Contourlet Based Feature Extraction Method for Classification of Breast Cancer using Thermogram Images

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Abstract— Breast cancer is the most common cause of cancer deaths among in women worldwide. Thermography is a non-invasive, non-contact imaging technique as well as not using radiation or compression for capture the images, so it is widely used in the medical arena. Medical thermography has proved to be useful in various medical applications including the detection of breast cancer where it is able to identify the local temperature increase caused by the high metabolic activity of cancer cells. Breast thermography is a safe and painless diagnostic procedure for an early detection of breast cancer. This paper proposes a Contourlet transform based GLCM features for the classification of breast thermogram images. These features are calculated from cancer and normal region and classified into normal or abnormal by using SVM network.

Index Terms— Thermogram Breast Cancer, GLCM, Feature Extraction, Contourlet, SVM.

1 INTRODUCTION

Breast thermography is a safe, painless diagnostic procedure that images the breasts to aid in the early detection of breast cancer. It is based on a careful analysis of skin and tissue temperatures which allow practitioners to see where there is abnormal chemical and blood vessel activity in body tissue. It is both non-invasive and comfortable, using no radiation or compression. Breast Thermography measures the heat that is constantly radiating from our breasts. High resolution images of the breasts are taken with an infrared camera to show temperature differences that could indicate cancerous tissue (abnormal tissue growth generates more heat than normal tissue). By carefully examining changes in the temperature and blood vessels of the breasts, signs of possible cancer or pre-cancerous cell growth may be detected up to 10 years prior to being discovered using any other procedure. This provides for the earliest detection of cancer possible. The use of Digital Infrared Imaging is based on the principle that metabolic activity and vascular circulation in both pre-cancerous tissue and the area surrounding a developing breast cancer is higher than in normal breast tissue. This process results in an increase in regional surface temperatures of the breast.

Thermography is a particularly good choice for younger breasts, which tend to be denser. Contourlet is geometry of transformation based on image. The multi-scale decomposition and the directional decomposition are two independent processes which will effectively to express the contours and texture-rich of image [1]. Contourlet transform is flexible multiscale, multidirection, and shift-invariant image decomposition that can be implemented efficiently [2]. The GLCM based contourlet transform gives better classification than wavelet and curvelet transform [3].

The appropriate multiresolution transform was applied and a set of texture descriptors were extracted from the transformed Image. These features characterized the textural properties of the images and were used to train the classifier to recognize each texture class [4]. Textural variation in the ultrasound image has been found as a useful feature to identify benign and malignant tumors [6]. The Feature Extraction algorithm that yields a large number of features. It is difficult to manually see and select the optimal features. So, feature reduction method like principle component analysis is employed [7]. Features from Law's Method, Autocorrelation Method, Edge Frequency Method and Gabor wavelet are extracted and their recognition rate in classification of abnormalities is compared by using Back propagation Network [8].

The MultiResolution Analysis tool such as Wavelet, and Ridgelet, and features from co-occurrence based methods are computed for feature extraction and genetic algorithm is applied for feature selection for better classification [9]. Support Vector Machine (SVM) is a learning tool based on modern statistical learning method that classifies binary classes. The SVM is selected for classification because it has good capacity of generalization, it is highly robust and work well with images. In SVM, over training problem is less compared to other neural network classifiers [11].

In this work, the image is preprocessed and the features from the normal and cancer region are extracted by contourlet feature extraction method and then it is classified into normal or cancerous using the SVM network

2 METHODOLOGY

The image is preprocessed and the features are calculated for every 10*10 pixel of the 64*64 slice of tumor by contourlet feature extraction method and classified as normal or

cancerous. The block diagram of the project is shown below in Fig 1.

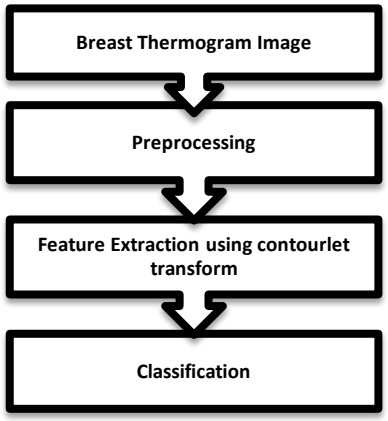

Fig 1: Block Diagram

2.1 FEATURE EXTRACTION METHOD

All Feature extraction is very important part of pattern classification. The GLCM features are obtained by the contourlet transforms. These features are given to the SVM network for classification.

i) Contourlet Transform

Multiscale and time-frequency localization of an image is offered by wavelets. But, wavelets are not effective in representing the images with smooth contours in different directions. Contourlet Transform (CT) addresses this problem by providing two additional properties viz., directionality and anisotropy.Contourlet transform can be divided into two main steps: Laplacian pyramid (LP) decomposing and directional filter banks (DFB).

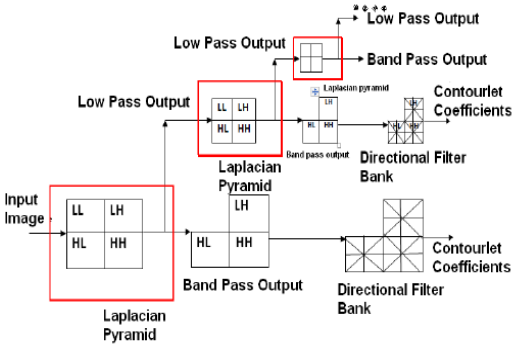

Fig 2: Contourlet Decomposition

A double filter bank structure of the Contourlet is shown in Fig 2 for obtaining sparse expansions for typical images having smooth contours. In the double filter bank structure, Laplacian Pyramid (LP) [12] is used to capture the point discontinuities and then followed by a Directional Filter Bank (DFB), which is used to link these point discontinuities into linear structures. The Contourlet have elongated supports at various scales, directions, and aspect ratios. This allows Contourlet to efficiently approximate a smooth contour at multiple resolutions.

B. Classification

The support vector machine (SVM) based on statistical learning theory, is introduced by Vapnik. Classification and regression techniques based on SVMs have attracted a lot of attention from scientists and researchers. SVM-based techniques have proven to be powerful in classification and regression and provide a higher performance than that of traditional learning machines [11]. The features calculated by contourlet feature extraction method for both normal and cancerous region are found. Depending upon the features, it is classified into normal or cancerous using SVM network.

3 Results and discussion

A. Feature Extraction

The Thermogram image is preprocessed and the features are calculated for every 10*10 pixel of the 64*64 slice of tumor by contourlet feature extraction method. The GLCM features are calculated by using contourlet transform method.

TABLE 1: Tabulation of Contourlet based GLCM Features of Normal and Cancerous Region

PARAMETERS	Normal		Cancer	
	Mean	±Std	Mean	±Std
Autocorrelation	10.22	1.925	14.08	2.069
Contrast	0.544	1.22E-16	0.598	1.16E-16
Correlation	0.038	0.099	-0.027	0.154
Clusterprominence	1065.6	177.9	1111.6	283.54
Cluster Shade	60.98	18.02	49.44	23.13
Dissipation	2.842	0.376	3.524	0.463
Energy	0.229	0.038	0.437	0.014
Entropy	1.293	0.105	1.62	0.069
Homogenity	0.638	0.045	0.756	0.056
Maxprobability	0.485	0.054	0.675	0.034
Variance	20.10	2.686	25.73	1.213
SumAverge	6.261	0.529	9.382	0.260
Sum Variance	48.87	6.141	59.54	4.659
SumEntropy	1.017	0.112	3.074	0.103
Difference Entropy	19.7	2.650	29.59	3.308

The GLCM features like Autocorrelation, Contrast, Correlation, Energy, Entropy, Homogenity, Sum of squares: variance, Sum Average, Sum Variance, Sum Entropy, Difference Entropy are calculated. The GLCM features for both normal and the cancer region are calculated by contourlet transform.

The features are tabulated and it is shown in Table 1.

In the Table 1 shows that some of the features like Autocorrelation, Contrast, Correlation, Dissipation, Homogenity, Entropy, Sum of Squares: Variance, Sum Average, Difference Entropy values has some variation between normal and cancer image.

B. Classification

A total of 30 image samples from normal and cancer images are considered in which the random set of 15 are used as training data set. The remaining is used as testing data set. The features are calculated by the contourlet transform and it is given to SVM for classification. From the Table 2, it is seen that the SVM performance of contourlet features in the indices of accuracy, Sensitivity and specificity. They are calculated using the following formulae.

$$\text{Sensitivity} = \frac{TP}{TP+FN} \quad (1)$$

$$\text{Specificity} = \frac{TN}{TN+FP} \quad (2)$$

$$\text{Accuracy} = \frac{TP + TN}{TP+TN+FP+FN} \quad (3)$$

Where, TP (True Positive) - Malignant area detected by classifier as malignant
FP (False Positive) - Malignant area detected by classifier as benign
FN (False Negative) - Benign area detected by classifier as malignant
TN (True Negative) -Benign area detected by classifier as Benign

All three objective indices of the proposed SVM with contourlet based GLCM feature extraction method show much higher accuracy.
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TABLE 2 Performance of the Classifier

Parameters	Accuracy	Sensitivity	Specificity
SVM with Contourlet Features	85%	85%	85%

Thus, it is clear that the proposed approach can classify normal and cancer image with respect to the three objective indices more accurately.

4 Conclusion

In this paper, we proposed a Contourlet based GLCM Feature extraction method which can produce a high accuracy rate of classification. The GLCM based contourlet feature extraction method gives better classification. In future, if the more number of features are calculated and then the performance of the classifier may be improved for better diagnosis.

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