Medical image enhancement using Global mean and variance with Localization function

Manjeet Singh Walia
Student (Department of Information Security),
Chandigarh Engineering College, Landran , India

Manish Mahajan
Associate Professor (Department of IT)
Chandigarh Engineering College, Landran , India

. Abstract- In medical images we mostly use x-ray source to produce the images. The image formation is so obtained by using the concept of back projection. This means that source generate the x ray energy and pass through patient body and make the image through the sensor. This may lead to have a poor image contrast because of the poor usage of the available range of possible gray levels. Due to this the images may lead to overexposure & underexposure [1]. Some parts having soft tissues, generate high contrast while some other parts havig hard tissue generate low contrast. Most of the contrast enhancement methods are used to correct the contrast, but all the methods have limited efficiency to do this correction. So we need a method that could generate contrast for local means. Local means make a effect over small changed level of gray values.In the current paper we are going to implement the new method of image contrast enhancement that uses the concept of Global mean and global variance by using localization functions. The results of this technique show that it proves to be better, accurate and improves the contrast of images

Keywords- Image enhancement, Rayleigh CLAHE, global mean and variance

I.INTRODUCTION

The principal objective of image enhancement is to process a given image so that the result is more suitable than the original image for a specific application. It will improve the image features like edges, boundaries, or contrast to make a better graphic display which helpful for display and examination. The enhancement doesn't increase the inherent information related to the data, but it will boost the dynamic range of the chosen features so that they can be detected easily. The advantage of image enhancement either may be a human observer or a computer vision program performing some kind of higher-level image analysis, it also detect target or understand scenes.

A. General registration process

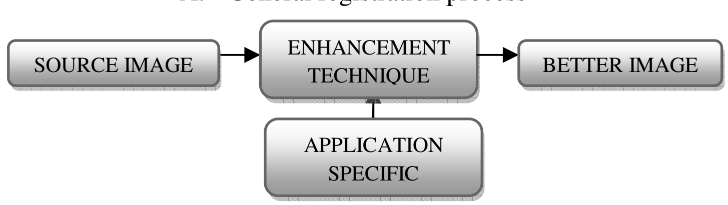


Fig. 1 General image enhancement process

Source Image: In this step the image which is to be enhanced is uploaded.

Enhancement Technique: This is the second step in this different Image Enhancement method are applied to the image to enhance different features of the image.

Application specific: In this step the application is specified for which application the enhancement method is used, as it may vary from one application to other.

Better Image: This is the final step, in this we receive the image after the enhancement of the image is done & a better image is received.

B. Techniques

Many image enhancement techniques have been proposed in the literature. Basically, they are categorized into two classes: Spatial Domain and Frequency domain enhancement [2]. Spatial domain image enhancement mainly based on pixels. The advantage of spatial based domain technique is that they conceptually simple to understand. But these techniques generally lacks in providing adequate robustness and imperceptibility requirements. Frequency domain image enhancement is a term used to describe the analysis of mathematical functions or signals with respect to frequency and operate directly on the transform coefficients of the image. This technique is used to enhance the image by manipulating the transform coefficients.

Contrast Enhancement process in digital x-ray

X-ray imaging has been available to dental practitioners in the past few decades and currently this imaging is widely used. There are already two dental radiography techniques which are often used, i.e. intra-oral and extra-oral. On intraoral technique, the radiographic film or sensor is placed inside the mouth and the radiographic film or sensor both are kept out of the mouth, on the other side of the head from the X-ray source, that will produce an extra-oral radiographic view [3]. Panoramic radiography is extra oral technique, in which the film is exposed while outside the patient's mouth. The panoramic image can be visualized the entirety of the maxilla and mandible jaws on the one image planes. Currently, film based panoramic radiography is widely used on the mostly dental clinic and laboratory in Indonesia, although the direct digital panoramic radiography has been available. For visual analysis, dental radiologist placing negative film in front of the viewer. The quality of film-based image has significant limitation due to chemical processing and the image enhancement of the film-based image cannot be done if required, since the level of contrast image is only depend on the level of light intensity of viewer. One of solution to allow improve the quality of contrast image is digitized film-based image to digital image. Digitized film-based image is performed using flatbed scanner on transmission and reflection mode. Scanners are preferred to digital cameras as they practically eliminate optical distortion and the reflection from the surface of the radiograph that would otherwise reduce image quality. However, often digitized film-based image has results undesired brightness and contrast of image. Therefore, image enhancement was required as it will lead to improvement in the quality of image. [4, 5, 6]

In this paper, the contrast quality of digital image that scanned using transmission and reflection mode is evaluated based on mean and standard deviation of the image. Furthermore, the quality of digital image is enhancement based on spatial technique using contrast stretching; histogram equalization (HE), adaptive histogram equalization (AHE), and contrast limited adaptive histogram equalization (CLAHE). Evaluation of the preference image quality is performed based on an objective criterion.

A. Contrast Stretching Contrast stretching is a point image enhancement method, that attempts to improve the contrast in an output image by 'stretching' the range of intensity values it contains to span a desired range of values.[7]

B. Histogram Equalization Histogram based techniques for image enhancement, are mostly based on equalizing the histogram of the whole image which increase the dynamic range corresponding to the image[8]. In other words, the pixel value of enhanced image depends on global pixel value of the original image. The process of histogram equalization is attempts to change the histogram through the use of a function $b = f(a)$ into a histogram that is constant for all brightness values, with equation:

$$f(a) = (2^B - 1) \cdot P(a)$$

Where $P(a)$ is the probability distribution function. In other words, the quantized possibility function is normalized from 0 to 2^{B-1} is the look-up table required for histogram equalization. [9, 10]

C. Adaptive Histogram Equalization (AHE)

Adaptive histogram equalization (AHE) differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct region of the image, and uses them to rearrange the lightness values of the image. The objective of process is to improve the local contrast of an image. The process steps on AHE are consists of define local neighbourhood of image pixel in specific section, calculation and equalization histogram neighbourhood and mapping of pixel value on the centre of neighbourhood based on equalized local histogram. To avoid discontinue value between the specific region, bilinear interpolation is applied to estimate pixel value on the region. [11, 12, 13, 14]

D. Contrast Limited Adaptive Histogram Equalization (CLAHE) is an image enhancement method that develops from AHE method. CLAHE method utilizes a parameter limit value of histogram in order to obtain adequate brightness and contrast on the enhanced image. The contrast limit is controlled on the histogram equalization process. The process of histogram distribution is defined based on contrast range of original image. [11, 12, 13, 14, 15]

II. PROPOSED WORK

We have proposed that we can do contrast enhancement by using a new method as in medical images we mostly use x-ray source to produce the images. The image formation is so obtained by using the concept of back projection. This meas that source generate the x ray energy and pass through patient body and make the image through sensor. This leads to have a poor image contrast may be because of poor usage of the available range of possible gray levels. The images may suffer from overexposure or from underexposure. Some parts having soft tissues, generate high contrast while other part havig hard tissue generate low contrast. Most of the methods increases the contrast wich is not suitalble or up to the mark So we need a method that could generate contrast for local means. Local means make a effect over small changed level of gray values.

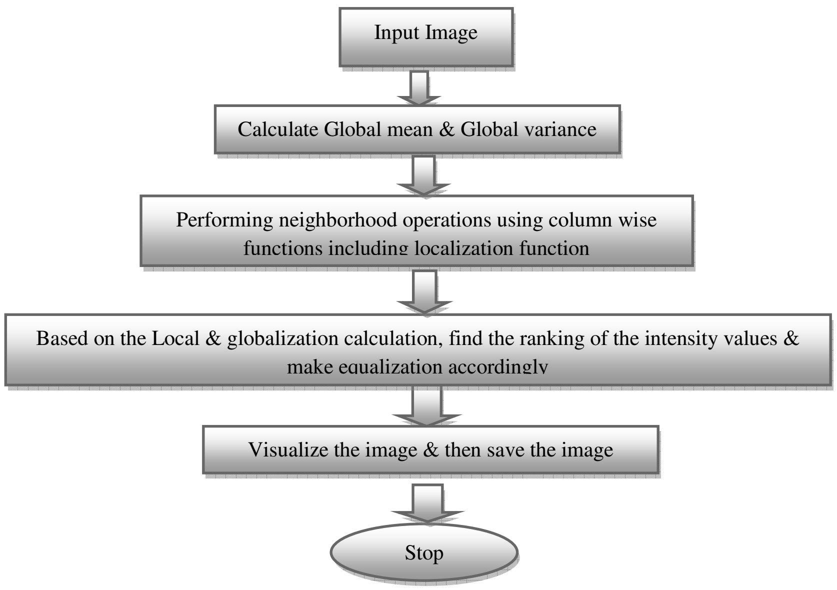


Fig. 2. Image Enhancement process using proposed algorithm

STEP-1 Input the Image: Firstly the source image is selected & then the different operations are performed on it.

STEP-2 Calculate Global mean & Global variance: Let M be the Mean of the Image

Global Mean1 = (M/Local mean)

Global Mean2 = (1- Local Mean/Local Mean+1)

STEP-3 Performing neighborhood operations using column wise functions including localization function:
Localization Function = [GlobalMEAN1 GlobalMEAN2 GlobalMEAN1; GlobalMEAN2 -4/(LOCALMEAN+1)GlobalMEAN2;GlobalMEAN1 GlobalMEAN2 GlobalMEAN1];

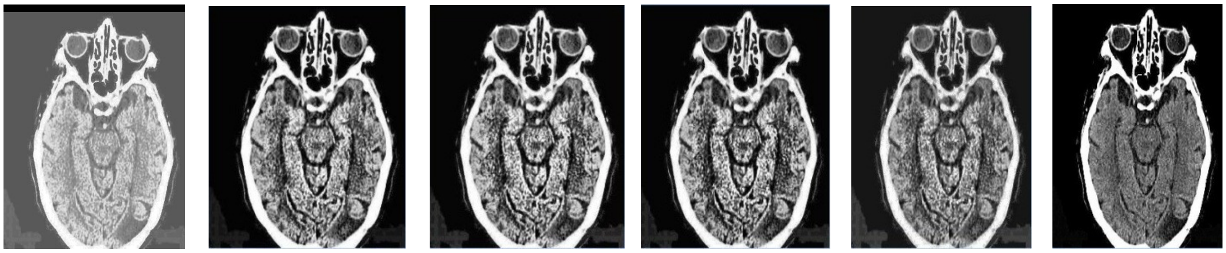
STEP-4 Apply Step 3 to the image matrices.

STEP-5 Based on the Local & globalization calculation, find the ranking of the intensity values & make equalization accordingly

Step- 6 Obtained Enhanced Image

III. EXPERIMENTAL RESULTS

The performance of the proposed technique is calculated using eight sets of images. Three error matrices are used to compare image compression quality i.e. mean square error(MSE) ,peak signal to noise ratio(PSNR) & normalized absolute error(NAE).Greater value of PSNR means quality of image is improved . The lower the value of MSE, the lower the error, normalized absolute error (NAE) is tested on images which indicates absolute error difference between pixels.



(a) (b) (c) (d) (e) (f)

Example 1. Contrast Enhancement experimental results
(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed

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Example 2. Contrast Enhancement experimental results
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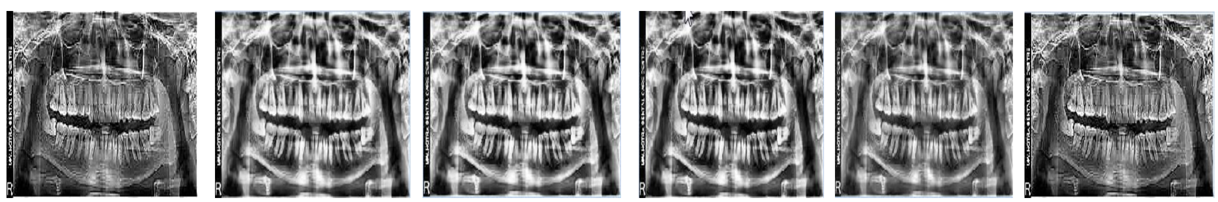
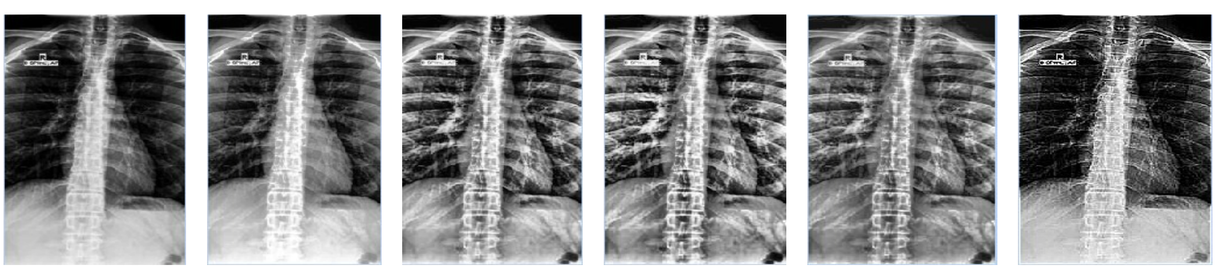


(a) (b) (c) (d) (e) (f)

Example 3. Contrast Enhancement experimental results
(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed



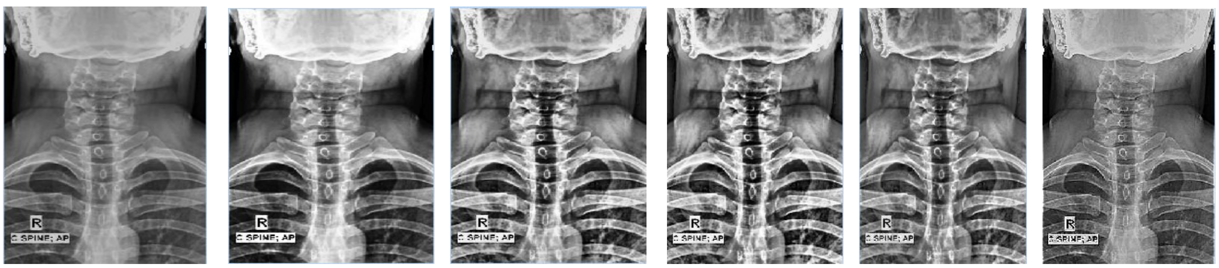
(a) (b) (c) (d) (e) (f)

Example 4. Contrast Enhancement experimental results
(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed

(a) (b) (c) (d) (e) (f)

Example 5. Contrast Enhancement experimental results

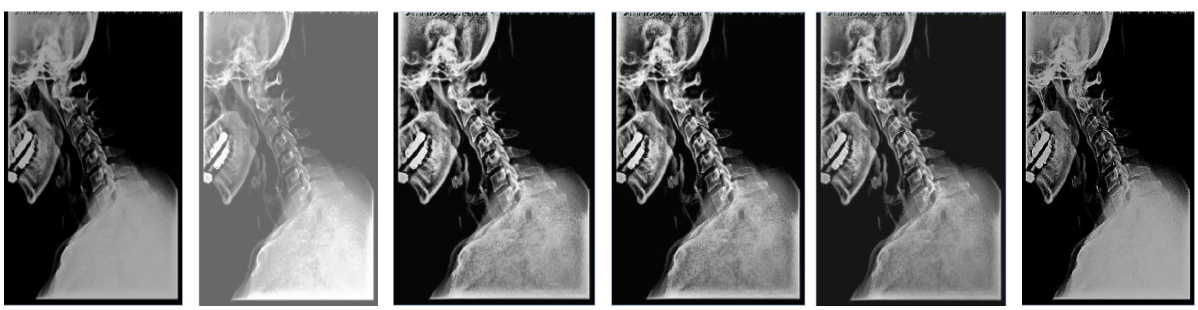
(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed



(a) (b) (c) (d) (e) (f)

Example 6. Contrast Enhancement experimental results

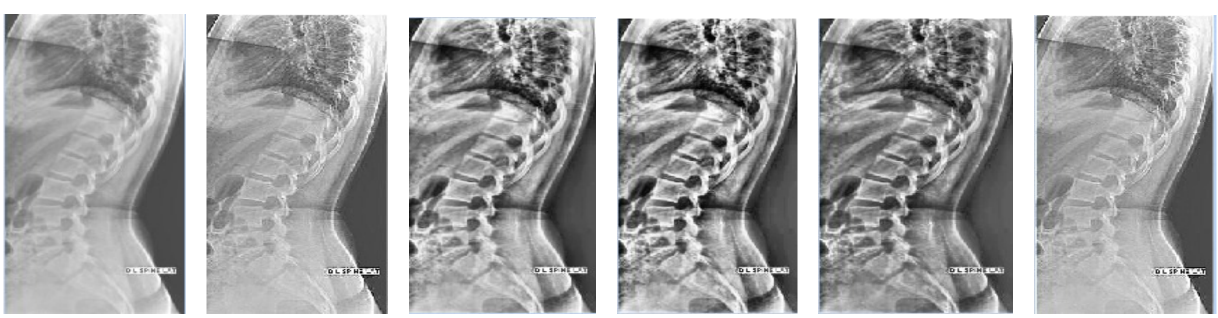
((a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed



(a) (b) (c) (d) (e) (f)

Example 7. Contrast Enhancement experimental results

(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed



(a) (b) (c) (d) (e) (f)

Example 8. Contrast Enhancement experimental results

(a) Histogram Equalization (b) Adaptive Histogram Equalization (c) Contrast Limited Adaptive Histogram Equalization uniform (d) Contrast Limited Adaptive Histogram Equalization Expo (e) Contrast Limited Adaptive Histogram Equalization Rayleigh (f) Proposed

Table 1: Comparing results of different methods from example 1

Technique	PSNR	MSE	NAE
HE	10.082	6380.8727	1.0861
AHE	19.309	762.3931	0.25538
CLAHE UNIFORM	18.2115	981.5914	0.30868
CLAHE EXPO	19.1798	785.4117	0.27152
CLAHE RAYLEIGH	18.4863	921.4142	0.3684
PROPOSED	26.7565	137.2241	0.08498

Table 2: Comparing results of different methods from example 2

Technique	PSNR	MSE	NAE
HE	18.6734	882.5584	0.24237
AHE	20.6668	557.7013	0.16351
CLAHE UNIFORM	18.9197	833.8981	0.20193
CLAHE EXPO	18.8166	853.9339	0.20512
CLAHE RAYLEIGH	20.1374	629.9997	0.17507
PROPOSED	27.4881	115.9509	0.048321

Table 3: Comparing results of different methods from example3

Technique	PSNR	MSE	NAE
HE	16.7514	1373.859	0.29029
AHE	16.1526	1576.9509	0.3143
CLAHE UNIFORM	15.3789	1884.486	0.34472
CLAHE EXPO	16.2609	1538.1115	0.30774
CLAHE RAYLEIGH	18.036	1022.0609	0.25063
PROPOSED	18.8313	851.0314	0.19015

Table 4: Comparing results of different methods from example 4

Technique	PSNR	MSE	NAE
HE	19.9256	661.4899	0.21589
AHE	14.8319	2137.4423	0.3528
CLAHE UNIFORM	12.4405	3707.1086	0.46551
CLAHE EXPO	12.7773	3430.4469	0.44656
CLAHE RAYLEIGH	12.8491	3374.2111	0.47363
PROPOSED	22.0088	409.4462	0.11918

Table 5: Comparing results of different methods from example 5

Technique	PSNR	MSE	NAE
HE	10.0827	6379.8902	1.2823
AHE	14.1927	2476.353	0.70125
CLAHE UNIFORM	11.5356	4565.8022	0.96868
CLAHE EXPO	12.4487	3700.1006	0.85041
CLAHE RAYLEIGH	12.9939	3263.5143	0.87612
PROPOSED	25.1906	196.7976	0.12649

Table 6: Comparing results of different methods from example 6

Technique	PSNR	MSE	NAE
HE	18.1466	996.3738	0.23185
AHE	16.9337	1317.3674	0.25426
CLAHE UNIFORM	15.3506	1896.7896	0.31203
CLAHE EXPO	15.7361	1735.6932	0.29815
CLAHE RAYLEIGH	17.3456	1198.174	0.24903
PROPOSED	24.8475	212.9735	0.068311

Table 7: Comparing results of different methods from example 7

Technique	PSNR	MSE	NAE
HE	9.2417	7743.0006	1.3181
AHE	20.0306	645.6817	0.25395
CLAHE UNIFORM	19.0255	813.8163	0.30625
CLAHE EXPO	19.8372	675.081	0.27784
CLAHE RAYLEIGH	19.0154	815.7254	0.39176
PROPOSED	28.3084	95.9939	0.064135

Table 8: Comparing results of different methods from example 8

Technique	PSNR	MSE	NAE
HE	14.1953	2474.8476	0.2677
AHE	17.4491	1169.9515	0.16391
CLAHE UNIFORM	15.0192	2047.2127	0.2204
CLAHE EXPO	13.9731	2604.7806	0.25472
CLAHE RAYLEIGH	14.9393	2085.2197	0.23664
PROPOSED	25.4375	185.9229	0.040584

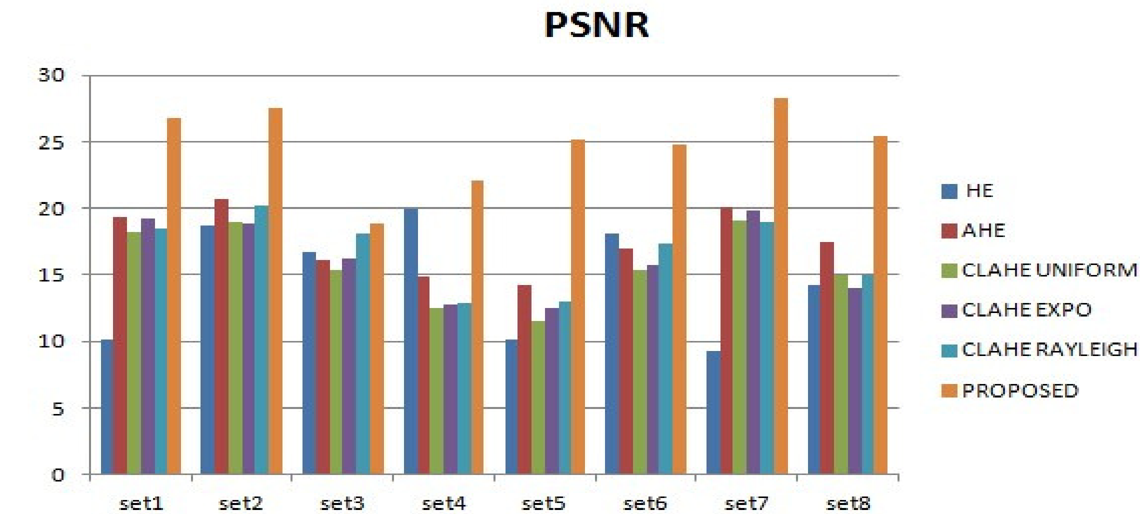


Fig 3: Bar chart comparing values of PSNR for different methods

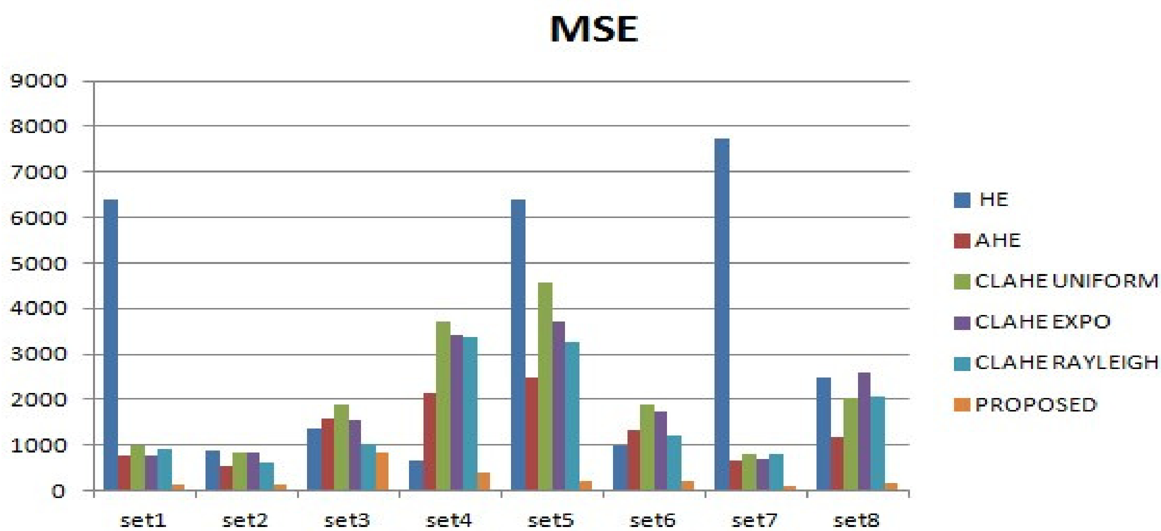


Fig 4: Bar chart comparing values of MSE for different methods

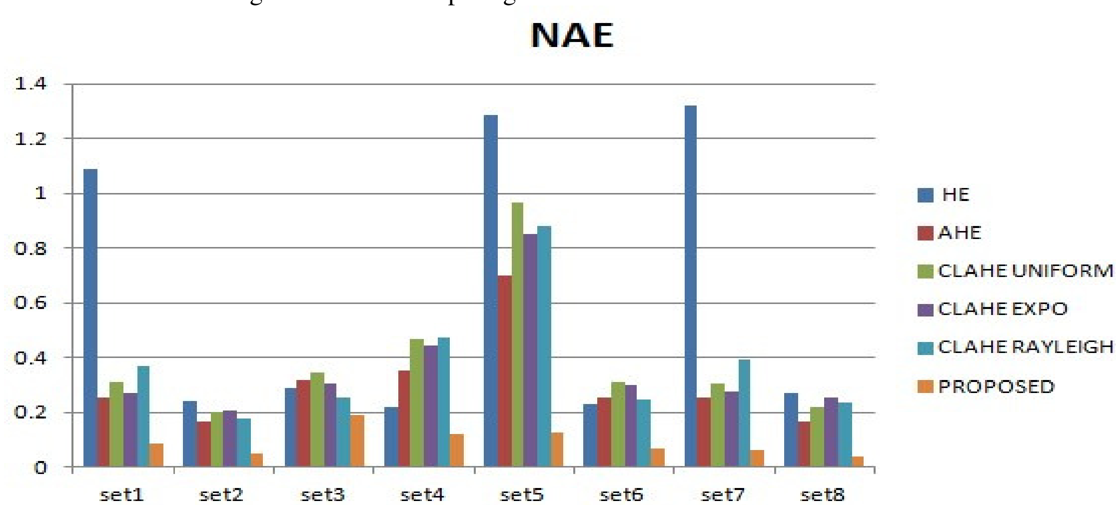


Fig 5: Bar chart comparing values of NAE for different methods

IV. CONCLUSION AND FUTURE WORK

It is seen from different techniques of image contrast enhancement that it improves the visible quality of the image. In medical imaging, contrast in the image plays the better role. Thus to make an image lighter or darker, or to increase or decrease the contrast of the resulting image for a specific application or set of images, contrast enhancement purposes better results and has greater visibility over the original image. In future we will make the Hypothesis filters with our technique and compare the Results with Performance matrices

REFRENCES

[1] Scott T. Acton, Oklahoma State University Dong Wei, The University of Texas at Austin Alan C. Bovik, The University of Texas at Austin J. Webster (ed.), Wiley Encyclopedia of Electrical and Electronics Engineering Online Copyright © 1999 by John Wiley & Sons, Inc. All rights reserved. Article Online Posting Date: December 27, 1999

[2] Jinshan Tang Eli Peli, and Scott Acton, "Image Enhancement Using a Contrast Measure in the Compressed Domain", IEEE Signal processing Letters , Vol. 10, NO. 10, October 2003

[3] Whaites, Eric dan R.A. Cawson. Essentials of Dental Radiography and Radiology, Churchill Livingstone: Elsevier Science Limited, 2003.

[4] Jose V. Rios et.all, Assessment of Periapical Status: A Comparative Study Using Film-Based Periapical Radiographs and Digital Panoramic Images, Jurnal Periodontology, Vol. 6, 2010.

[5] Wei-Chun Lin.all, Contrast Enhancement of X-ray Image Based on Singular Value Selection, Optical Engineering Opt. Eng. 49, 047005 (Apr 13, 2010).

[6] Yasuhiro Morimoto, et.al, New Trends and Advances in Oral and Maxillofacial Imaging, Current Medical Imaging Reviews, 2009, 5, 226-237.

[7] N. R. Moktar, Nor HazlynaHarun and M. Y. Mashor, "Image Enhancement Techniques Using Local, Global, Bright, Dark and Partial Contrast Stretching For Acute Leukemia Images", The World Congress on Engineering, Vol. 1, 2009.

[8] Bin Liu, Weiqi Jin, Yan Chen, Chongliang Liu, and Li Li, "Contrast enhancement using Non-overlapped Sub-blocks and Local Histogram Projection." IEEE Transactions on Consumer Electronics, Vol. 57, No. 2, May 2011

[9] MENOTTI D, NAJMAN L, FACON J, et al., "Multi-histogram equalization methods for contrast enhancement and brightness preserving", Consumer Electronics, IEEE Transactions on, vol. 53(3), 2007, pp. 1186-1194.

[10] KONG N S P, IBRAHIM H, "Color image enhancement using brightness preserving dynamic histogram equalization", Consumer Electronics, IEEE Transactions on, vol. 54, No.4, 2008, pp. 1962-1968.

[11] Young, Ian T, Jan J. Gerbrands, Lucas J. van Vliet, Fundamentals of Image Processing, Delft University of Technology.

[12] Garg, Rajesh, Bhawna Mittal, Sheetal Garg, Histogram Equalization Techniques For Image Enhancement, IJECT Vol. 2, Issue 1, March, 2011.

[13] Salem Saleh Al-amri, N.V. Kalyankar, S.D. Khamitkar, Linear and Non- Linear Contrast Enhancement Image, IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.2, February 2010.

[14] Wang, Xin;Wong, Brian Stephen;Chen, Guan Tui, Spotting Defects More Clearly: Radiographic Image Enhancement, Industrial Heating; Jan 2006.

[15] YisuZhao Distrib. & Collaborative Virtual Environments Res.Lab.(DISCOVER),Univ.of Ottawa,Ottawa,ON,Canada Georganas, Nicolas D. ; Petriu, E.M., (I2MTC), 2010 IEEE