International Journal of Power Control Signal and Computation (IJPCSC)
Vol. 4 No. 2 April- June -2012
©gopalax journals,singapore
ISSN:0976-268X
Available at : http://ijcns.com

NOVEL ENHANCEMENT TECHNIQUES FOR MAMMOGRAMS USING HISTOGRAM EQUALIZATION

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ABSTRACT:
Themostsignificantfeatureofdiagnosticmedicalimagesi storeducenoise and whichiscommonlyfound inmedicalimagesandmakebetterimagequality.Inrecent years,technologicaldevelopmenthassignificantlyimpro ved analyzingmedicalimaging.Thispaperproposesdifferent Histogram Equalization Techniques fortheremoval of noiseby topologicalapproach.The Histogram Equalization and Contrast Limited Adaptive Histogram Equalization (CLAHE) are the techniques here for displaying the better results of mammograms to find out the calcium levels. .Aset ofsuch operationsissuggestedonthe base oftheanalysis ofawide variety of Histogram Equalization described intheliterature.

Keywords: topological approach, mammograms, calcium levels, topological development

I.INTRODUCTION

In theearly development of image processing,Linear filters were the primary tools for image enhancement and restoration.

Their mathematical simplicityandtheexistence ofsomedesirableproperties made them easy todesignandimplement. Moreover, linearfilters offeredsatisfactory performanceinmany applications. However,they havepoorperformanceinthe presenceofnon-additivenoiseand in situationswhere system nonlinearities or Gaussian statistics are encountered..Inimageprocessingapplications, linear filterstendto blurtheedgesand do notremoveGaussian and mixedGaussian impulse noise effectively. Previously, anumberofschemeshavebeen proposedfor Gaussian mitigation. Inherently noise removal from image introduces blurringinmany cases.Anadaptivestandard recursivelow pass filterisdesigned byKlausRankand Rolf Unbehauen [6] considered the three local image featuresedge, spotandflatsasadaptive regionswith Gaussian noise. Median filter has been introducedby Tukey[12]in 1970.Itisaspecialcaseofnon-linear filters usedforsmoothingsignals.

A. Image processing operations:

Image processing operations can be roughly divided into three major categories:

a) Image Restoration
b) Image Enhancement
c) Image Compression
d) Image Segmentation

B. Image Restoration

Restoration takes a corrupted image and attempts to recreate a clean image. As many sensors are subject to noise, they results in corrupted images that don't reflect the real world scene accurately and old photograph and film archives often show considerable damage.

Thus image restoration is important for two main applications:
a) Removing sensor noise,
b) Restoring old, archived film and images. curvelet and wavelettransformsbySivakumar[11].Theobjectiveof thisstudyistodevelopnewhybridfilteringtechniques and investigate theirperformanceonmedicalimages.

Thisworkis organizedas follows: Section2 discussestypesof noisesinvolvedinmedicalimaging. In Section 3 basic definitions areintroduced. Section 4 discussesthe variousexistingfilteringtechniquesfor de- noising the medicalimages. Section 5 deals with proposed hybridfilteringtechniques for de-noisingthe Gaussian noise and salt and pepper noise in the medical images. In Section 6experimental results and Section 7 putsforwardthe conclusion drawn by thispaper.

II. TYPESOFNOISES

A. Salt &Pepper Noise

Saltandpeppernoiseisaform ofnoisetypically seenonimages.Itrepresentsitselfasrandomlyoccurring whiteandblackpixels.A"spike"orimpulsenoisedrivest heintensityvaluesofrandom pixelstoeithertheir maximum orminimum values.Theresultingblackand whitefleckintheimageresemblesaltandpepper. This

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typeof noiseisalsocaused by errorsin data transmission.

B. Speckle Noise

Specklenoiseaffectsallinherentcharacteristic s of coherent imaging, including medical ultra soundimaging.It is causedby coherent processingof backscattered signalsfrommultipledistributedtargets. Speckle noiseis caused by signals from elementary Scatters. Inmedicalliterature,speckle noiseisreferredto as'texture'andmay possibly containusefuldiagnostic information. For visual interpretation, smoothing the texturemaybelessdesirable. Physiciansgenerally havea preference fortheoriginalnoisy images, morewillingly, thanthesmoothedversionsbecausethefilter,evenifthey aremoresophisticated,can destroysomerelevantimage details. Thus it is essential to develop noise filters which canpreserve thefeaturesthatare ofinteresttothe physician.Several different methodsareusedtoeliminate specklenoise,basedupondifferentmathematicalmodels ofthephenomenon. Inourwork, werecommendhybrid filteringtechniques for removingspeckle noise in ultrasound images. The speckle noise model has thefollowingform(denotesmultiplication).Foreachimagepixel withintensity value f_{ij} ($1\leq i \leq m, 1\leq j\leq n$ foranmx nimage),thecorrespondingpixelofthe noisyimageg_{ij} is given by,

$$g_{i,j}=f_{i,j}+f_{i,j} \quad n_{i,j} \qquad (1)$$

where,eachnoisevalueisdrawnfrom uniform distributionwithmean 0 andvariance.

C. Gaussian Noise

Gaussian noise is statistical noise that has aprobability densityfunction (abbreviated pdf) of the normaldistribution(also knownas Gaussiandistribution). Inother words,thevaluesthatthenoisecantakeonare Gaussian-distributed.Gaussiannoiseisproperlydefined asthenoisewithaGaussian amplitude distribution. Noise ismodeledas additive white Gaussiannoise (AWGN), where all the image pixels deviate from their original valuesfollowingthe Gaussiancurve.Thatis,foreach image pixelwithintensity valuef_{ij} ($1\leq i\leq m, 1\leq j\leq n$ for anmxnimage),thecorrespondingpixelofthenoisy imageg_{ij} is given by,

$$g_{i,j}=f_{i,j}+ n_{i,j} \qquad (2)$$

where,eachnoisevalueisdrawnfromazero–meanGaussian distribution.

III .HISTOGRAM INTRODUCTION

An **image histogram** is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance.

Image histograms are present on many modern digital cameras. Photographers can use them as an aid to show the distribution of tones captured, and whether image detail has been lost to blown-out highlights or blacked-out shadows.

The horizontal axis of the graph represents the tonal variations, while the axis represents the number of pixels in that particular tone. The left side of the horizontal axis represents the black and dark areas, the middle represents medium grey and the right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of these zones. Thus, the histogram for a very bright image with few dark areas and/or shadows will have most of its data points on the right side and center of the graph. Conversely, the histogram for a very dark image will have the majority of its data points on the left side and center of the graph.**Histogram** is a graphical representation, showing a visual impression of the distribution of data. It is an estimate of the probability distribution of a continuous variable and was first introduced by Karl Pearson.

A histogram consists of tabular frequencies, shown as adjacent rectangles, erected over discrete intervals (bins), with an area equal to the frequency of the observations in the interval. The height of a rectangle is also equal to the frequency density of the interval, i.e., the frequency divided by the width of the interval. The total area of the histogram is equal to the number of data. A histogram may also be normalized displaying relative frequencies. It then shows the proportion of cases that fall into each of several categories, with the total area equaling 1. The categories are usually specified as consecutive, non-overlapping intervals of a variable. The categories (intervals) must be adjacent, and often are chosen to be of the same size.

A. Mathematical Definition

In a more general mathematical sense, a histogram is a function m_i that counts the number of observations that fall into each of the disjoint

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categories (known as *bins*), whereas the graph of a histogram is merely one way to represent a histogram. Thus, if we let *n* be the total number of observations and *k* be the total number of bins, the histogram m_i meets the following conditions:

$$n = \sum_{i=1}^{k} mi$$

B. Histogram equalization

Sometimes the histogram of an image contains mostly dark pixels this is the case of an insufficiently exposed photograph (Figure.2). The image can be enhanced by constant addition but *histogram equalization* is generally more efficient technique for this purpose (Figure.2). It is also applicable whenever the contrast of the image is too small for whatever reason. The idea of the method is to spread the histogram as evenly as possible over the full intensity scale. This is done by calculating cumulative sums of the pixel samples for each gray level value *x* in the histogram. The sum implies the number of gray levels that should be allocated to the range [0, *x*], and is proportional to the cumulative frequency *t*(*x*), and to the total number of gray levels

$$f(x) = g.t(x)/n - 1$$

C. Adaptive histogram equalization

Adaptive Histogram Equalization is a computer Image Processing technique used to improve contrast in images. It differs from ordinary histogram in the respect that the adaptive method computes several histograms each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image.Ordinary histogram equalization simply uses a single histogram for an entire image.

Consequently, adaptive histogram equalization is considered an image enhancement technique capable of improving an image's *local contrast*, bringing out more detail in the image. However, it also can produce significant noise. A generalization of adaptive histogram equalization called *contrast limited adaptive histogram equalization*, also known as CLAHE, was developed to address the problem of noise.

D. *Contrast limited adaptive histogram equalization (CLAHE):*

In Image Processing, **CLAHE** stands for *Contrast Limited Adaptive Histogram Equalization*. CLAHE is a technique used to improve the local contrast of an image. It is a generalization of adaptive histogram equalization and ordinary histogram equalization.

Contrast Limited Adaptive Histogram Equalization, CLAHE, is an improved version of AHE, or Adaptive Histogram Equalization. Both overcome the limitations of standard histogram equalization.

A variety of adaptive contrast-limited histogram equalization techniques (CLAHE) are provided. Sharp field edges can be maintained by selective enhancement within the field boundaries.

Selective enhancement is accomplished by first detecting the field edge in a portal image and then only processing those regions of the image that lie inside the field edge. Noise can be reduced while maintaining the high spatial frequency content of the image by applying a combination of CLAHE, median filtration and edge sharpening. This technique known as Sequential processing can be recorded into a user macro for repeat application at any time.

IV.EXPERIMENTALRESULTS, ANALYSIS AND DISCUSSIONS

The proposedCLAHE techniquehave BeenimplementedusingMATLAB 7.0. Theperformance of various hybridfilteringtechniquesis analyzedand discussed.The measurementof medical image enhancementis difficultand thereis no unique algorithm availabletomeasureenhancementofmedicalimage.

The measurement of medical image enhancement is difficult and there is no unique algorithm available to measure enhancement of medical image. We use statistical tool to measure the enhancement of medic images. The Root Mean Square Error (RMSE)(Ei)and Peak Signal-to-Noise Ratio (PSNR) are used to evaluate the enhancement of medical images.

$$E_i = \sqrt{\frac{1}{n}\sum_{j-1}^{x}\left(P_{(IJ)} - T_j\right)^2}$$

$$PSNR = 20\log 10\left(\frac{MAX_f}{\sqrt{MSE}}\right)$$

Here f (i,j) is the original brain tumor image with Gaussian noise , g(i,j) is an enhanced image and m and n are the total number of pixels in the horizontal and the vertical dimensions of the image. If the value of RMSE is low and value of PSNR is high then the enhancement approach is better. The original noisy image and filteredimage of brain tumor obtained by various hybrid filteringtechniques are shown in Figure-1. Table-1 shows the Proposed CLAHE method Comparison of Mean, Variance, RMSE and PSNR values For Histogram Equalization and CLAHE.

Each time an image is acquired, window and level parameters must be adjusted to maximize contrast and structure visibility. This must be done before the image is saved in any other format than the generic format of the acquisition software HIS.For the moment, very little post-processing in addition to window-level is applied to the image after its acquisition. This is due in part to the good quality of the image without processing, but also because of the short experience and tools we have working with 16 bit images.

CLAHE seems a good algorithm to obtain a good looking image directly from a raw HIS image, without window and level adjustment. This is one possibility to automatically display an image without user intervention. Further investigation of this approach is necessary.

LAHE was originally developed for medical imaging and has proven to be successful for enhancement of low-contrast images such as portal films.

The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to each one. This evens out the distribution of used grey values and thus makes hidden features of the image more visible. The full grey spectrum is used to express the image.
Contrast Limited Adaptive Histogram Equalization, CLAHE, is an improved version of AHE, or Adaptive Histogram Equalization. Both overcome the limitations of standard histogram equalization.

A variety of adaptive contrast-limited histogram equalization techniques (CLAHE) are provided. Sharp field edges can be maintained by selective enhancement within the field boundaries. Selective enhancement is accomplished by first detecting the field edge in a portal image and then only processing those regions of the image that lie inside the field edge. Noise can be reduced while maintaining the high spatial frequency content of the image by applying a combination of CLAHE, median filtration and edge sharpening. This technique known as Sequential processing can be recorded into a user macro for repeat application at any time. A variation of the contrast limited technique called adaptive histogram clip (AHC) can also be applied. AHC automatically adjusts clipping level and moderates over enhancement of background regions of portal images.

V. CONCLUSIONS

Inthiswork, wehaveintroduced Histogram Equalization ,ADHE and CLAHE images for medicalimages..Theproposedmethodare simpleandeasy toimplement.

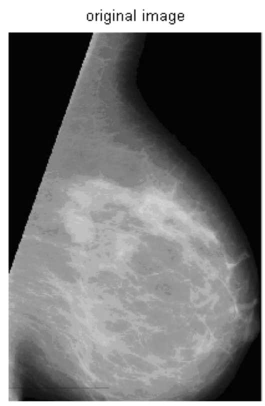

Figure 1. Histogram Image

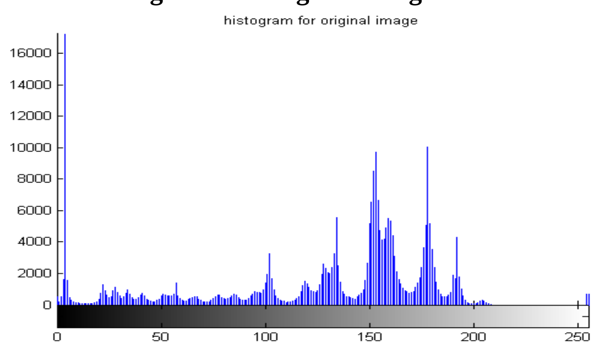

Figure 2.Histogram for FIG 1.

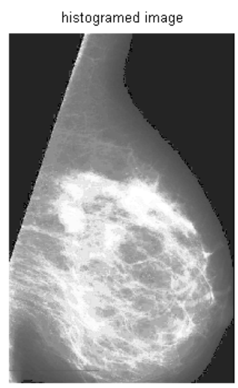

Figure 3.Histogram Equalized Image for FIG 1.

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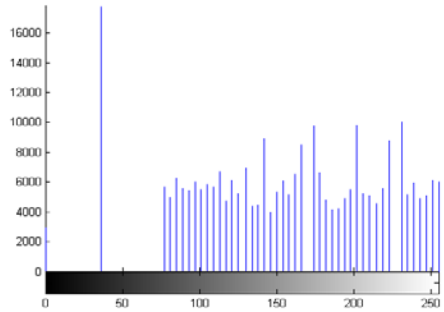

Figure4.Histogram for histogram equalized mammogram image

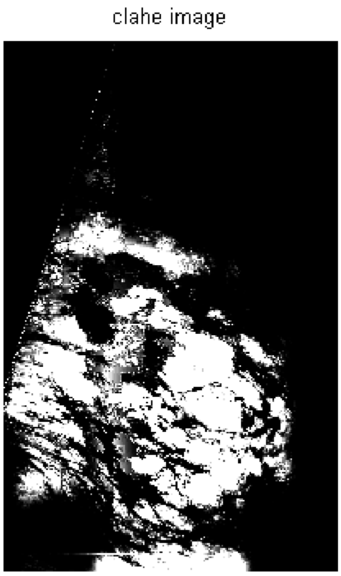

Figure 5.CLAHE Image for FIG 1

Table1. Comparison of Mean, Variance, RMSE and PSNR values For Histogram Equalization and CLAHE

Mammograms images names	Mean		Variance		Standard Deviation		PSNR Value	
	Histogram Equalization	CLAHE	Histogram Equalization	CLAHE	Histogram Equalization	CLAHE	Histogram Equalization	CLAHE
Mamo.jpg	46.788	20.093	127.00	54.91	11.26	7.41	37.611	39.432
Mamo2.jpg	18.85	42.07	139.48	31.47	11.81	5.61	37.408	40.64
Mamo3.jpg	13.287	42.513	127.27	42.38	11.28	6.51	37.60	39.99
Mamo4.jpg	10.325	14.261	163.24	22.91	12.77	4.78	37.066	41.33
Mamo5.jpg	27.809	11.479	127.58	53.13	11.29	7.28	37.61	39.50

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©gopalax journals,singapore
ISSN:0976-268X
Available at : http://ijcns.com

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