamic histogram equalization for image contrast enhancement." *IEEE Transactions on Consumer Electronics* 53.2 (2007).

[3] Wang, Qing, and Rabab K. Ward. "Fast image/video contrast enhancement based on weighted thresholded histogram equalization." *IEEE transactions on Consumer Electronics* 53.2 (2007).

[4] Wang, Yu, Qian Chen, and Baeomin Zhang. "Image enhancement based on equal area dualistic sub-image histogram equalization method." *IEEE Transactions on Consumer Electronics* 45.1 (1999): 68-75.

[5] Wongsritong, K., et al. "Contrast enhancement using

multipeak histogram equalization with brightness preserving." *Circuits and Systems, 1998. IEEE APCCAS 1998. The 1998 IEEE Asia-Pacific Conference on*. IEEE, 1998.

[6] Ooi, Chen Hee, Nicholas Sia Pik Kong, and Haidi Ibrahim. "Bi-histogram equalization with a plateau limit for digital image enhancement." *IEEE Transactions on Consumer Electronics*55.4 (2009).

[7] Kim, Mary, and Min Gyo Chung. "Recursively separated and weighted histogram equalization for brightness preservation and contrast enhancement." *IEEE Transactions on Consumer Electronics* 54.3 (2008).

[8] Chen, Soong-Der, and Abd Rahman Ramli. "Minimum mean brightness error bi-histogram equalization in contrast enhancement." *IEEE transactions on Consumer Electronics* 49.4 (2003): 1310-1319.

[9] Yeganeh, Hojat, Ali Ziaei, and Amirhossein Rezaie. "A novel approach for contrast enhancement based on histogram equalization." *Computer and Communication Engineering, 2008. ICCCE 2008. International Conference on*. IEEE, 2008.

[10] Stark, J. Alex. "Adaptive image contrast enhancement using generalizations of histogram equalization." *IEEE Transactions on image processing* 9.5 (2000): 889-896.

[11] Cheng, H. D., and X. J. Shi. "A simple and effective histogram equalization approach to image enhancement." *Digital signal processing* 14.2 (2004): 158-170.

[12] Han, Ji-Hee, Sejung Yang, and Byung-Uk Lee. "A novel 3-D color histogram equalization method with uniform 1-D gray scale histogram." *IEEE Transactions on Image Processing* 20.2 (2011): 506-512.

[13] Menotti, David, et al. "Multi-histogram equalization methods for contrast enhancement and brightness preserving." *IEEE Transactions on Consumer Electronics* 53.3 (2007).

[14] Kim, Yeong-Taeg. "Contrast enhancement using brightness preserving bi-histogram equalization." *IEEE transactions on Consumer Electronics* 43.1 (1997): 1-8.

[15] Kim, Joung-Youn, Lee-Sup Kim, and Seung-Ho Hwang. "An advanced contrast enhancement using partially overlapped sub-block histogram equalization." *IEEE transactions on circuits and systems for video technology* 11.4 (2001): 475-484.

[16] Pizer, Stephen M., et al. "Contrast-limited adaptive histogram equalization: speed and effectiveness." *Visualization in Biomedical Computing, 1990., Proceedings of the First Conference on*. IEEE, 1990.

[17] Wang, Qian, Liya Chen, and Dinggang Shen. "Fast histogram equalization for medical image enhancement." *Engineering in Medicine and Biology Society, 2008. EMBS 2008. 30th Annual International Conference of the IEEE*. IEEE, 2008.

[18] Yang, X-D., Qinghan Xiao, and Hazem Raafat. "Direct mapping between histograms: An improved interactive image enhancement method." *Systems, Man, and Cybernetics, 1991.'Decision Aiding for Complex Systems, Conference Proceedings., 1991 IEEE International Conference on*. IEEE, 1991.

[19] Raju, G., and Madhu S. Nair. "A fast and efficient color image enhancement method based on fuzzy-logic and histogram." *AEU-International Journal of electronics and communications*68.3 (2014): 237-243.

[20] Kim, Yeong-Taeg. "Quantized bi-histogram equalization." *Acoustics, Speech, and Signal Processing, 1997. ICASSP-97., 1997 IEEE International Conference on*. Vol. 4. IEEE, 1997.

[21] Ziaei, Ali, et al. "A novel approach for contrast enhancement in biomedical images based on histogram equalization." *BioMedical Engineering and Informatics, 2008. BMEI 2008. International Conference on*. Vol. 1. IEEE, 2008.

[22] Pichon, Eric, Marc Niethammer, and Guillermo Sapiro. "Color histogram equalization through mesh deformation." *Image Processing, 2003. ICIP 2003. Proceedings. 2003 International Conference on*. Vol. 2. IEEE, 2003.

[23] Senthilkumaran, N., and J. Thimmiaraja. "Histogram equalization for image enhancement using MRI brain images." *Computing and Communication Technologies (WCCCT), 2014 World Congress on*. IEEE, 2014.

[24] Tan, KokKeong, and John P. Oakley. "Enhancement of color images in poor visibility conditions." *Image Processing, 2000. Proceedings. 2000 International Conference on*. Vol. 2. IEEE, 2000.

[25] Celik, Turgay, and Tardi Tjahjadi. "Automatic image equalization and contrast enhancement using Gaussian mixture modeling." *IEEE Transactions on Image Processing* 21.1 (2012): 145-156.

[26] Zuo, Chao, Qian Chen, and Xiubao Sui. "Range limited bi-histogram equalization for image contrast enhancement." *Optik-International Journal for Light and Electron Optics* 124.5 (2013): 425-431.

[27] Lee, Chulwoo, et al. "Power-constrained contrast enhancement for emissive displays based on histogram equalization." *IEEE transactions on image processing* 21.1 (2012): 80-93.

[28] Panetta, Karen A., Eric J. Wharton, and Sos S. Agaian. "Human visual system-based image enhancement and logarithmic contrast measure." *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)* 38.1 (2008): 174-188.

[29] Jin, Yinpeng, Laura Fayad, and Andrew Laine. "Contrast enhancement by multiscale adaptive

histogram equalization." *Proc. SPIE*. Vol. 4478. 2001.

[30] Kaur, Manpreet, Jasdeep Kaur, and Jappreet Kaur. "Survey of contrast enhancement techniques based on histogram equalization." *International Journal of Advanced Computer Science and Applications* 2.7 (2011): 137-141.

[31] Wang, Chao, and Zhongfu Ye. "Brightness preserving histogram equalization with maximum entropy: a variational perspective." *IEEE Transactions on Consumer Electronics* 51.4 (2005): 1326-1334.

[32] Kim, Tae Keun, Joon Ki Paik, and Bong Soon Kang. "Contrast enhancement system using spatially adaptive histogram equalization with temporal filtering." *IEEE Transactions on Consumer Electronics* 44.1 (1998): 82-87.

[33] Kim, Joung-Youn, Lee-Sup Kim, and Seung-Ho Hwang. "An advanced contrast enhancement using partially overlapped sub-block histogram equalization." *IEEE transactions on circuits and systems for video technology* 11.4 (2001): 475-484.