Digital Image Visual Quality Enhancement Using Histogram Equalization Techniques with Proposed Linear Perception Neural Network Method

Khushboo Singh[1]
M. E. Scholar Department of Digital Communication Engg.
R.G.P.V, University
Bhopal, M.P., (India)

Dr Anubhuti Khare
A.P. in Digital Communication Engg
R.G.P.V, University
Bhopal, M.P., (India)

***Abstract*—** Image improvement is one among the issues in low visual quality and low enhancement level of image histogram method. Image improvement completely different methods like histogram leveling, multipoint histogram equalizations and picture component dependent distinction protecting, but of this technique are not up to marks. Projected linear perception network methodology for image improvement that features an additional strong result for distinction improvement with brightness preservation. Image element mutuality linear perceptron network supported curvelet transform and perceptron network. Curvelet transform image transform into multi-resolution mode. it's a realize element distinction of pixel for the dependency of characteristic and matrix work as a weight vector for perceptron network and so the perceptron network is in work to alter the load of input image or values. Image mutuality linear perceptron network for distinction improvement has applied on several pictures and compared the results of our proposed methodology with various image improvement methods like histogram leveling. Absolute mean brightness error (MBE) is used to measure the degree of brightness preservation. Low AMBE and also called is best, Peak signal to noise quantitative relation (PSNR) is used to measure the degree of distinction improvement, larger PSNR and also called is best. In experiment image secure encoding improvement technique using histogram leveling with proposed methodology supported the MBE low and PSNR High. Image secure cryptography improvement have found that proposed methodology is best than existing methodology (HEM).

Keywords: **Contrast Enhancement, Image Histogram, Histogram Equalization, Brightness Preserving, AMBE, PSNR, HEM.**

I.INTRODUCTION

Contrast improvement is one of the foremost important phenomena which can improve the visual quality of an image. Everyday individuals capture great deal of images, and these photos might demand improvement due to the existence of noise, cloud, quality of the image capturing devices, etc. Digital image method may be a broad subject and generally involves procedures which can be mathematically advanced, but central set up behind digital image method is kind of simple. The ultimate word aim of image Process is to use data contained at intervals the image to alter the system to understand, acknowledge and interpret the processed data out there from the image pattern [1]. Image improvement techniques improve the quality of an image as perceived by human. Usually image improvement techniques are accustomed get detail that is obscured, or to concentrate on sure choices of interest in image. In image improvement methodology one or extra attributes of image area unit modified. Image improvement is applied to altogether completely different areas of science and engineering. except for illumination conditions, quality of images is in addition affected by external noises and environmental disturbances like close pressure and temperature fluctuations. Thus, image improvement is very important. Approaches of distinction restricted image improvement via stretching the bar graphs over a reasonable dynamic vary and multi-scale adjective histogram equalizations is developed. Associate adjective rule is customized to the image intensity distribution either globally or regionally. By separating swish and detail areas of an image, the rule is applied to each of them to avoid excessive sweetening of noises. In most cases, quality of images is affected by atmosphere medium and water medium, so image improvement is required [2]. The aim of image improvement is to enhance the interpretability or perception of data in image for human viewers, or to supply `better' input for different automatic image process techniques. pictures will be processed by completely different suggests that, however image process mistreatment digital computers is that the most typical methodology as a result of digital strategies area unit quick, flexible, and precise. Image improvement improves the standard of pictures for seeing. In associate application specific image improvement technique the system is educated for the particular procedures to get a higher output image as shown by the diagram of Figure 1.1

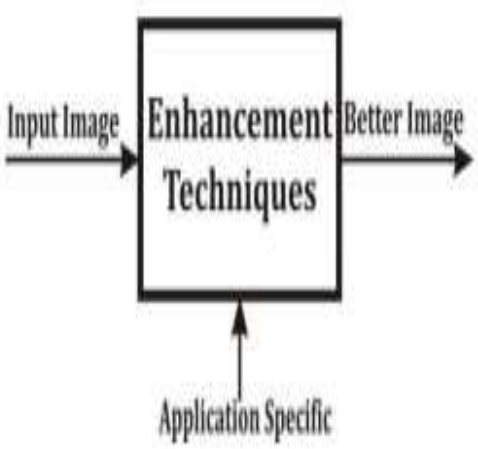

Fig1 Application specific image enhancement

1.1Describe Histogram

Histogram equalization (HE) may be a well-known methodology for image distinction improvement that uses bar graph of image in its process. He's a special domain technique that modification of pixels intensity values is completed directly which results in improvement of image. Bar graph method is employed in image improvement the information inherent in histogram could utilize in several image method applications like image segmentation and compression. A bar graph simply plots the frequency at that each grey-level happens from zero (black) to 255 (white). bar graph method got to be the initial step in preprocessing. to produce a so much higher image bar graph exploit and bar chart specification (matching) area unit 2 ways that wide used to modify the bar chart of an image.

The bar chart may well be a separate perform that is shown in figure a combine of.1 bar chart represents the frequency of prevalence of all gray-level inside the image, which suggests it tell u. s. of America but the values of individual part during a image ar distributed. Bar chart is given as-

h (rk) = nk/N

Where an area unit strength and vary of pixels in image with intensity severally. bar graph equalization (HE) is that the one amongst the celebrated technique for image distinction upgrade[3].

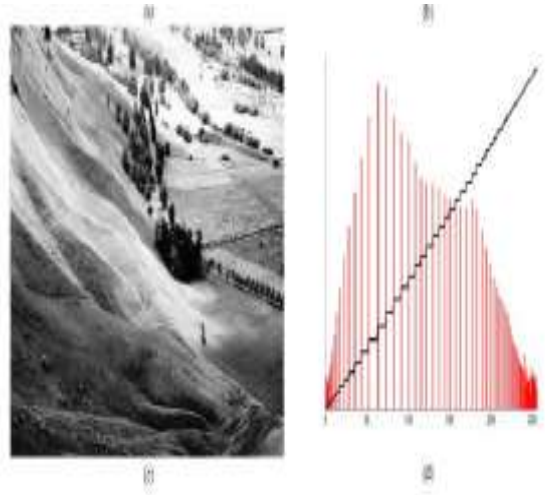

Fig2 bar graph (Image Histogram)

1.2 Types of Image Enhancement

1. Bar graph Enhancement: The bar graph of a distinct gray-level image represents the frequency of occurrence of all gray-levels within the image. bar graph leveling (HE) may be a technique unremarkably used for image distinction improvement, since he's computationally quick and easy to implement. It works by flattening the bar graph and stretching the dynamic vary of the gray-levels by victimization the additive density performs of the image.

2. Local Enhancement: Previous ways of bar graph equalizations and bar graph matching area unit world. So, native improvement is employed. outline sq. or rectangular neighborhood (mask) and move the middle from picture element to picture element. for every neighborhood, calculate bar graph of the points within the neighborhood. get bar graph equalization/specification perform. Map grey level of picture element targeted in neighborhood. It will use new picture element values and former bar graph to calculate next bar graph. Bar graph leveling Technique: bar graph leveling may be a common technique for enhancing the appearance of pictures. Suppose we've got a picture that is preponderantly dark. Then its bar graph would be skew towards the lower finish of the gray scale and every one the image detail is compressed into the dark finish of the bar graph. If we may `stretch out' the gray levels at the dark finish to supply a additional uniformly distributed bar graph then the image would become a lot of clearer. bar graph exploit stretches the bar graph across the complete spectrum of pixels (0 – 255). It will increase the distinction of pictures for the determinateness of human review and might be applied to normalize illumination variations in image understanding issues. bar graph exploit is one amongst the operations which will be applied to get new pictures supported bar graph specification or modification. bar graph leveling is taken into account a world technique. This method is kind of easy and for every brightness j within the original image, the new pel level worth (k) is calculated as given in equation wherever the add counts the quantity of pixels within the image with brightness capable or but j, and T is that the total variety of pixels .The main purpose of bar graph leveling is to search out grey level transformation perform T to remodel image f specified the bar graph of T(f) is 'equalized' .

1.3Types of Image Improvement Operations

Image improvement operations area unit removing blur and noise, increasing distinction and revealing details.

1. Improvement distinction: Image Contrast is that the distinction in look of 2 or additional elements of a picture seen at the same time. Distinction enhancement is employed to extend the seeing of distinction between completely different elements of a picture. variety of algorithms for distinction improvement area unit presently in use throughout the globe. The ways of brightness distinction and color distinction has been mentioned here. a picture should have sensible brightness distinction for correct vision. in a very low distinction image, we can't distinguish clearly between objects. Increasing the distinction makes the sunshine areas become lighter and dark areas become darker. 3 ways area unit won't to auto-correct the distinction of image. 1st technique uses linear stretching of bar graph over the complete vary. this system maps the intensities to new values specified the information is stretched to the entire vary.

2. Removing Noise: Digital pictures area unit susceptible to a range of varieties of noise. Noise is that the results of errors within the image acquisition method that end in picture element values that don't mirror actuality intensities of the important scene. Noise is introduced into digital pictures because of many reasons like a) If the image is scanned from a

photograph, the film grain may be a supply of noise. It is a result of a broken film or because of the scanner itself. b) If the image is captured directly from a photographic camera it is because of mechanism of gathering the information. c) It can even be introduced because of less light-weight or high shutter speed of digital cameras) Electronic transmission of image information can even introduce noise. Linear Filtering is best method to remove sure kind of noise. Averaging or Gaussian filter may be wont to accomplish this job. Averaging filter is beneficial to remove grain noise. every picture element gets set to the common of its neighboring pixels. the problem with averaging filter is that edges of image get blurred. Median filter works during a similar method as averaging filter, the only distinction is that the output price of a picture element is set by the median of the neighboring picture element instead of mean. The principle advantage of median filtering over averaging is that it's a lot of less sensitive to extreme values. Therefore, median filtering is best ready to take away noise while not blurring the sides. Adaptive filtering victimization Wiener filter usually turn out far better results than linear filtering. Accommodative filter preserves edges and different high frequency data of a picture thus it's additional selective then linear or median filters. This filter produces best output once noise is AWGN.

3. Blur Reduction: once we use a camera, we would like the recorded image to be a trustworthy illustration of the scene that we see however each image is additional or less indistinct. Once a picture doesn't shows sharp details of its options it's known as blurred image. Thus, image declaring is key in creating photos sharp and helpful. Some blurring continuously arises within the recording of a digital image; as a result of its inescapable that scene data “spills over” to neighboring pixels. In image deploring, we tend to request to recover the initial, sharp image by using a mathematical model of the blurring method. Sadly there's no hope that we are able to recover the initial image exactly! This can be because of numerous ineluctable errors within the recorded image. The foremost vital errors are fluctuations within the recording method and approximation errors once representing the image with a restricted number of digits.

II.PREVIOUS WORK HAS BEEN DONE

The previous work provides the information or data of hiding scheme that gives responsibility of information concealing in information science. a number of the theme is mention below. The section describe concerning previous connected work under image process.

Kim et al [9]. RSWHE proposed which is another improved version of HE. RSWHE consists of three modules such as bar graph segmentation, bar graph coefficient and bar graph equalization. In the bar graph segmentation modules, several sub-histograms of square measurement products support the mean and median image. Meanwhile, in the low coefficient graph modules, separate histograms are weighted by Stevens' normalized law. This module offers additional possibilities at rare gray levels. Finally, it was applied to each of the weighted bar charts. However, some applied mathematical data may be lost when the transformation of the low activity graph and the specified improvements are not obtained. Histogram equalization (HE) is widely used for improving contrast. However, it tends to vary the brightness of a photo and, therefore, is not suitable for consumer electronics, where maintaining the first brightness is important to avoid annoying problems. The bi-histogram equalization (BBHE) has proposed and analyzed mathematically that it can keep the first brightness of a particular range. However, there are still cases that are not treated well by BBHE, as they require the highest degree of preservation. This article proposes a generalization of BBHE which is called the Equivalent Repetitive Histogram Equation (RMSHE) to provide not only better but also scalable brightness conservation. BBHE separates the image entry histogram into two supported means before assimilating them independently. While the separation is done only once in BBHE, this article proposes to do the separation in another way; separate each new histogram to support their respective means. It is analyzed mathematically, which means that the brightness of the output image will converge towards the average light image input because the number of repetitions means of separation. In addition, the repetitive nature of RMSHE also makes it possible to preserve the evolving brightness, which is very useful in consumer electronics. The results of the simulation show that the cases which are not well treated by HE, BBHE and the dualist sub-image equalization histogram (DSIHE), are well reinforced by RMSH

Ch. Ganapathy Reddy et al. [10]. Provided an algorithm in which he first executed the DWT to decompose the images into views of a group of band-limited parts, called HH, HL, LH and sub-band. Since the sub band contains the lighting data, the logarithmic average brightness is calculated from the LL sub band to calculate the dominant brightness of the input image. The LL sub-band is divided into 3 layers of low, medium and high concentration depending on the. Intensity of the director. The adjusted operative intensity transfer is deliberately divided into 3 layers divided by the most important intensity, the operative transfer of the knee, and therefore the operative gamma shift. Then, the transfers adjust the operating concerns for a high speed differential protection improving the colors. The results increase the image obtained by the inverse DWT (IDWT). Improving contrast is very important for better perception and reproduction of colors. In this article, we explain the improvement techniques below: equogram equalization, bi-histogram equalization, contrast improvement using the discrete wavelet transform (DWT) and decomposition into singular value (SVD), the transformation into discrete cosine (DCT) and the decomposition into singular value (SVD).) and therefore proposed contrast enhancement techniques to support the dominant brightness and adaptive transformation. The performance of each method is evaluated with parameters such as the mean square error (MSE), the improvement measure (EME), the peak signal-to-noise ratio (PSNR) and the mean absolute error (MAE) .

Li-Yu Chang Jiang et al. [11]. has developed a fuzzy approach to improve the distinction of distant image information in order to partition the value of the image element with the degree of artifact disappearing in order to reimburse the native light lost in dark and bright areas. The algorithm consists of 3 stages: mainly, the satellite image is distorted compared to the members of origin of gray level by groups of fuzzy average. Second, the appropriate stretching model for each group is performed to support the corresponding members. Third, the image is re-edited in the grayscale area by merging the gray stretch values in each cluster. Many conventional contract improvement techniques take a global approach to improving image brightness. However, it is generally difficult to apply all of the land cover classes that appear on satellite images, as information and details of the local contract may also be lost in dark and bright areas. during this study, an image enhancement method based on blurring is developed to partition the pixel values at different degrees of artifact in order to compensate for the local brightness lost in the dark and bright areas. The algorithm takes place in three stages: First, the satellite image is transformed from gray level space into member space by a fuzzy cMeans grouping. Second, they make stretching patterns appropriate to each group to support the corresponding member. Third, the image is

transformed back into the grayscale space by merging the gray stretch values in all clusters. Finally, the performance of the proposed scheme is assessed visually and quantitatively. The results show that the proposed method can improve the image thanks to high quality visualization and high index image measurement.

S.C. Huang et al. [12] In addition to its image-based enhancement technique, another technique is already planned. AGCWD is intended for where gamma correction and light probability distribution panels are used. Although most AGCWD boxes improve the brightness of the input image, it may not offer satisfactory results if the input image lacks too bright pixels. Following this case, the simplest potential enhancement node cuts the intensity of the first image input which can be simply understood. This article provides an effective method for changing histograms and improving the contrast of digital images. Improvement plays a major role in digital image processing, computer vision and pattern recognition. We present an automated transformation technique that improves the brightness of the immature image via gamma correction and the probability distribution of the luminance pixels. enhancing the video, the proposed image enhancement method uses time information about the difference between each image to reduce the magnitude of computational complications. Experimental results demonstrate that the proposed method produces an improved image quality comparable to or better than that produced using the previous modern state methods.

Chen et al. [13] to reduce the problems encountered by BBHE, Wan et al. proposes another change, it is named DSIHE. Here, the bar graph is separated into 2 sub-images to support the median instead of the average and equalize an equivalent like BBHE. Even if DSIHE does not allow vital average changes, it fails to maintain average clarity in some cases. In addition, DSIHE may further produce artifacts or not apply to some extent. for example, the image intensity elements one, 2, 3, 200, 205, 208 and 210. Here, the median is two hundred; as a result, the first 3 pixels are often over-improved, which may not be desired.

In L.J. Huang et al. [14], discussed NIE (Nonlinear Image Enhancement). Simulation and identification processes are used along with the proposed NIE method. This process uses clipping and scaling parameters which are an appropriate combination of various images. This process enhances the quality of blurred image and a better quality is achieved, and PSNR (signal-to-noise ratio) performance is obtained than other nonlinear enhancement techniques.

In Ehsani et al. [15], proposed an adaptive and iterative histogram matching (AIHM) algorithm for chromosome contrast enhancement used in medical applications. To meet the different requirements and obtain the different results, some parameters in the presented model could be selected. The detailed simulations were accomplished using different sets of single chromosomes, indicating that the proposed method enhances the details adequately.

Table 1. Explain related work

S.No.	Authors	Technique	Description
1	Kim et al.	Recursively separated and weighted histogram equalization for brightness preservation and contrast enhancement	Low embedding and low PSNR
2	Ch. Ganapathy Reddy et al.	contrast Enhancement for Remote Sensing Images with Discrete Wavelet Transform	ABMSE is more and low robustness or PSNR
3	Li-Yu Chang Jiang et al.	A Fuzzy-Based Method For Remote Sensing Image Contrast Enhancement	ABMSE is more and low robustness or PSNR
4	S.C. Huang et al.	Efficient contrast enhancement using adaptive gamma correction with weighting distribution	low robustness very low distortion and relatively large capacity
5	Chen et al.	Minimum mean brightness error bi-histogram equalization in contrast enhancement	blocks data embedding but low PSNR and more AMBE
6	L.J. Huang et al.	Non-linear image enhancement	good imperceptibility but more AMBE
7	In Ehsani et al.	chromosome image contrast enhancement using adaptive, iterative histogram matching	High IBE and low PSNR.

III. PROBLEM DESCRIBED

The main problem poor visual quality of digital image. This thesis is to propose an efficient a good and efficient technique for image improvement. In digital image process varied techniques have planned to reinforce the standard of image like bar graph leveling technique and component dependent distinction protective , however they doesn't give the higher result for distinction improvement and brightness preservation. Distinction improvement and image security main drawback overcome our planned a replacement technique for image improvement that's supported curvelet remodel and linear perceptorn network technique and it provides an improved result for distinction improvement with brightness preservation. Drawback of image could also be of poor visual quality as a result of its distinction is low, or it's clattery, or it's blurred, etc. then low distinction within the pictures. Image distinction improvement may be a ancient drawback space in image process.

IV.IMPLEMENTATION TOOL DESCRIBED

In this section they're describing the code demand for our planned analysis work. By looking out we've discovered that for our planned work the MATLAB2013 is best code. MAT-LAB could be a code package for top performance numerical computation and image. It provides interactive surroundings with many inbuilt operate for technical computation, graphics and animations. The name MAT-LAB stands for Matrix Laboratory. One amongst most feature of MAT-LAB is its platform independence. Once you're in MATLAB, for the foremost half, it doesn't matter which pc you're on. In MAT-LAB the M-files are the quality code text files, with a .m extension to the file name. There are 2 files of this file: script file and performance file. All most programs in write in MAT-LAB are saved in M-files. Fig-files are binary files with a .fig extension that may be opened once more in MAT-LAB as figures. Such files are created by saving a figure during this format victimization save or save as possibility from File menu or victimization the save as command in command window-files are compiled M-files with a .p extension that may be executed in MAT-LAB directly. There are many elective toolboxes are accessible from developers of MAT-LAB. These toolboxes are assortment of operate written for special applications like symbolic computation, image process, statics, system, neural network, and etc. following Key options.

V. EXPERIMENTAL RESULT ANALYSIS

(a)AMBE Analysis based on Barbara_image: In this experimentation analysis using Barbara image (184KB). AMBE analysis based on HEM, ESIHEM and PLPNM.

Table 2 Experimental Analysis on barbara_image AMBE Values

Method	Image(in jpg)	AMBE (in db)
HEM	Barbara_image (184KB)	41.6821
ESIHEM		24.405
PLPNM		10.2534

(b) Result Graph Analysis Based on AMBE Values:
In this experimentation analysis using Barbara image (184KB). Result graph analyses based on AMBE Values are HEM and ESIHEM more but PLPNM less and also show fig.3.below

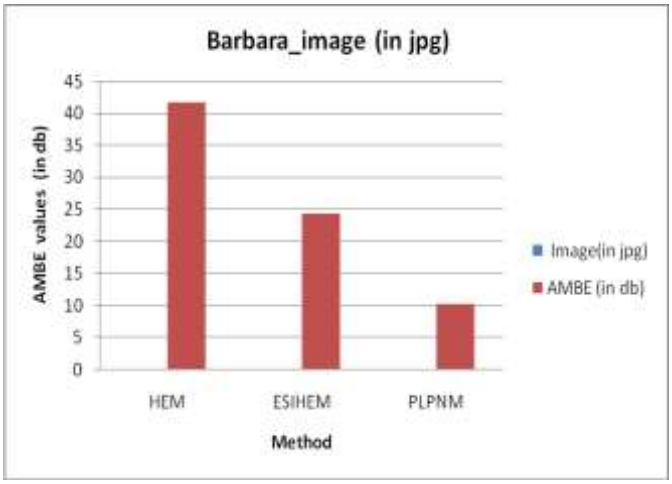

Fig3 Performance Analysis based mostly AMBE in barbara_image

c) PSNR Analysis on barbara_image
In this experimentation analysis using Barbara image (184KB). PSNR analysis based on HEM, ESIHEM and PLPNM.
Table 3Experimental Analysis on barbara_image PSNR Values

Method	Image(in jpg)	PSNR(in db)
HEM	Barbara Image (184KB)	11.9638
ESIHEM		14.3575
PLPNM		26.1217

(d) Result Graph supported PSNR Values:
In this experimentation analysis using Barbara image (184KB). Result graph analyses based on PSNR Values are HEM and ESIHEM low but PLPNM high and also show fig4.below.

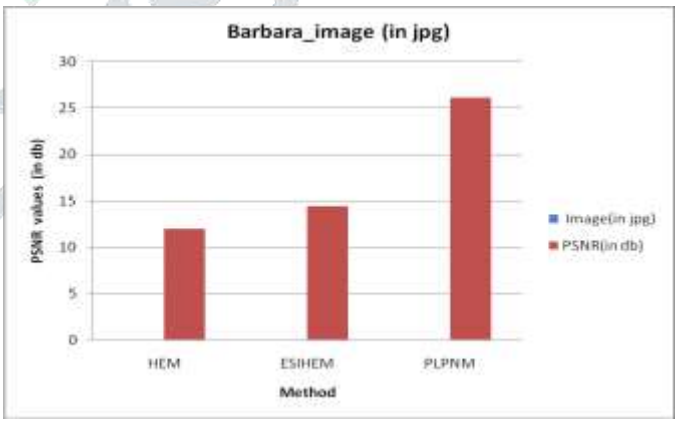

Fig4 Performance Analysis based mostly PSNR in barbara_image

VI.CONCLUSION

The main objective of image enhancement is to identify and analyze various image enhancement techniques that improve the quality of an image, including noise, contrast and brightness. These techniques help researchers compare various improvement algorithms and choose the simplest among them according to the targeted specification. In the area of image security improvements, various techniques have been provided for improving image quality such as histogram

upgrade, multi-histogram upgrade and protection of image security. Component dependent image, a planned line perception technique (PLPNM) for image enhancement which provides an improved result for enhancement of distinction. With the preservation of brightness. PLPNM uses the curvelet and perceptron network to improve the images. Curvelet remodeling is used to rework an image in multi-resolution mode and the work of the perceptron network to manage the input or value load of the image. Our technique for improving image security has been applied to many images and compared to our techniques and different ways of improving image security. The main disadvantages of the square really measure an increase in the contract for large objects and in addition a decrease in the contract for small objects in the image. Method proposed to determine the parameters in particular AMBE and PSNR; the technique is envisaged compared to this method in particular HEM and ESIHEM However, the techniques identified in the graph leveling pulses have drawbacks which limit their use for image processing in automatic mode. Mathematics establishes that the planned technique is sound and that the visual quality of digital images is superior to that of work is a false victim of MATLAB simulation tools. The proposed linear network method (PLPNM) better image enhancement or PSNR and AMBE minimization.

REFERENCES

[1] S. Rahman, M. M. Rahman, K. Hussain, S. M. Khaled, and M. Shoyaib, "Image enhancement in spatial domain: A comprehensive study," in Computer and Information Technology (ICCIT), 2014 17th Intl. Conf. on. IEEE, 2014, pp. 368–373.

[2] S.S. Bedi, Rati Khandelwal "Various Image Enhancement Techniques- A Critical Review" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 3, March 2013.

[3] Sapana S. Bagade, Vijaya K. Shandilya, "Use of Histogram Equalization In Image Processing For Image Enhancemen", International Journal of Software Engineering Research & Practices Vol.1, Issue 2, April, 2011.

[4] Tang, Jinshan, Eli Peli, and Scott Acton. "Image enhancement using a contrast measure in the compressed domain." IEEE Signal Processing Letters 10, no. 10: 289-292, 2003.

[5] Bai, Xiangzhi, Fugen Zhou, and Bindang Xue. "Image enhancement using multi scale image features extracted by top-hat transform." Optics & Laser Technology 44, no. 2: 328-336, 2012.

[6] hmed, Hanan SS, and Md Jan Nordin. "Improving diagnostic viewing of medical images using enhancement algorithms." Journal of Computer Science 7, no. 12: 1831, 2011.

[7] M. M. Rahman, S. Rahman, E. K. Dey, and M. Shoyaib, "A gender recognition approach with an embedded preprocessing," International Journal of Information Technology and Computer Science (IJITCS), vol. 7, no. 7, p. 19, 2015.

[8] Csapodi, Márton, and Tamás Roska. "Adaptive Histogram equalization with cellular neural networks." 1996 Fourth IEEE International Workshop on Cellular Neural Networks and their Applications Proceedings (CNNA-96). IEEE, 1996.

Ch2

[9] M. Kim and M. G. Chung, "Recursively separated and weighted histogram equalization for brightness preservation and contrast enhancement," Consumer Electronics, IEEE Trans. on, vol. 54, no. 3, pp. 1389– 1397, 2008.

[10] Ch. Ganapathy Reddy, G. Veena, V. Uma, "Contrast Enhancement for Remote Sensing Images with Discrete Wavelet Transform", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-2, Issue-3, July 2013

[11] Li-Yu Chang ,Chi-Farn Chen, Hung-Yu Chang, "A Fuzzy-Based Method For Remote Sensing Image Contrast Enhancement" The International Archives of the Photogrammetric, Remote Sensing and Spatial Information Sciences. Vol. VII. Part B2. Beijing 2008.

[12] S.C. Huang, F.C. Cheng, and Y.-S. Chiu, "Efficient contrast enhancement using adaptive gamma correction with weighting distribution," Image Processing, IEEE Trans. on, vol. 22, no. 3, pp. 1032–1041, 2013.

[13] Chen, Soong-Der, and Abd Rahman Ramli. "Minimum mean brightness error bi-histogram equalization in contrast enhancement." IEEE transactions on Consumer Electronics 49, no. 4 (2003): 1310-1319.

[14] L.J., Huang, Wang, Y.C.: Non-linear image enhancement using opportunity costs, published in Second International Conference on Computational Intelligence Communication Systems and Networks (CICSyN), IEEE, pp. 256–261, 2010.

[15] Ehsani, S.P., Mousavi, H.S., Khalaj, B.H.: Chromosome image contrast enhancement using adaptive, iterative histogram matching, published in 7th Iranian conference on Machine Vision and Image Processing (MVIP), IEEE, pp. 1–5, 2011.

[16] Shi, Zhixin, Srirangaraj Setlur, and Venu Govindaraju. "Digital enhancement of palm leaf manuscript images using normalization techniques." In 5th International Conference On Knowledge Based Computer Systems, pp. 19-22. 2004.

[17] Bai, Jing, Chuxiong Ding, Jianwen Luo, and Ping He. "Estimation and reduction of decorrelation effect due to tissue lateral displacement in elastography." ieee transactions on ultrasonics, ferroelectrics, and frequency control 49, no. 5 (2002): 541-549.

[18] Phanthuna, Nattapong. "Contrast Image Enhancement Using Multi-Histogram Equalization." The International Journal of Advanced Culture Technology 3, no. 2 (2015): 161-170.

[19] Calhoun, Vince Daniel, T. Adali, V. B. McGinty, James J. Pekar, T. D. Watson, and G. D. Pearlson. "fMRI activation in a visual-perception task: network of areas detected using the general linear model and independent components analysis." NeuroImage 14, no. 5 (2001): 1080-1088

[20] Altunbasak, Yucel, Tarik Arici, and Toygar Akgun. "Method and apparatus for adjusting the contrast of an image." U.S. Patent 7,738,698, issued June 15, 2010.

[21] Seo, Suk Tae, In Keun Lee, Hye Cheun Jeong, and Soon Hak Kwon. "Gaussian Kernel-Based Multi-Histogram Equalization." IEICE TRANSACTIONS on Information and Systems 93, no. 5 : 1313-1316, 2010.

[22] Al-amri, Salem Saleh, N. V. Kalyankar, and S. D. Khamitkar. "Linear and non-linear contrast enhancement image." International Journal of Computer Science and Network Security 10, no. 2 (2010): 139-143.

[23] Pizer, Stephen M., R. Eugene Johnston, James P. Ericksen, Bonnie C. Yankaskas, and Keith E. Muller. "Contrast-limited adaptive histogram equalization: speed and

effectiveness." In [1990] Proceedings of the First Conference on Visualization in Biomedical Computing, pp. 337-345. IEEE, 1990.

[24] Ko, S-J., and Yong Hoon Lee. "Center weighted median filters and their applications to image enhancement." IEEE transactions on circuits and systems 38, no. 9 (1991): 984-993.

[25] Rajavel, P. "Image dependent brightness preserving histogram equalization." IEEE Transactions on Consumer Electronics 56, no. 2 (2010): 756-763.