Proceedings of the 11th INDIACom; INDIACom-2017; IEEE Conference ID: 40353
2017 4th International Conference on "Computing for Sustainable Global Development", 01st - 03rd March, 2017
Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi (INDIA)

Classification of Breast Lesions using Gabor Wavelet Filter for Three Classes

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Abstract - Breast cancer is one such disease that has got great attention in the last decades. In breast cancer the breast lesion are differentiated into two classes, Benign and Malignant. In this paper Computer- Aided Detection (CAD) system is designed for detecting lesions that may indicate the presence of breast cancer. The ROI is extracted from the ultrasonic images using imageJ software and then the different image processing techniques are applied i.e. preprocessing, feature extraction, and feature classification using MATLAB. The aim of this paper is to achieve higher accuracy and results using Gabor Wavelet as compared to the previous researches done. SVM classifier is extensively used for classification. In this paper we obtained the accuracy of 89.5% using three class classification.

Keywords- Breast cancer, primary Benign, primary malignant, secondary malignant, Classification, Ultrasound.

I. INTRODUCTION

Breast Cancer is biocide form of the cancer after the lung cancer in women, it is the most comprehensive form of cancer resulting in the loss of life. The American Cancer Society's estimated breast cancer in the United States for 2016, about 246,665 new cases of protruding breast cancer will be diagnosed in women, about 61,000 new cases of carcinoma in situ (CIS) will be diagnosed (CIS is non-intrusive and is the earliest form of breast cancer)[1].Early detection of the cancer not only help in the proper diagnosis but also minimizes the risk of the death. Various early detection techniques are available these days including breast exam by physician, X-Ray, Ultrasonography, Magnetic Resonance Imagining (MRI) and Biopsy[2]. In a biopsy the cells or tissue are removed from the apprehensive area of the breast and are tested under a microscope to see if cancer is present. To reduce unnecessary biopsies, the most frequent method includes Mammography, Ultrasonography. X-ray mammograms may lead to early analysis of breast cancers when they are most amenable. It may also find ductal carcinoma in situ (DCIS)[3], abnormal cells in the lining of a breast duct that may develop into intrusive cancer, it is the only breast cancer screening tool known to reduce deaths from the disease[4].Ultrasound imaging, is portable and less expensive, and acts as an alternative to mammography, also being non-radioactive, non-intrusive, real time display it has low cost and better penetration ability as compared to the X-ray Mammography. Benign tumors have well defined curve with bulbous and smooth shape and margin where as the intrusive type of cancer, malignant type tumors are having the architectural distortions, angular margins, irregular shape, acoustic shadowing, duct extension [5].

Primary Benign case is Fibroadenoma and Primary Malignant case is Carcinoma [1]. The secondary case of Malignancy is Metastasis. Till now, most of work is done to distinguish between only the Benign and Malignant class but in this work, we will distinguish between Fibroadenoma, Carcinoma, Metastasis. In this paper a computer aided design (CAD) system has been proposed for three class classification using Gabor wavelet and SVM classifier.

II. METHODOLOGY

The experimental flow of the system follows a sequence as shown in Figure 1.

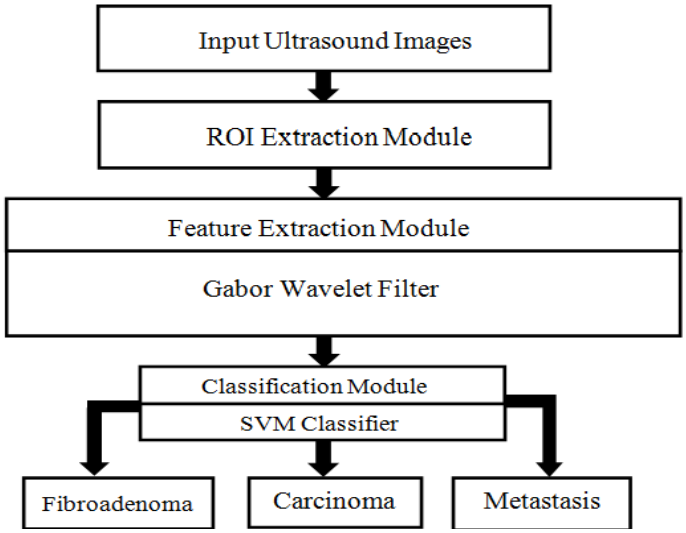


Fig. 1. Overview of system

A). Database Ultrasound Images

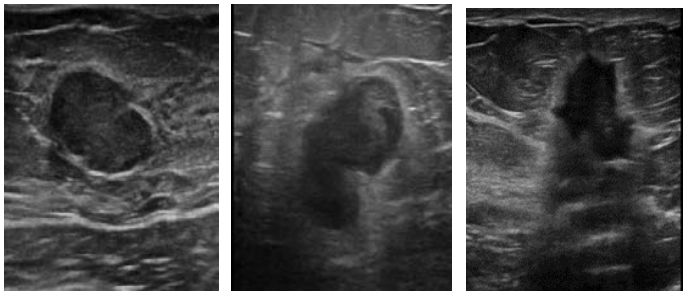
The ultrasound images are taken for analysis of Fibroadenoma, Carcinoma, Metastasis .Data was taken for 167 cases

 ISSN 0973-7529; ISBN 978-93-80544-24-3

discarding the cases of biopsy and cases having blood vessels. The data base contains 60 cases of Fibroadenoma and 50 cases of Carcinoma and 57 cases of Metastasis.

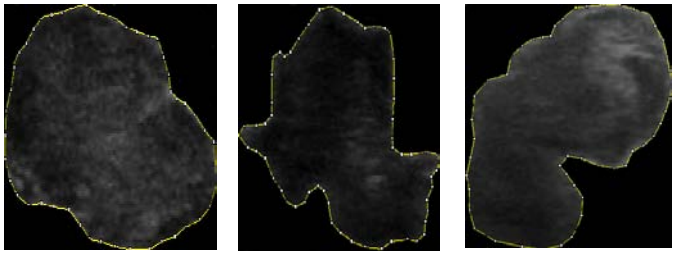
B). ROI (Region of Interest) Extraction Module

The deformity in the ultrasound is identified and segmented with the help of *ImageJ* software [7].This software helps marking and segmenting the infected area. The segmented region is confined into a rectangular box adjoining the boundaries of abnormality as shown in Fig 2 shows the three types of breast cancer while Fig 3 shows the extracted ROI.



(a) (b) (c)

Fig. 2. (a) image of Fibroadenoma , (b) image of Carcinoma, (c) image of Metastasis



(a) (b) (c)

Fig. 3. (a) ROI marked of Fibroadenoma, (b) ROI marked of Carcinoma , (c) ROI marked of Metastasis

C). Feature extraction Module

The feature extraction is the process used to transform the visually extractable and non-extractable features into mathematical descriptors [8-15]. Any pathological or traumatic discontinuity of tissue or loss of function of a part is called a lesion; this module contains texture statistical features that are classified as:

a. Signal Processing Based Methods
b. Statistical Methods
c. Transform Domain Methods

In our work the transform domain over various scales by using different multi resolution schemes like wavelet packet transform (WPT) and Gabor Wavelet transform (GWT) [16-19]. It is logical to compute texture features in the transform domain as human visual system processes images in a multi scale way and scale is considered to be an important aspect for analysis of texture

Two Dimensional Gabor Wavelet Transform

The application of 2D-GWT results in a set of frequency and orientation selective filters which capture energy at specific frequency and orientation [19-22]. The 2D-GWT, considering three scale (0,1 and 2) and seven angels(22.5^0, 45^0, 67.5^0, 90^0, 112.5^0,135^0,157.5^0) resulting in a group of 21 wavelets (7×3). Mean and standard deviation are computed as features forming a texture feature vector (TFV) of length 42.

D). Classification Module

The basis for classification is, differentiation the testing samples into classes. Classification is characterized into two categories namely supervised and unsupervised classification. Under supervised classification the classes are already defined and under unsupervised classification the classes are not defined. In this paper we have used SVM classifier, which comes under the category of supervised classification.LibSVM has been used to carry out work with SVM classifier.[12-18].The working of SVM is on the concept of decision planes in which the decision boundaries are defined. Nonlinear mapping of training in kernel based classifiers, input space to high dimensional feature space data is done using the kernel functions. The choice of the regularization parameter C and kernel parameter γ is used for having a good generalization performance. By doing the search, that is carried out in the parameter space for the values of $C \in \{2^{-4}, 2^{-3} \ldots 2^{15}\}$, $\gamma \in \{2^{-12}, 2^{-11} \ldots 2^{4}\}$,the values for C and γ are obtained. [23-27]

III. RESULTS AND DISCUSSIONS

This paper proposes a CAD system for the radiologists as a second opinion tool for the breast cancer using Gabor Wavelet transform. For classification we have different classifiers, but the most extensively used classifier is SVM. The experiments carried out in the present work signify that the Gabor Wavelet transform with 100 training set images and 67 testing set images which yields the maximum OCA of 89.5% for differential diagnosis between benign and malignant breast lesions using the ultrasound images with sensitivity of 95.45% for fibroadinoma, 88.57% for carcinoma and 80% for metastasis. The computed results are shown in the table 1.

Till yet no work has been done for three class classification. Further author didn't find any paper on Gabor wavelet for three class classification.

IV. CONCLUSION AND FUTURE WORK

After carrying out extensive literature survey, it was concluded that various CAD system designs have proven useful to the radiologists in routine medical practice as second opinion tools for breast lesions classification of ultrasounds in cases where a clear discrimination cannot be made subjectively. In light of this fact, different CAD system designs employing the transform domain features. Classification of Breast Lesions based on Gabor Wavelet for Three Class Classification. As we got the result as 98% for the above work using SVM classifier.

Table 1: Result of SVM classifier

TFV(*l*)	CM				sensitivity	OCA
		FA	CR	MS		
TFV(42)	FA	21	0	1	95.45%	89.5%
	CR	4	31	0	88.57%	
	MS	0	2	8	80%	

TFV: Texture Feature Vector , CM: Confusion Matrix OCA: Overall classification Accuracy, FA: Fibroadinoma, CR: Carcinoma, MS: Metastasis, *l*:length of TFV

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