A Medical Image Enhancement Based On Lifting Transform With Gamma Correction Method

Amit Gupta (Research Scholar)[1], Vivek Jain(Asst. Proff)[2]
[1, 2] Dept of CSE
[1, 2] Banmore, India

Abstract- *Image enhancement (IE) is the process of enhancing visual appearance of image in order to make it more effective for computer to process. In this paper, a new method has been proposed for low contrast IE in the medical field based on Lifting wavelet transform (LWT), Adaptive median filter (AMF), Adaptive histogram equalization (AHE) and Gamma Correction (GC) method. The given input image decomposes in four sub-bands with LWT scheme. Then, we estimate the noise free matrix of the low-high and high-high sub-band image using AMF and by applying inverse LWT reconstruct combined image. After that enhance the contrast of an image using AHE and smoothen the image using GC. The proposed method also compared with the existing traditional methods like general HE, contrast limited adaptive histogram equalization (CLAHE), AHE and brightness bi histogram equalization (BBHE). The method is tested on different images. The result of proposed method is measured using Peak Signal Noise Ratio (PSNR) and Mean Square Error (MSE). The results show that proposed method is better than existing methods.*

Keywords- Image Enhancement; LWT; AMF; Gamma Correction; PSNR; MSE.

I. INTRODUCTION

In medical X-ray image imaging process, due to the equipment, the operator's experience, the patient's own factors and some other reasons, which may cause the imaging effects is not ideal, such as low brightness, low contrast, poor or blurred details and other issues, at this time we need to enhance these X-ray images. Some traditional methods such as brightness transformation, piecewise linear gray level transformation and histogram equalization can improve the brightness and contrast of the image, but the treatment were relatively homogeneous which are only singly change the image's brightness or contrast, the ability of enhance the image details is poor; Some frequency domain enhancement methods, such as high frequency emphasis filter, unsharp masking, etc., by superimposing weighted high frequency information on the original image, can enhanced the detail texture features of the image, but without considering the effects of noise may cause the noise amplification and over-enhancement [1]. An ideal medical image enhancement technology, can not only enhance the local contrast and global contrast of image, but also enhance the edge and contour information of image, so can highlight the internal details of image and improve the visual effect [2][3]. Research shows that the comprehensive use of various enhancement methods can achieve the better enhancement results on medical images [4-6], but low-contrast microscopic image enhancement research is still relatively less. In this study proposed a work on image enhancement for medical X-rays images to denoise and improve the low contrast and brightness on different enhancement methods. The rest paper is organized as, Section II describes the literature review of existing research work in medical x-ray enhancement, Section III describe the proposed methodology, algorithm and techniques for medical enhancement used in work. In section IV, shows the experiment result of work on different performance parameters and in last section present the conclusion of overall research study.

II. LITERATURE REVIEW

Savitha et al. [8] discusses a unique technique of chest x-rayimage enhancement where the enhancement is carried outusing multiple ranges of operation. For an efficient analysis, various numbers of images is used in experiment, altering the various of weight, variance, correction factor, etcand monitoring the outcomes. In this accomplishing better PSNR values even in comparison to themost frequently used median filters in medical imageprocessing.

Wen et al. [1] proposed an algorithm based on homomorphic filtering and CLAHE to enhance the medical x-ray image low contrast, brightness details, also effectively suppress the noise amplification and avoid the over-enhancement phenomenon.
The result of proposed algorithm is better from traditional enhancement algorithm and enhances the details of medical X-ray images.

Mayank et al. [9] proposed an efficient method to enhance contrast as well as to preserve brightness of medical images. The proposed work is done two stepprocess, in initial step use of adaptive gamma correction method to enhanced the global contrast of an image and in second step, for sharpening an image use of homomorphic filtering so as to preserve the image brightness. The result of proposed method gives images with significant contrast and good interpretation of local details and reduces the mean brightness error more accurately with other contrast enhancement methods.

G.N. Sarage [10]proposed a technique to enhance the performance of hand X-ray images using different low and high Pass Filter. For this high boost filter is used to increase the image performance and to eliminate noise in image use of low pass filter. The result of X-ray image shows the better image quality contrast enhancement from the original image.

III. PROPOSED METHODOLOGY

This proposed algorithm presented medical IE using LWT, AHE and Gamma correction technique. In this process, first take an input gray image. Change the size of an input image with NXN dimension. As we know that after applying the LWT the whole image is decomposed into four different sub-bands and each sub-band has different significance. The Low-Low sub-band contains average information of the image and other three sub-bands (LH, HL, and HH) contain the detail coefficients of image. These three sub-bands give the information about edges. Now, we consider the last three sub-bands for further processing. Select all three bands for further processing because it is noisy pixels and remaining one band is clear image. For the high frequency coefficients of image wavelet decomposition, considering that it may contain the details and noise information, so carry on the AMF processing, in order to reduce the impact of the image noise. After applying the inverse LWT one can get the reconstructed image. After that, applying AHE for enhance contrast of an image. Finally, apply GC for improving the smoothness of an image.

a) Lifting Wavelet Transform

The signal transform is utilized to change the signal to the distinctive area, play out a few operations on the signal transform and reverse the change and prepare to the first space i.e. change ought to be invertible Wavelet transform can be performed using filter bank i.e. Low pass filter and high pass filter. Lifting scheme splits the samples into odd and even samples. In 1998, Sweldens et al. present the LWT, second era wavelet transform to expand the utility of wavelet strategies. Lifting technique is straightforward and effective as there is no complex mathematical computation. In LWT, digital signal are integer number and wavelet transform is floating point number as output, so for inverse transformation integer to integer conversion is required and in LWT it can be modified to operate on integers and thus during inverse transform rounding error can be avoided [11].
The process of LWT transform is divided into three steps as:

1. Split:

In this step a signal is split into an odd signal subsets (the wavelet coefficients filtered through high-pass filter) and even signal subsets (filtered through low-pass filtered).

2. Predict:

In this step use only an even signal subsets to divide the signal into even and odd signal subsets by transforming odd signal subsets into wavelet coefficient.

3. Update:

In Update step, only even signal subsets is processed using wavelet coefficient and those processed in predict phase for calculating the scaling function.

In Lifting wavelet decomposition (LWD)an image is decomposed into approximation coefficient subset (cA) and detail coefficient subsets, horizontal (cH), vertical (cV) and diagonal (cD).

b) Adaptive Median Filtering(AMF)

The AMF has been applied widely as an advanced method compared with standard median filtering. The AMF performs spatial handling to figure out which pixels in a picture have been influenced by impulsive noise. The Adaptive Median Filter arranges pixels as clamor by contrasting every pixel in the picture with its encompassing neighbor pixels. The measure of the area is customizable, and in addition the limit for the examination. A pixel that is unique in relation to a greater part of its neighbors, and in addition being not basically lined up with those pixels to which it is comparable, is named as impulsive noise. These noise pixels are then replaced by the median pixel value of the pixels in the neighborhood that have passed the noise labeling test [12].

c) Adaptive Histogram Equalization (AHE):

Adaptive Histogram Equalization (AHE) is a massive contrast enhancement method for both Natural images and Medical images. The method engagesapplying to each pixel in HE [13]. In the adaptive each pixel is customized based on the pixels that are in a region neighboring that pixel. This region is called contextual region. If an image of n x n pixels, with k intensity levels and the size of contextual region is m x m, then the time required for calculations is O(n2 (m + k))[14]. The results are better obtained through four nearest grid points of a moving window instead using histogram of neighborhood pixels.

$$a = \frac{y - y_-}{y_+ - y_-}, b = \frac{x - x_-}{x_+ - x_-} \quad (1)$$

d) Gamma Correction

Gamma correction is a non-linear operation adjusting lightness or darkness of image [15]. Gamma is the term used to describe non-linearity of a display monitor. According to the gamma value only image brightness can be adjust. Gamma value ranging from 0.0 to 10[7].

0.0 →Darker
1.0 →No change
10.0 →Lighter

If gamma value less than 1.0(<1.0), darken an image. Else if gamma value greater than 1.0(>1.0), lighten an image. Else gamma value equal to 1(=1), produce no effect on image [16]. Gamma is applied only for display image not to the data of image. Monitor of identical gamma are used for any single image and as long as nothing further is done in the image, computationally [17].

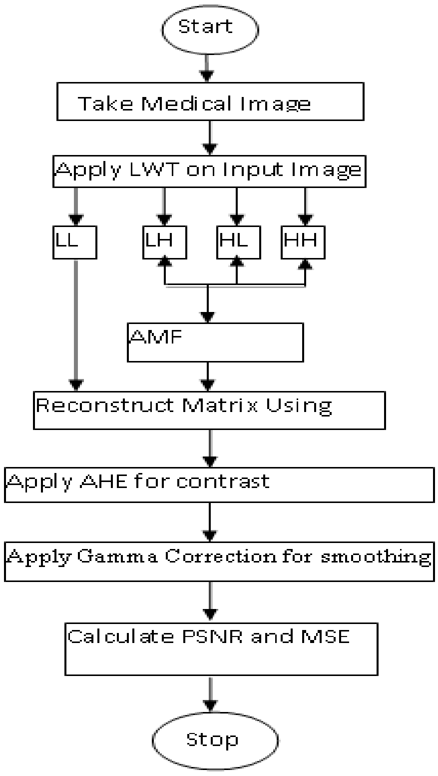


Fig. 1 Proposed Architecture

In fig 1 of proposed architecture, first of all take gray image. Apply LWT, split the input image into four bands: imLL, imLH, imHL and imHH. Consider LH, HL and HH band for further processing. Apply the AMF filter on all channels. Finally, all bands are combined using inverse LWT. After that, applying AHE for enhance contrast of an image. Finally, apply GC for improving the smoothness of an image.

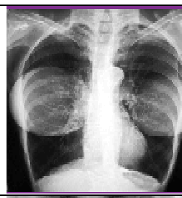
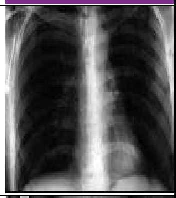
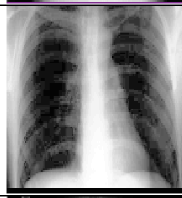
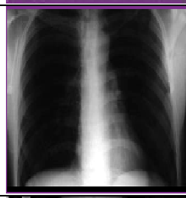
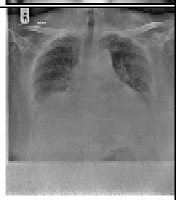
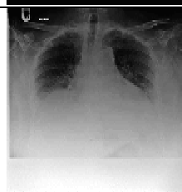
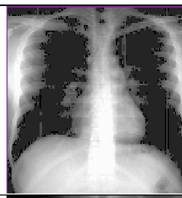
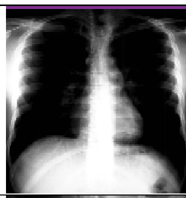
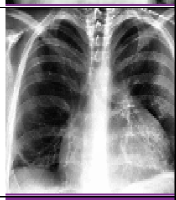
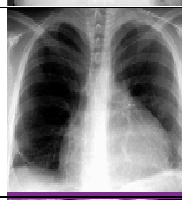
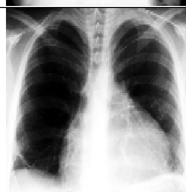
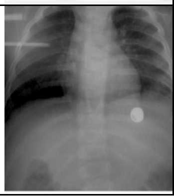
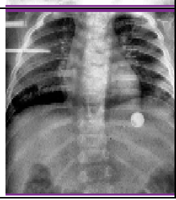
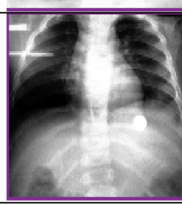
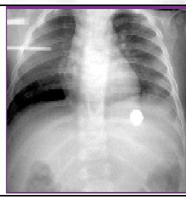
Proposed Algorithm

1. Consider an input image is represented as $I_{in}$with 418X602 sizes.

   $$[r, c] = size(I_{in}) \quad (2)$$

   Where $[r, c]$ is a row and column ofI_{in}
2. Apply I-LWT on the I_{in} to divide into 4 sets such as$imLL, imLH, imHL, imHH$. $imLL$did not consider for further processing because this band shows clear image and remaining bands is noisy.
3. Apply AMF on remaining three bands for removing noise.
4. Apply I level inverse LWT (ILWT) on the LWT transformed image, to create the noise free image I_{noise_free} on 4 coefficients
5. Applying the obtain mapping to each pixel to$I_{noise_free}$to get the contrast image by using AHE.
6. Apply Gamma Correction on enhanced image from previous step. The value of Gamma lies in between 0and infinity. If the value of Gamma is 1(default) then linear mapping is done, if the value of Gamma is less than 1, the mapping is weighted toward higher (brighter) output values. If the value of gamma is greater than 1, the mapping is weighted toward lower (darker) output values.
7. Finally get the improved medical image $I_{improve}$.

TABLE I. RESULT COMPARISON BETWEEN PROPOSED WITH BASE SYSTEM, BBHE AND CONTRAST ADJUSTMENT SYSTEM

Label Name	**Input Image**	**Base [1] Result**	**BBHE Result**	**CA Result**	**Proposed Result**
(a)					
(b)					
(c)					
(d)					
(e)					
(f)					

IV. PERFORMANCE MEASURE

i) Mean Square Error (MSE):

It is defined as the average square difference between reference signals to distorted signal. It can be calculate by adding up the squared difference pixel-by-pixel and dividing by the total pixel count. Suppose M x N is an input image I_{in} and $I_{improve}$ is defined as the improved image. Then the MSE between these two signals is defined as:

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[I_{in}(i,j) - I_{improve}(i,j)\right]^2}{M * N} \quad (3)$$

ii) Peak Signal to Noise Ratio (PSNR):

PSNR is the evaluation standard of the reassembled image quality and is the most wanted feature. It can be calculate in decibels (dB) and it is given by

$$PSNR = \frac{10\ X log_{10}\,(I_{max} - I_{min})^2}{MSE} \quad (4)$$

Where I_{max} and I_{min} are the maximum and minimum of the image gray values, usually taken 255 and 0.The higher value of PSNR shows the better reassembled image.

Table II. psnr comparison between proposed with base system, bbhe and contrast adjustment (ca) system

Label Name	Base [1] PSNR	BBHE PSNR	CA PSNR	Proposed PSNR
(a)	45.45	22.10	23.59	60.31
(b)	46.05	19.55	23.97	59.06
(c)	45.61	21.48	22.85	61.02
(d)	45.84	20.89	29.22	61.34
(e)	45.63	22.56	24.78	63.20
(f)	45.53	20.67	19.97	58.67

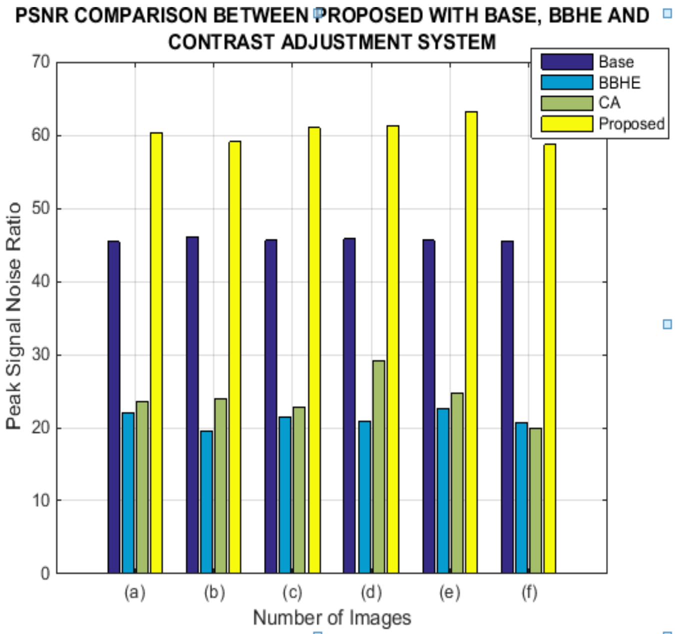


Fig 2. Shows PSNR Comparison

Table III. mse comparison between proposed with base system

Label Name	Base MSE	Proposed MSE
(a)	1.8520	0.0605
(b)	1.6137	0.0806
(c)	1.7831	0.0514
(d)	1.6932	0.0477
(e)	1.7766	0.0311
(f)	1.8189	0.0883

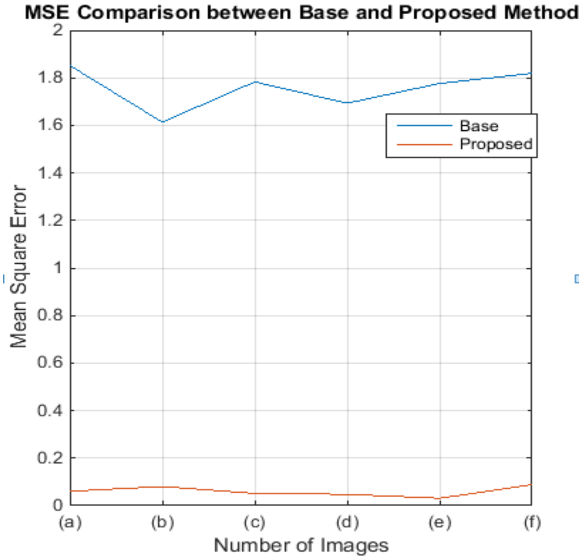


Fig. 3 Shows MSE Comparison between Base and Proposed Method

V. CONCLUSION

In this research, we have proposed a simple, efficient, and effective technique for contrast enhancement in the medical field using LWT, AHE, AMF and GC method. The PSNR of proposed technique for medical images is better where the main problem in such images is low illumination and low down contrast. With the implementation, we can assert thatthe proposed algorithm is able to get good contrasted imagewhich increases the brightness of the low contrasted images.This algorithm is tested on various types of images and resultsare encouraging.The proposed can be further extended for other medical images, satellite pictures with the other optimization algorithm.

REFERENCES

[1] He Wen, Wu Qi, Li Shuang,” Medical X-ray Image Enhancement Based on Wavelet Domain Homomorphic Filtering and CLAHE”, DOI 10.1109/ICRIS.2016.50, 2016 IEEE,pp 249-254.

[2] Koushlendra K Singh, Rajesh K. Pandey, Suraj Suman,” Contrast Enhancement Using LiftingWavelet Transform”, ICCICCT @2014 IEEE, pp 447-451.

[3] Shi Meihong, Zhang Junying, Li Yonggang, Wu Deming, "A New Method of Low Contrast Image Enhancement", Application Research of Computers, vol. 22, pp.235-238, Jan. 2005.

[4] Zhang Yanhong, Hou Dewen, "An Image Enhancement Algorithm Based on Wavelet Frequency Division and Bi-Histogram Equalizat ion", Computer Applicat ions and Software, vol. 24, Nov. 2007, pp:159-161.

[5] CCLeung, KSChan, HMChan,WKTsui, "A new approach for image enhancement applied to low-cont rast -Iow-illuminat ion IC and document images", Pattern Recognition Letters, vol. 26, pp. 769-778, May 2005.
[6] Yuan Lihong, Ma Xiaoyan, Yang Yong, Gu Xinchao. "Enhancement technology for container X-ray images", Journal of Computer Applicat ions, vol. 30, pp. 44-46, Jan. 2010.
[7] Shanto Rahman, Md Mostafijur Rahman, M. Abdullah-Al-Wadud, Golam Dastegir Al-Quaderi and Mohammad Shoyaib,"An adaptive gamma correction for image enhancement", DOI 10.1186/s13640-016-0138-1, EURASIP (2016),pp 1-13
[8] Savitha S.K, N.C. Naveen "Algorithm for Pre-Processing Chest-X-Ray usingMulti-Level Enhancement Operation" IEEE WiSPNET conference, 2016.
[9] Mayank Tiwari, Bhupendra Gupta "Brightness Preserving Contrast Enhancement of Medical Images Using Adaptive Gamma Correctionand Homomorphic Filtering" Students' Conference on Electrical, Electronics and Computer Science, IEEE, 2016.
[10] G.N.Sarage, "An Evolutionary Approach of Hand X-Ray Image Enhancement Using High Pass and Low Pass Filtering Techniques" (2012).
[11] Shveti Sejpal, Nikesh Shah "Comparative Performance Analysis of Secured LWTSVD Based Color Image Watermarking Technique in YUV, YIQ and YCbCr Color Spaces" International Journal of Computer Applications (0975 – 8887) Volume 147 – No.7, August 2016.
[12] PENG Lei (ID: 03090345)," Adaptive Median Filtering", 140.429 Digital Image Processing.
[13] Alex Stark J, "Adaptive image contrast enhancement using generalizations of histogram equalization", IEEE Transactions on Image Processing, VOL. 9, 2000.
[14] Elisabeta Antonia Haller, "Adaptive histogram equalization in GIS", Mathematics and Computer Science Series, Volume 38(1), Pages 100{104, 2011.
[15] Senthilkumaran N, Thimmiaraja J "Histogram Equalization for Image Enhancement Using MRI brain images" World Congress on Computing and Communication Technologies, IEEE, 2014.
[16] Y.-S. Chiu, F.-C. Cheng, and S.-C. Huang, "Efficient contrastenhancement Using adaptive gamma correction and cumulativeintensity distribution, "in Proc. IEEE Conf. Syst. Man Cybern., Oct. 2011,pp. 2946–2950.
[17] Shih-Chia Huang, Fan-Chieh Cheng, and Yi-Sheng Chiu Efficient Contrast Enhancement Using Adaptive Gamma Correction With Weighting Distribution" IEEE Tranaction on Image Processing Vol.22, No.3 March2013.
[18] S.Gayathri, N.Mohanapriya, Dr.B.Kalaavathi "Survey on Contrast Enhancement Techniques" International Journal of Advanced Research in Computer and Communication EngineeringVol. 2, Issue 11, November 2013.