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EFFICIENT PREPROCESSING TECHNQIUE FOR MAMMOGRAM IMAGE ENHANCEMENT

[1]S.PITCHUMANI ANGAYARKANNI, [2]Dr.NADIRA BANU KAMAL, [3] Dr.RANJIT JEBA THANGAIYA

[1]Assistant Professor, Department of Computer Science, Lady Doak College, Madurai, Tamil Nadu, India
[2]Head of the Department,Department of M.C.A, TBAKCollege,Kilakarai,Ramnad,Tamil Nadu,India
[3]Head of the Department, Department of M.C.A., Karunya University,Coimbatore, Tamil Nadu, India

ABSTRACT

The main objective of CAD system is to improve the diagnostic accuracy with consistency of radiological interpretation with output references. The main focus should be on reduction of image reading recall rate which is very essential in medical science. Breast cancer is considered to be a dreadful disease. It is considered to be challenging research area. Electronic image of the breast is captured using digital mammogram. These images are of low-contrast, noisy, fuzzy and blurred. Therefore mammogram images should be pre-processed and enhanced for efficient detection of cancerous masses. Interpretations of mammogram images are very difficult and therefore there is a need for an efficient and effective pre-processing and enhancement methods. The proposed research work incorporates a modified fuzzy based approach. The proposed work is a modified approach in which the input image is histogram equalized. The rule based fuzzy logic approach is used for image pre-processing and enhancement. Several performance metrics are used to evaluate the performance and efficiency of the proposed pre-processing technique.

Keywords: Image pre-processing, Histogram equalization, Fuzzy logic and Performance metrics.

1. INTRODUCTION

The goal of this proposed preprocessing and image enhancement technique is to develop an efficient detection system to assist radiologists in locating the abnormalities in mammogram images. There is a need for an efficient mammogram enhancement technique. The main goal of the enhancement technique is improving the image quality by removing the various artifacts which leads to false positive detection. The main objective behind choosing a proper preprocessing technique is to perform proper segmentation of ROI by removing the unwanted noise present in the mammogram image.The adopted preprocessing architecture should remove dissimilar and surplus information present in the background of the mammogram.

Segmentation becomes extremely difficult due to noise, poor image contrast and special labels present in the mammogram. Enhancing the texture and masses feature is considered to be an effective method for mammogram enhancement (Santle et al., 2011). The different stages of the proposed approach are shown in the architecture diagram below. The figure 1 clearly depicts the various phases that are involved in the proposed tumor detection framework for accurate detection of cancerous masses in mammogram image.

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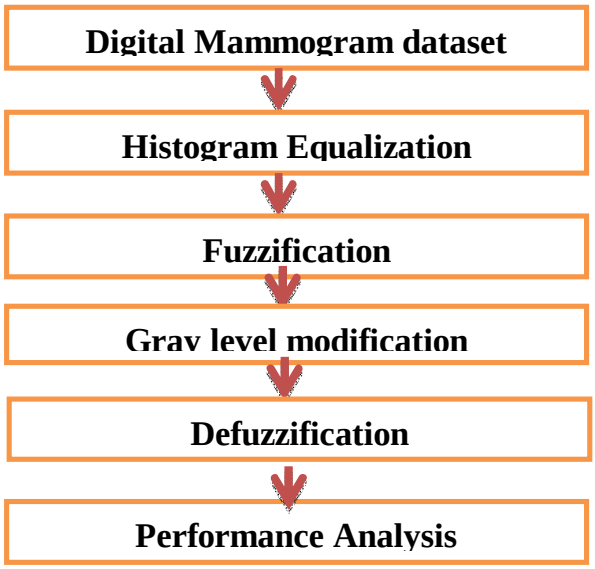

Figure 1 Block diagram for mammogram enhancement

2. PROPOSED METHODOLOGY

The major steps involved in contrast enhancement and brightness preservation in mammogram is performed through fuzzy based approach. The proposed preprocessing techniques involve three major steps like fuzzification based on histogram equalization, gray level modification and defuzzification. The proposed preprocessing techniques impart a modified fuzzy based approach for removing the pectoral muscles, artifacts and enhance the contrast of the mammogram images. The process involves five different steps to enhance the quality of the mammogram image to perform easy and effective segmentation of the region of interest.The fuzzy logic based HE technique is used to improve the image contrast (Magudeeswaran and Ravichandran, 2013).

(i) image fuzzification and intensification

(ii) fuzzy histogram computation

(iii) histogram partitioning and equalization

(iv) image defuzzification.

2.1 PLOT THE HISTOGRAM EQUALIZATION OF THE INPUT IMAGE

Using cumulative distribution function plot the pixel values of the image. The Histogram Equalization of the input image is plotted and from that the initial parameters used in fuzzy Histogram Equalization is initialized.

3. FUZZIFICATION

Find the minimum (min) and maximum (max) gray levels from the plotted Histogram Equalization. Determine the median gray levels of the histogram equalized image. Perform initialization of the following parameters used for fuzzification.

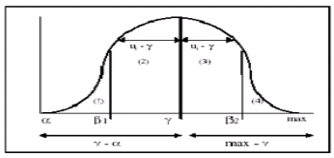

Figure 2 Histogram Equalization of the input image with parameters like α, β, γ and μ

The intensity value γ represents the median value of the distribution, α is the minimum, and max is the maximum. The aim is to decrease the gray levels below ß1, ß1 and above ß2. Intensity levels between ß1 and γ, and ß2 and γ are stretched in opposite directions towards the median γ. The fuzzy transformation function for computing the fuzzy plane value P is defined as follows:

α= min
β1= (α+ γ) /2
β 2= (max + γ) /2
γ = median

These parameters set in histogram equalization of the input image are depicted in figure 3.

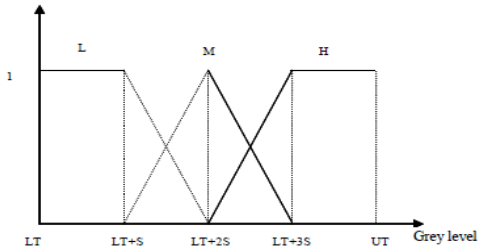

Figure 3 Input Image intensity Fuzzification

The main approach is to map the gray levels into fuzzy plane. This is done using appropriate membership function as shown in figure 5.5. This method generates higher contrast image when compared to original image. This process is done by incorporating weight larger than gray levels to the median gray level of the image compared to those that are farther from the median.

4.GRAY LEVEL MODIFICATION

The input pixel values are converted into binary values. These intensity values are represented as three different labels like Low, Medium and High within upper limit and lower limit threshold .

5. DEFUZZIFICATION

The process of finding a measurable result in crisp logic from the given fuzzy set and the degree of the membership is defuzzification. Defuzzification of the input image is based on gmin,gmax and gmedian the new enhanced gray level values are calculated.

6. MAMMOGRAM SUBTRACTION

It is a process by which the digital pixel values of the input image is subtracted from the modified fuzzy histogram equalized image. It is done to perform two important things 1) leveling uneven sections of the image 2) detecting changes between the two images.

Algorithm: FBPCE(I)

Step 1: Plot the histogram equalization of the image
Step 2: Parameter initialization
α= min;
β1= (α+ γ) /2;
β 2= (max + γ) /2;
γ = median
Step 3: Fuzzification
For i=1 to m of pixel values
For j=1 to n of pixel values
If ((image[i][j]>= α) && (image[i][j]< β1))
Set NewGrayValue=2*(pow(((image[i][j]-min)/(median- min)),2))
If ((image[i][j]>= β1) && (image[i][j]<median))
Set NewGrayValue=1-(2*(pow(((data[i][j]-median)/(median-min)),2)))
If ((image[i][j]>=median) && (image[i][j]<max))
SetNewGrayValue=2*(pow(((image[i][j]-median)/(max-median)),2))
If ((image[i][j]>=β2) && (image[i][j]<max)
SetNewGrayValue=2*(pow(((data[i][j]-median)/(max-median)),2))
Step 4: Gray level modification
SetFuzzyImage[i][j]= pow(NewGrayValue,2)
Step 5: Defuzzification

For all FuzzyImage(i,j) within the image
SetEnhancedImage[i][j]=FuzzyImage[i][j]*image[i][j];
Step 6:
EnhancedImage[i][j]=Imsubtract(Image[i][j],EnhancedImage[i][j])
End

7. EXPERIMENTAL RESULTS

The performance of the proposed technique is evaluated by an expert opinion may be obtained or standard criteria may be used. The standard performance metrics like Peak signal to Noise Ratio (PSNR), Mean Squared Error (MSE), Root Mean Squared error (RMSE), Mean Absolute error (MAE) , Target to background contrast measure based on entropy, Target to Background Contrast Measure based on Standard Deviation, Amplitude Mean Brightness error (AMBE)(Aboul and Jafar,2003), Structural Content, Enhancement by Entropy (EME), Index of Fuzziness and fuzzy Entropy (Hassanien, 2007)were used to evaluate the performance of the proposed technique. The table 1 clearly indicates the accuracy of the proposed methodology in image preprocessing and enhancement. The high PSNR value indicates the high quality of the reconstructed image. The proposed enchantment algorithm is best determined through the high value of TBCSD and TBCENTROPY. Lower value of fuzzy entropy, mean absolute error and structural content clearly indicates the grayness ambiguity is reduced by the proposed technique.

Table 1: PERFORMANCE METRICS FOR EVALUATING THE PROPOSED ENHANCEMENT METHOD

Metrics	Original Image	Output Image
PSNR	30.5837	59.8323
MSE	65.8468	6.7584
RMSE	8.114	2.59
TBC_{SD}	0.01	0.47
$TBC_{ENTROPY}$	0.011	0.92
INDEX OF FUZZINESS	0.217752	0.01
FUZZY ENTROPY	0.289137	0.053
AMPLITUDE MEAN BRIGHTNESS ERROR	6.243	1.94
ENHANCEMENT BY ENTROPY	177.78	88.89
ENTROPY	5.761	2.320
MEAN ABSOLUTE ERROR	7.12	0.0604
SIM	67.89	22.09

The figure 4 below indicates the proposed preprocessing algorithm implemented using Graphical User Interface of SCILAB. The output represented in the form of histogram clearly indicates the contrast is enhanced; the label artifacts present in the image is removed and has limited the finding for abnormalities with no influence of the background of mammogram. The proposed pre-processing algorithm gives a better result for finding of masses, calcification, architectural distortion, two-sided asymmetry. This is used for early detection of breast cancer, which is determined through the various evaluation metrics proposed in table 1 and its discussion.

Table 2: Microcalcificationns shown using mean ranks of the original and four enhanced images (BABU AND RAMESH, 2013)

Radiologist	Original Image Mean Value	Nature of Image Preprocessing and Enhancement Algorithm (Numbers in parentheses represent the highest preference assigned based on number of cases)				
		Adaptive Unsharp Masking	CLAHE	Wavelet based approach	Multi-wavelet based enhancement	MFHE
#1 Malignant (n=10)	2.7 (0)	3.2(1)	4.5(0)	1.8(4)	1.7(6)	1.6(9)
#2 Malignant (n=10)	3.0(1)	3.2(1)	4.9(0)	2.7(3)	2.3(5)	2.2(9)
#3 Malignant (n=10)	2.8(1)	2.5(1)	5.0(0)	2.0(6)	1.7(4)	1.6(10)
All radiologist Malignant (n=30)	2.8(2)	3.0(3)	4.8(0)	2.2(13)	1.9(15)	1.8(30)

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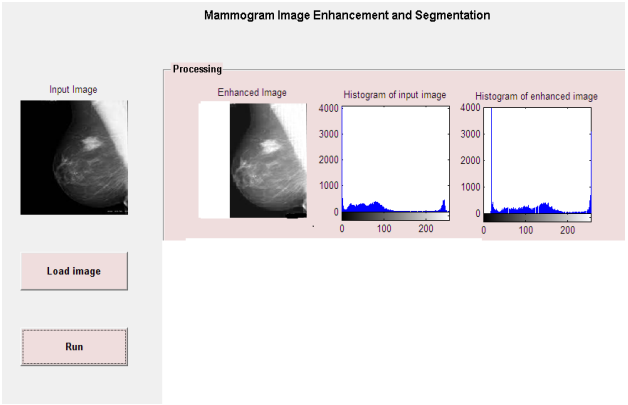

Figure 4: GUI for Mammogram Image Preprocessing using Modified Fuzzy HE (MFHE)

Digital mammogram images are medical images and therefore they are difficult to interpret, thus we need an effective preprocessing technique to improve image quality and make the results of segmentation to be more accurate. The proposed preprocessing algorithm using modified fuzzy HE removes the noise present in the image like high and low intensity labels, tape artifacts etc.. This algorithm further enhances the quality of the image in order to perform effective search for abnormalities without the background image influence and finding and removing pectoral muscle using segmentation. The proposed method enhances both masses and microcalcification

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AUTHOR

Pitchumani Angayarkanni received the B.Sc., degree in physics and MCA, M.Phil and Ph.D in Computer Applications from Karunya University. Currently working as Associate Professor in Computer Science department of Lady Doak College. I Have 15 years of teaching experience.