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Mammogram Image Segmentation Technique

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Abstract

The breast cancer problem is becoming a major death of women in the world; clinical experience provides that the early detection and proper diagnosis can protect the patients from breast cancer problem. The human vision is always accurate in detecting different changes in the intensity of the vision. The visual representation of any object is used to provide the proper communication to each other. This paper provides the segmentation after preprocessing then classification of the different types of breast cancer problems. The mammogram imaging can be analyzed by applying proper algorithms to segment and classify the stage of cancer images. The preprocessing technique is important to get accurate segmentation of the mammogram image matrix. The preprocessing can be divided into two parts. First part of preprocessing is to filter the mammogram image to eliminate noses like salt and pepper noise, random noise and speckle noise. After image de-noising, the second part of preprocessing is image enhancement. The image enhancement is used to improve the contrast and brightness of the image. The is the qualified image to segment the Region Of Interest (ROI). The ROI is further subjected to extract the data for data mining. The data features are given to the support vector machine (SVM) classifier to classify whether given mammogram image is normal or abnormal and its stages.

Keywords: mammogram, image de-noising, image enhancement, image feature extraction, data mining, neural network, Support Vector Machine

1. INTRODUCTION

Threshold-primarily based techniques may be categorized into global and local threshold. Global threshold focuses on global statistics together with the histogram of the mammograms. While masses are sufficiently brighter than surrounding tissue, it's far feasible to apply a global threshold. However, neighborhood threshold determines a local threshold price for every pixel based totally on neighbor pixels intensity values. The Threshold techniques have been broadly

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used for mammographic mass segmentation. Region growing-based techniques start from preliminary seed point and regroup pixels of comparable traits to divide the mammographic image into homogeneous regions. Cao et al. [1] proposed an adaptive place developing approach with hybrid assessment feature blended with most probability evaluation and maximum gradient evaluation. This approach is used to section mammographic loads. Berber et al. [1] proposed an extension of the classical seeded vicinity developing for mass segmentation in mammographic regions of hobby. In fact, on this work the threshold value is adjusted adaptively based on mass size estimation to save you over- and underneath-segmentation. Recently many preprocessing techniques for image matrix data filtering and enhancement are proposed by many scholars with appreciable novelty to give innovative solutions on mammography images. The soft computing technique is used to segment the images that have cancer. The cancer region has to be properly segmented by applying the clustering technique to group the pixels exactly. Also some hybrid techniques and partial differential equations (PDE) are used to segment the image matrix data to detect the cancer. The segmentation is grouped into two parts. First part is clustering technique. Using the clustering technique the mammogram image matrix data has to be grouped into different pixel intensities. The threshold technique is the second part. The high intensity pixels are highlighted using threshold. There are many techniques are used for segmentation to extract the ROI from the mammogram images. Some of the techniques are K means clustering, Fuzzy C Means Clustering, Expectation Maximization (EM) algorithm, wavelet and fuzzy, wavelet and neural network, fuzzy and neural network, active contour model, genetic optimization technique, optimization techniques and some of the hybrid techniques are used to segment the cancer portion of the images.The support vector machine is used to classify the mammogram image whether it is affected by the cancer or not.

2.1 EXISTING SYSTEM

Previously, the region growing algorithm is used to segment the mammogram image.

Demerits of existing system

The region growing algorithm required seed point selection procedure. The seed point selection varies from image to image. The automated seed point selection is not available in the existing system.

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2.2 PROPOSED SYSTEMS

1. Image Restoration – Anisotropic Diffusion Filter (PSNR is high)
2. Image Enhancement – Adaptive Mean Adjustment algorithm
3. Image Segmentation for Data mining – Modified Expectation Maximization Algorithm for Region Of Inter (ROI) data estimation
4. Feature Extraction for database generation– Gray level Co-occurrence Matrix is applied to extract the data from ROI and stored as database
5. Classification – neural network for data mining classification

3.1 LITERATURE SURVEY

Samir M. Badawyand Alaa A. Hefnawy are proposed an quantitative study on breast cancer detection with mammogram segmentation. Within the system, the technique of double threshold segmentation applied for Mammograms' imagery segmentation was implemented. An enhancement has been performed to the segmentation approach by using applying some morphological operations after double threshold.Rabi Narayan Panda and Bijay Ketan [6] are proposed Feature Extraction for Classification of Micro-calcifications and Mass Lesions in Mammograms for breast cancer detection. Numerous traits that can characterize medical problems, which includes dissimilarities between the breasts, imagery distortion, and confluent densities related to benign fibrosis and calcifications etc are identified with the useful resource of Mammography. Tiny deposits of minerals (calcium) that seem like localized high-depth regions (spots) within the mammogram are referred to as calcification. Calcification is one of the sizable and huge finding that are often obvious in a mammogram. Micro-calcification and macro calcifications or coarse calcifications are the 2 common classes of calcifications. The benignity or malignancy of the tumor is indicated through the number calcifications that incorporate a cluster. Micro-calcification is minute (less than 1/50 of an inch or ½ of a millimeter) spots of Calcium deposits that may exist in a place of swiftly dividing cells [7].

3.2 BLOCK DIAGRAM

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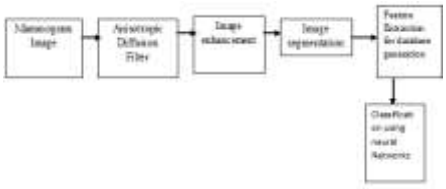


Figure 1: Block diagram

4.1 IMAGE DENOISING

The input image is affect by impulse noise, the typical poverty model at point (i, j) in a 2D matrix can be written as

$$y(i, j) = x(i, j) + n(i, j), \qquad (1)$$

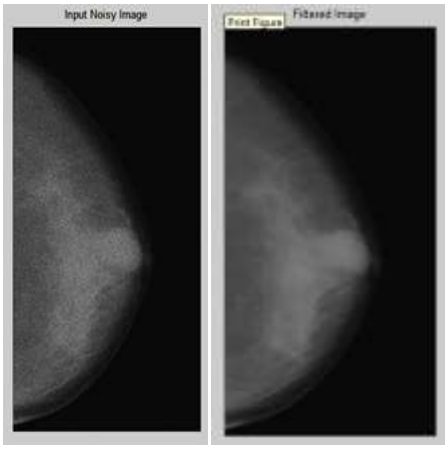


Figure 2: Input Noisy Image, Filtered Image

Where x, y , and n represent an input image, the noisy image, and the impulse noise, respectively. For successful filtering, it is popular to get a reliable degradation estimation function that can find the degree of the noise as well as the noise's pixels [2]. The adaptive median filter reflects on all pixels in the image in roll and seems at its close by adjacent pixels to choose whether or not it is representative of its background [2]. Instead of restore the pixel value with the mean of neighbor's pixel values, it is restored with the median of those values. The proposed filter differs from the existing median filter [3]. The proposed filter performs spatial

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functioning to find which pixels in an image have been degraded by noise. The proposed filter organizes pixels as noise by evaluating each pixel in the image to its neighbor pixels. The size of the surrounding is adaptable and the threshold for the evaluation. A pixel that is different from a majority of its surroundings and being not properly managed with those mentioned pixels, to which it is comparable, is tagged as a noise. These noise pixels are restored by the median rate of the pixels in the surrounding that have moved the noise test. Thus, the proposed filter resolves the double purpose of extracting the noise from the image and dropping deformation in the image.

The figure 5 shows that the filtered output image after applying the first level of preprocessing method of anisotropic diffusion filter.

Figure 2 show that adaptive anisotropic diffusion image after eliminating speckle and salt and pepper noise [2].

Image Acquisition

Step2: Apply Adaptive Median Filter for both Gray and Colour space Images

Step3: Subtract the Filtered Image from Input Image

$$\mathbf{I}, = \text{div}\,(\,c\,(\,x\,,y,t\,)\nabla l\,) \;=\; \mathbf{c}(\mathbf{x},y.r)\Delta l \;+\; \nabla c\,\nabla I$$

4.2 IMAGE ENHANCEMENT USING HISTOGRAM MEAN ADJUSTMENT

Image enhancementis the process of adjusting digital image so that the results are most suitable for display. It is used to improve the quality of the image. The Adaptive Mean Adjustment [9]is used to enhance the image.Adaptive Mean Adjustment [2] is a computer image processing technique used to improve contrast in images. It modifies the allocation of the pixels to become more consistently increase out more than the obtainable pixel variety. In histogram dealing out, a histogram displays the sharing of the pixel intensity values. Dark image will have low pixel values whereas a bright image will have high pixel values.

Mean adjustment [2] formula is given by,

Mean adjustment = X(I,j)-Xmin(I,j)/Xmax(I,j)- Xmin(I,j)

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Where ,X is the image,Xmin-Minima of the image,Xmax-maxima of the image.

The main aim of the image enhancement is to improve the contrast and brightness of the image in order to improve the quality of the image [8].

The image is considered as a function z=f(x,y), it is an 2D matrix.

Where z is the gray level of the image.

f(x,y) = a1*x +a2*y + a3 +e(x,y), --(2)

Calculate the values a1, a2, a3, i.e. $\hat{a}1,\ \hat{a}2,\ \hat{a}3,$

We have to reduce the sum of square of residuals at each pixel,

$$S^2 = \sum_x \sum_y [\hat{a}1 * x + \hat{a}2 * y + \hat{a}3 - f(x,y)]^2, \qquad (3)$$

It gives
$\hat{a}1,\ \hat{a}2,\ \hat{a}3$ by

$$\hat{a}1 = \frac{\sum_x \sum_y x * f(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = \frac{\sum_x \sum_y y * f(x,y)}{\sum_x \sum_y y^2},$$

$$\hat{a}3 = \frac{\sum_x \sum_y f(x,y)}{\sum_x \sum_y 1}. \qquad (4)$$

Thus,
F has an F distribution with 2,n-3 degree of freedom.

When considering 3*3 window, n-3= 6.
Now we derive the following. Change f(x,y) by equation (2) ,

Ie).,
a1*x +a2*y + a3 + e(x,y) ,

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$$\hat{a}1 = a1 + \frac{\sum_x \sum_y x * e(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = a2 + \frac{\sum_x \sum_y y * e(x,y)}{\sum_x \sum_y y^2},$$

$$\hat{a}3 = a3 + \frac{\sum_x \sum_y e(x,y)}{\sum_x \sum_y 1}. \quad (6)$$

From above equation and noise equation, it drives variances of $\hat{a}1,\ \hat{a}2,\ \hat{a}3$

$$\sigma^2_{\hat{a}1} = \frac{\sigma^2}{\sum_x \sum_y x^2,} \quad \sigma^2_{\hat{a}3} = \frac{\sigma^2}{\sum_x \sum_y x^2,} \quad (7)$$

the covariance is 0, nN

Now noises are un-correlated for pixels.

From equations (2) (4) (6):

$$S^2 = \sum_x \sum_y e^2(x,y) - (\hat{a}1 - a1)^2 \sum_x \sum_y x^2 - (\hat{a}2 - a2)^2 \sum_x \sum_y y^2 - (\hat{a}3 - a3)^2 \sum_x \sum_y 1. \quad (8)$$

Now e(x,y) ~ N(0),

$$\frac{\sum_x \sum_y e^2(x,y)}{\sigma^2} \sim \chi^2_n, \quad (9)$$

The χ^2_n → for the chi-squared distribution with n degrees of freedom, n can be calculated as,

$$n = \sum_x \sum_y 1. \quad (10)$$

Because e(x,y) is a normal distribution function, based on the equation (6), $\hat{a}1,\ \hat{a}2,\ \hat{a}3$ gives the normal distribution :

$\hat{a}1 \sim N(a1,\ \sigma^2_{\hat{a}1}), \hat{a}2 \sim N(a2,\ \sigma^2_{\hat{a}2}), \hat{a}3 \sim N(a3,\ \sigma^2_{\hat{a}3}),$ (11)

with the variance given in equation (23), so

$$F = \frac{[(\hat{a}1 - a1)^2 \sum_x \sum_y x^2 + (\hat{a}2 - a2)^2 \sum_x \sum_y y^2]/2}{S^2/(n-3)} \quad (5)$$

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$$\frac{(\hat{a}1-a1)^2}{\sigma_{\hat{a}1}^2}=\frac{(\hat{a}1-a1)^2\sum_x\sum_y x^2}{\sigma^2}\sim\chi_1^2,$$

$$\frac{(\hat{a}2-a2)^2}{\sigma_{\hat{a}2}^2}=\frac{(\hat{a}2-a2)^2\sum_x\sum_y y^2}{\sigma^2}\sim\chi_1^2,$$

$$\frac{(\hat{a}3-a3)^2}{\sigma_{\hat{a}1}^2}=\frac{(\hat{a}3-a3)^2\sum_x\sum_y 1}{\sigma^2}\sim\chi_1^2. \quad (12)$$

Following the equations (9), (10), (12) ,

$$\frac{S^2}{\sigma^2}\sim\chi_{(n-3)}^2, \quad (13)$$

U~ χ_j^2 , V ~ χ_k^2 , then

$$\frac{U/j}{V/k}\sim F_{j,k.}$$

$$\frac{[(\hat{a}1-a1)^2\sum_x\sum_y x^2+(\hat{a}2-a2)^2\sum_x\sum_y y^2]/2}{S^2/(n-3)}\sim F_{2,n-3.} \quad (14)$$

DN (Digital number)

Estimate the Digital Number (DN) as

DN = WF * RV + (1-WF) * DN(old), (15)

RV - > Reference value for the pixels

WF - > Weight vector

WF = max (WF1, WF2) (16)

The contrast of the image is calculated as follows,[7]

(Image contrast enhancement)

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$$WCON = \frac{DN\max(window) - DN\min(window)}{DN\max(image) - DN\min(image)} \quad (17)$$

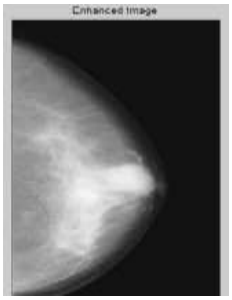


Figure 3: Image enhancement using adaptive mean adjustment.

Figure 3 show that the enhanced image by applying adaptive mean adjustment algorithm. It has high contrast and brightness as shown in the figure.Figure 3 shows that the enhanced image by applying the adaptive mean adjustment. Here the contrast and brightness are improved well as shown in the figure.

Step1: Input the Filtered Image

Step2: Case 1: Input Image

Step3: Set the thresholding values (Median)

Step4: Set Lower and Upper thresholding values to calculate the Minima and Maxima.

Step5: Apply the double Precision to the Image

Step6: Apply Normalization

Step7: Calculate the Mean of the Gray Scale Value

Step8: Adjust the Mean Value

Step9: Case 2: Noisy Image

Step10: Set lower and Upper thresholding values to calculate the Minima and Maxima

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Step11: Color Image Thresholding (Image Bandwidth)

Step12: Convert from Multispectral RGB Image to NTSC Color format (to

Improve Luminance, the intensity of light emitted from a surface per unit area in a given direction)

Step13: Calculate the Mean adjust value for Green layer using Color Image Upper Thresholding

Step14: Calculate the Mean adjust value for Blue layer using Color Image Lower Thresholding

Step15: For Case 1 and Case 2:

Mean Adjustment for First Layer

Calculate Minima and Maxima

Step16: Apply formula (Image-Minima/Maxima-Minima)

Step17: Enhanced Image Output.

Mammogram Image segmentation by applying modified Expectation Maximization algorithm (MEM)

After enhancing the tumour is detected in the image using modified Expectation Maximization algorithm [10] segmentation technique is applied.The hybrid version of fuzzy c means clustering and expectation maximization algorithm gives the modified expectation maximization (MEM) algorithm that have more accurate than other previous 2 algorithm. So the tumour affected area are clearly shown.The segmented image is clustered and the gray scale image is converted into binary image using thresholding.The soft clustering technique modified EM [11] clustering is used.In MEM [12] each pixel of the image belongs to more than one cluster.In the clustering process the tumour is grouped accurately.

$$S_i^* = \sum_{\forall x_j \in X, i \neq j} U_{ij} \beta_{ij} = \frac{\sum U_{ij} \beta_{ij}}{\sum_{\forall i} \sum_{x_j \in X, i \neq j} U_{ij}} \quad (18)$$

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$$\beta_{k1} = \frac{1}{1+\exp(\theta_1 \| j-k \|)}$$

(19)

$$\beta_{k2} = \frac{1}{1+\exp(\theta_2 \| x_j - x_k \|)}$$

(20)

The spatial task is included into membership task as follows:

$$U_{ij}^{*} = \frac{U_{ij}^{p} * s_{ij}^{*q}}{\sum_{k=1}^{c} U_{kj}^{p} * s_{kj}^{*q}}$$
$$for \ \ i = 1,2,\ldots,c \quad and \quad j = 1,2,\ldots,n$$

(21)

The formula of this parameter is:
$$\alpha = \exp(-\min \frac{\| v_i - v_k \|^2}{\beta}) \quad (22)$$

We define β:

$$\beta = \frac{\sum_{j=1}^{n} \| x_j - \bar{x} \|^2}{n} \qquad where \ \ \bar{x} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (23)$$

The figure 4 shows that the mammogram image segmentation,



Figure 4: Mammogram image segmentation

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5. FEATURE EXTRACTION FOR DATABASE GENERATION

Mammogram image classification tool is proposed by the authors. The proposed system for class of mammogram image data is built primarily based on GLCM via making use of unique classifiers. The system is split into 5 tiers to categories mammogram image data. First step is the statistics set collection, 2nd is ROI extraction system, third is the pre-processing steps that's again divided into two steps filtering and enhancement, fourth is the feature extraction from GLCM and ultimate degree is class. Authentic mammogram image data have one-of-a-kind types of noises, artifacts of their heritage, pectoral muscle tissue and many others that are unwanted for feature extraction and classification. For this reason a cropping operation has been applied on mammogram image data to extract the ROIs which includes the abnormalities, other than the unwanted portions of the mammogram image data. MIAS database offers all of the details about every mammogram imagery, viz., length in pixels, individual of history tissue, magnificence of abnormality, Xc and Yc coordinate fee of centre of abnormality, 'r' radius of circle enclosing the abnormality by the radiologists [14]. This option vector contains relevant information and is used as input vector for classification. Capabilities may be labeled primarily based on color, texture and shape. In this proposed system, we are particularly involved about texture features and for extraction of functions; gray level Co-occurrence Matrix (GLCM) is used because it has been demonstrated as an effective tool for data extraction. On this proposed system texture data features specifically contrast, correlation, Energy, homogeneity are estimated for data mining.

Some of the important data extraction for data mining is,

Correlation,

$$F2 = \sum_{i=0}^{N_g-1} \sum_{j=0}^{N_g-1} \frac{(ij)p(i,j)-\mu_x\mu_y}{\sigma_x\sigma_y}$$

Energy,

$$F3 = \sum_{i=0}^{N_g-1} \sum_{j=0}^{N_g-1} \{p(i,j)\}^2$$

Homogenity,

$$F4 = \sum_{i=0}^{N_g-1} \sum_{j=0}^{N_g-1} \frac{p(i,j)}{1+(i-j)^2}$$

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6. CONCLUSION

The early detection of breast cancer is the most important in the modern medical field. The anisotropic diffusion filter is adaptively applied to any size of the mammogram image to de-noise and give the filtered output image matrix. The adaptive mean adjustment technique is applied to improve the contrast and brightness of the image.The modified expectation maximization algorithm is applied to extract the Region of Interest that has all data related to the breast cancer.The feature data are extracted from the segmented image using gray level co occurrence matrix. Finally the neural network is applied to classify the image whether it is normal abnormal.

7. FUTURE SCOPE

In future, the proposed algorithm can be evaluated for medical equipment with digital signal processing unit for filtering, segmenting and finally the data of the mammogram image of the patient can be processed through the Internet of Things (IoT) that can be stored in the webpage of the hospitals. The patients all details can be confidential and authenticated anytime by the authorities.

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