Mammogram Image Analysis for Breast Cancer Detection

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Abstract— Breast cancer is the uncontrolled growth of cells in the breast region. It is the second leading cause of death in women today. A mammography is an X-ray of the breast tissue. Mammographic image classification can be achieved using Gabor wavelet. The main purpose of the proposed work is to develop a system which classifies mammographic images using Gabor wavelet feature. The images are taken from Mammographic Image Analysis Society (MIAS) database. The proposed system involves three major steps called Pre-processing, Feature Extraction and Classification. Pre-processing reduces noise and normalizes staining intensity. After preprocessing a noise free image goes to the Segmentation phase. Segmentation is the process of partitioning an image into semantically interpretable regions. In feature extraction stage every image is assigned a feature vector to recognize it. Gabor Wavelet is used for Feature Extraction. The extracted features are then dimensionally reduced by Principal Component Analysis (PCA) method to avoid excess computations. Then Support Vector Machine (SVM) classifier is used for classification. The experimental results obtained from the system developed in this research will prove to be beneficial for the automated classification of mammographic images. The proposed method can allow the radiologist to focus rapidly on the relevant parts of the mammogram and it can increase the effectiveness and efficiency of radiology clinics.

Keywords: *Mammography image, Gabor Wavelet, Discrete Wavelet Transform, Support Vector Machine*.

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I. INTRODUCTION

Mammographic image classification is extremely challenging as the suspicious calcification or masses appear as free shape and irregular texture, so no precise patterns can be associated to them. In this proposed work, Gabor wavelet based texture features are extracted from mammographic images, as texture is an important characteristic that helps to discriminate and identify the objects/masses. Gabor wavelet is one method used for texture description in image processing

A complex Gabor wavelet (filter) is defined as the product of a Gaussian kernel with a complex sinusoid. Gabor filters decomposes an image into multiple scales and orientation and make the analysis of texture pattern easy.

Mathematically wavelet will correlate with the signal if the unknown signal contains information of similar frequency. This concept of correlation is at the core of Gabor wavelet features.

Once features are extracted directional properties and frequency spectrum of those features are analyzed with respect to the classification performance by employing Support Vector Machine (SVM) as classifier.

II. PROPOSED SYSTEM

In this proposed work only digital mammogram images are considered for database and analysis. The images are taken from Mammographic Image analysis Society (MIAS) database.[8]

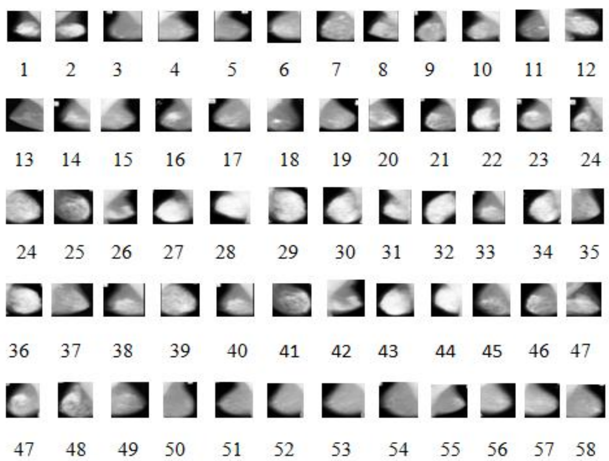

Figure 1: Input images

Figure 1 shows input mammographic images used for analysis. The images include both cancerous and non cancerous images. The cancerous images may be benign or malignant type. Automatic tumor detection is extremely challenging as the suspicious calcification or masses appear as free shape and irregular texture. So that no precise patterns can be associated to them.

Figure 2 shows a simplified block diagram of the proposed system.

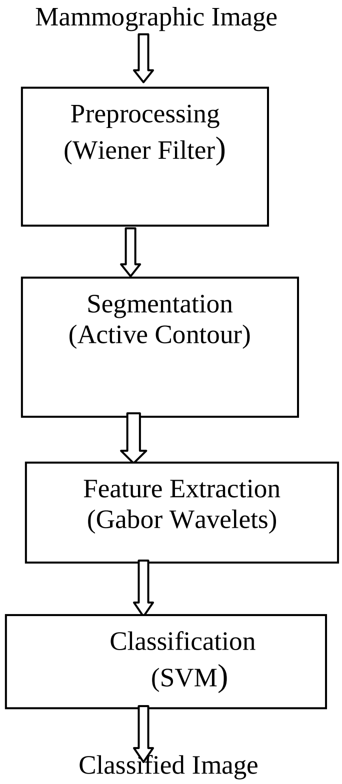

Figure 2: Block diagram

The proposed system has four major steps. A)Pre-processing B)Segmentation C)Feature Extraction D) Classification

A. Preprocessing: In this system Wiener filter is used to minimize the noise. Wiener filter tries to build an optimal estimate of original image by enforcing a smallest mean square error constraint between estimated and original image. To normalize staining intensity variations histogram based contrast enhancement method is proposed.

Wiener filter has capability of handling both degradation function and also noise. From degradation model, error between input signal f (m, n) and estimated signal f (m, n) is given by

$$E(M,N) = F(M,N) - F(M,N) \qquad (1)$$

Square error is given by

$$[F(M,N) - F(M,N)]^2 \qquad (2)$$

Mean square error is given by

$$E\{[F(M,N) - F(M,N)]^2\} \qquad (3)$$

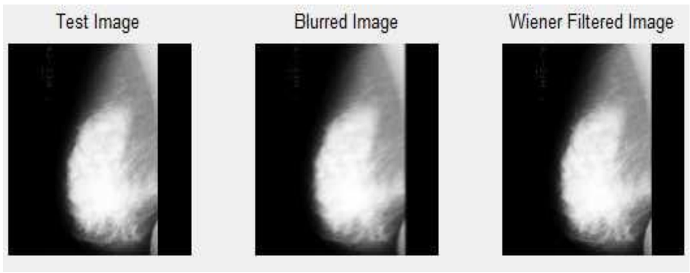

Figure 3: Wiener filter image

B. Segmentation: The segmentation methods divide the image into number of small segments. The goal of segmentation is to identify the correct areas (Region of Interest) to analyze the diagnosis and down sampling of the image using principal component analysis (PCA) for classification of mammogram images. In this proposed system Active Contour Method is used for segmentation. Figure 4 shows the extracted region.

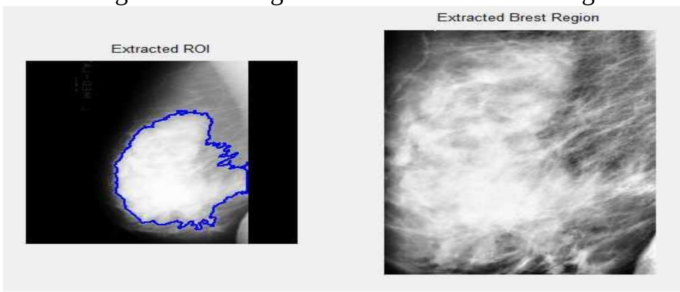

Figure 4 : ROI Extraction

C. Feature Extraction: In this system Gabor wavelet Method is used for feature extraction. Texture feature is extracted using Gabor wavelet. Set of wavelets (Gabor filters) are generally used to analyze data fully.

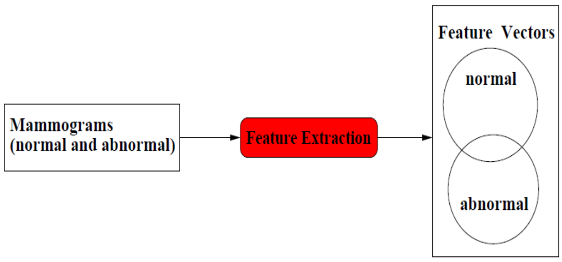

Figure 5 : Feature Extraction

After segmentation phase, collections of features are required for each image. In the feature extraction phase each picture is assigned feature vector to recognize it. This vector is used to distinguish image.

When a Gabor filter is applied to the Region of Interest (ROI), we get statistical values. These values are used as a feature for that particular Gabor filter. The method is repeated for all the Gabor filters in the bank of filters to generate feature vectors of the given Region of Interest.

The extracted features are then dimensionally reduced by Principal Component Analysis (PCA) method to avoid excess computations.

2D Gabor wavelets have been broadly used in PC vision applications and modeling biological vision, since current studies have shown that Gabor elementary functions are appropriate for modeling simple cells in visual cortex.

2D Gabor wavelet transform is defined as convolution of image I (z):

$$J_k(z) = \iint I(z')\psi_k(z-z')dz' \quad (1)$$

With family of Gabor filters:

$$\psi_k(z) = \frac{k^T k}{\sigma^2}\exp\left[-\frac{k^T k}{2\sigma^2}z^T z\right](\exp(ik^T z) - \exp(-\frac{\sigma^2}{2}) \quad (2)$$

Where **z** = (*x*, *y*) and **k** is characteristic wave vector:

$$k = (k_v \cos\varphi_\mu \quad k_v \sin\varphi_\mu)^T \text{ ....} \quad (3)$$

With

$$k_v = 2^{-\frac{v+2}{2}}\pi, \varphi_\mu = \mu\frac{\pi}{8}, v = 0,1,2,3,4, \mu = 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \quad (4)$$

Parameters v and μ define frequency and orientation of filter.

Figure 6 shows family of Gabor wavelets with four scales as well as eight Orientations.

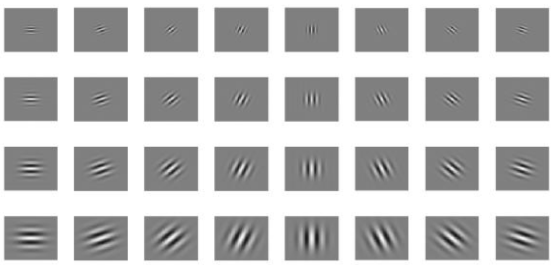

Figure 6 : Gabor wavelets

D. Classification: In this system Support Vector Machines (SVM) is used for Classification of mammogram images. Classification task typically involves with training as well as testing information. It uses the features extracted in the previous stage to identify the image segment according to preset rules. Support Vector machines (SVMs) training algorithm discover hyper plane with functional margin that predicts whether latest example falls into one category or other. A good classification is achieved by larger functional margin. Care should be taken to avoid misclassification.

III. EXPERIMENTAL RESULTS

The images are taken from the MIAS (Mammographic Image Analysis Society) database which consists of 41 normal images and 85 abnormal images. The abnormal images are further classified into two classes i.e. benign and malign. There are total 64 benign images and 21 malign images. To discard irrelevant (background) data like chest contour, patches of 140 *into* 140 pixels surrounding the abnormality region were extracted from the original 1024 *into* 1024 pixels images. Patch size assures that, for most odd cases not only oddity region is captured but as well surrounding area, providing us data about oddity shape. For normal case, patches were extracted from arbitrary position in the chest area.

In order to decrease computational load each picture was down sampled to last size of 30 *into* 30 pixels. We divide the mammographic information into 2 disjoint sets to test generalization ability of classifier with Gabor features as its input. First set representing 80 % samples from entire database is set where classes such as normal, benign, malign. These are known and left over 20 % samples are integrated in test set with unknown classes.

IV. CONCLUSION

The proposed method is developed for detecting the mammographic images and classifying them as a cancerous or not. The system involves three major steps called Pre-processing, Feature Extraction and Classification. Gabor wavelet based features are extracted which improves sensitivity and performance for detection of micro calcification in digital mammogram .The extracted features are then dimensionally reduced by Principal Component Analysis (PCA) method to avoid excess computations. The SVM classifier is used for Classification of mammogram images. Classification task typically involves with training as well as testing information. It uses the features extracted in the previous stage to identify the image segment according to preset rules.

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