An Accurate Method of Breast Cancer Detection from Ultra Sound images Using Probabilistic Fuzzy Clustering Algorithm

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***Abstract*—Breast cancer is the 2nd leading cancer diagnosed among world. The available methods like Mammogram, MRI ,CT, micro wave imaging and so on can detect both cysts and tumors in breast but possesses certain demerits. Ultra Sound is considered as an efficient way of breast cancer detection. This paper forward a method to classify benign and malignant tumor based on its boundary. Adaptive histogram equalization is used to enhance contrast. Hybrid filter is used to eliminate speckle noise. Probabilistic fuzzy clustering algorithm is employed to segment the ultra sound images. Morphological operations are done to extract specific regions. Comparison of hybrid filtered and homomorphic filtered images are done to find out the best speckle noise reduction filter.**

***Index Terms*— Ultra Sound, Benign, Malignant , Adaptive histogram equalization, speckle noise , Hybrid filter, Probabilistic fuzzy clustering algorithm, Morphological operation, homomorphic filter**

I. INTRODUCTION

Cancer is simply an abnormal growth of cells. The body cells divide in a continuous manner and invade to surrounding tissues. It is named after the part from which it is originated. Cancer is generally classified as benign and malignant masses. The benign ones are simple cysts which do not advance to the nearby tissues. It implies that they are not cancerous in nature. Whereas malignant masses spread to other parts of the body and grow in other organs and bones. Breast cancer which starts as a breast lump is the leading cancer diagnosed among women. In the western countries the surveys shows that one out of 11 women is suffering from breast cancer at some stages in their life. Most of the times breast cancer do not show any symptoms in the initial stages. In later stages it can be change in the breast shape, dimpling of the skin, fluid coming from the nipple, or a red scaly patch of skin. The early detection and timely medical treatment are the only factors responsible for the long term survival of breast cancer patients.

X ray mammography is considered as the golden standard tool for breast cancer detection. But it is possessed with high false negative and positive rate. It is not applicable in the case of women with dense breast tissue [2]. Statistical model of texture consider mammographic appearance as a spatially variable structure. It is not widely used since the synthesis speed is very low in this method [3] .MRI is an efficient method for certain high risk cases. But the lesion sensitivity and specificity determines the overall accuracy of this method[4]. Microwave imaging is accompanied by a significant amount of backscatter which falsifies the image [5]. Electrical impedance tomography is associated with high cost [7].

Ultra Sound are generally said to be complex because of data decomposition, it can be described in terms of speckle information. Ultra sound imaging method utilizes high frequency sound waves to explore inner parts of the body. It is a non destructive and noninvasive technology. Which means it does not alter the target being tested and do not cause any pain or discomfort. Ultra sound waves are emitted from a transmitter to the object which will reflect back if there is an impurity or a crack. The resultant echoes are analyzed to extract different parameters. High detection resolution, low cost and high flexibility are the other advantages of ultra sound imaging.

Ultrasound imaging (UT) has proved effective for soft-tissue characterization. It uses Computer Aided Design for classification. Lesion segmentation plays a crucial role in the CAD system since the computation of features related to lesion shape is largely dependent on the accuracy of segmentations [9]. Radial Gradient Index (RGI) filtering technique is used to detect lesions on breast ultrasound images automatically. In this method images are sub-sampled by a factor of 4. The overlap between lesions reduces the accuracy of this method. Watershed segmentation can be used for initial lesion detection. But the Region of Interest obtained through this method is not correct which falsifies the further processes [11]. Edge detection is employed to define Region of Interest in a particular method. But the efficiency of this method is much depended on the type of edge detection algorithm used [12]. Automated breast Ultrasound using adaptive threshold is used for multi-dimensional tumor detection. The overall efficiency of this method relies upon the threshold selected [13].Feed forward back propagation neural network is another method used to classify benign and malignant breast tumor. Here Levenberg-Marquardt (LM) is used as the training algorithm. The accuracy of this technique is defined as the

ratio of the number of samples correctly classified to the total number of samples tested [14].

This paper forward a technique to detect breast cancer from ultrasound images using FCM clustering. Fuzzy clustering allows one piece of data to belong to two or more clusters. By morphological processing of image the unwanted regions of the images can be excluded. MATLAB is the environment used for image processing.

II PROPOSED METHOD

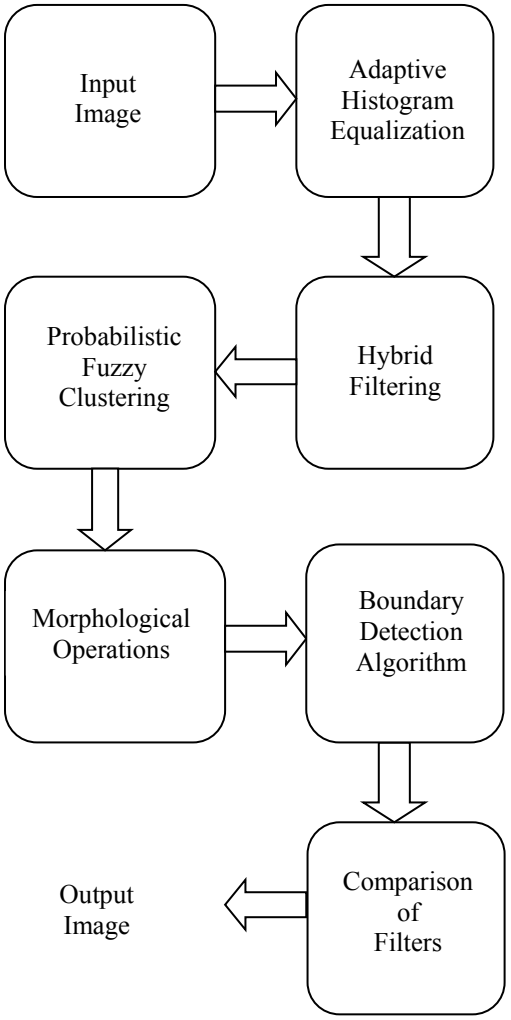

Fig 1. Block diagram of the experimental setup

A. *Input image*

Ultra sound images provides the internal structure of the body to detect diseases or abnormalities in tissues. The images can be distinguished as skin seems to be smooth and bright that is it can be echogenic, hyper echoic or highly reflective. Effusion or cyst is generally appeared as black (anechoic), though thicker fluids such as puss can be seen as bright or dark. Fat are generally bright or dark that is hypo echoic, but subcutaneous fat is typically dark.

B. *Adaptive Histogram Equalization*

It is an image processing method used to improve the contrast in the image. Ordinary histogram equalization increases the dynamic range of the input. The adaptive method computes several histograms, each corresponding to a distinct part of the image, and uses them to redistribute the lightness values of the image. Thus it is employed to enhance the definition of edges in each regions of an image and also to improve the local contrast. This equalization technique is used for the images which contains regions which is darker than or lighter than most of the image. Adaptive histogram equalization transform each pixel with a transformation function derived from a neighborhood region.

C. *Hybrid Filtering*

Ultra sound image consist of a vast amount of speckle noise. It is originated due to the interference of the returning wave at the transducer. Speckle noise in US images impinges edges and fine details which in turn limit the contrast resolution and make diagnostic more difficult. It can be modeled as

$$I_{i,j} = R_{i,j} * U_{i,j} + \propto_{i,j} \qquad (1)$$

where $I_{i,j}$ is the noisy image and $R_{i,j}$ denotes the intensity of the image without speckle, u (t) and α(t) are the multiplicative and additive components of the speckle noise respectively.

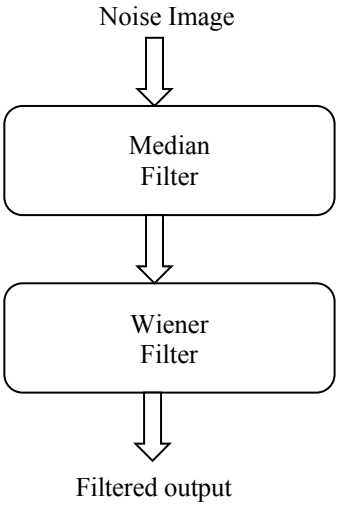

Fig 2.Hybrid filter

Hybrid filter which is a combination of median filter and wiener filter is used to remove mixed type of noises from the image. It efficiently removes Gaussian and impulse noise from digital images while preserving thin lines and edges in the original image.

D. *Probabilistic Fuzzy Clustering*

Clustering algorithms are used to divide an image into different clusters and similar objects are placed in the same cluster. Clusters are identified by similarity measures. Such as distance, connectivity, and intensity.Fuzzy clustering is used when boundary between clusters is ill defined, which yields same data object belongs to more than one class. Classical c-means clustering allow degrees of membership of a datum to different clusters. It uses only cluster centers for the cluster prototypes and relies on the Euclidean distance. This algorithm selects a number of clusters. Then it assign randomly to each point coefficients for being in the clusters. The algorithm is repeated until the algorithm has converged (that is, the coefficients change between two iterations is no more than the given sensitivity threshold).

E. *Morphological Operations*

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. It uses a set of operators that transform images according to the characterizations like size, shape, convexity, connectivity and so on. The basic morphological operators are dilation, erosion, opening and closing. Here erosion is used to extract the tumor or cyst regions.

F. *Boundary Detection Algorithm*

The boundary separates different regions in an image. The benign and malignant tumors can be distinguished by analyzing the boundaries. The former one has well defined boundaries whereas the latter has poorly defined boundaries.

G. *Comparison of different filters*

A number of filters are available to remove speckle noise from ultra sound images. Homomorphic filtering is a method which increases the contrast together with normalizing the brightness. It takes use of logarithmic transformation which converts multiplicative noise to additive noise. Then high boost butter worth filter is employed to reject the resulting additive noise.

PSNR(Peak Signal to Noise Ratio) and MSE(Mean Square Error) of both hybrid filtered and homomorphic filtered image are calculated to identify the best speckling reduction filter.

III. EXPERIMENTAL RESULTS

55 benign and 75 malignant tumor images are collected and analyzed. The processed images are obtained as follows.

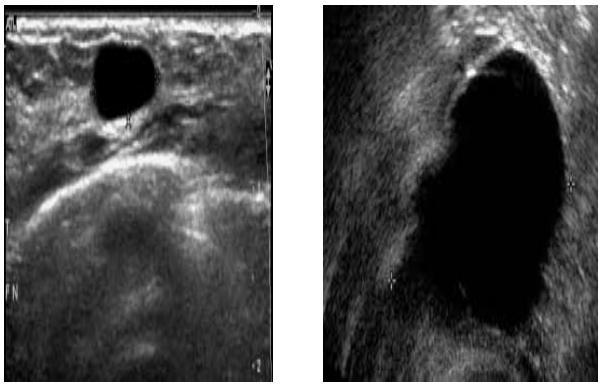

Fig 3. ultra sound images of a benign tumor(a) malignant tumor(b)

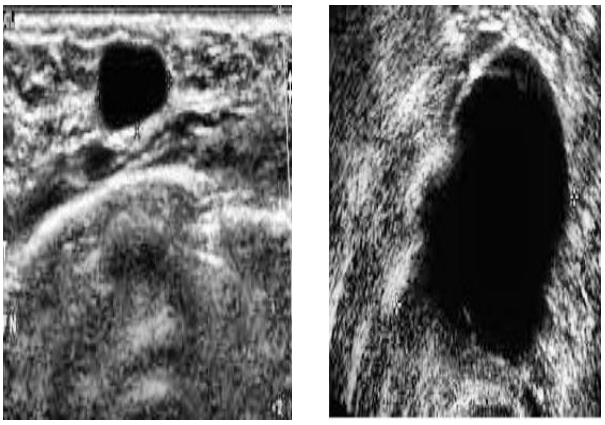

Fig 4. Adaptive Histogram Equalized image of a benign tumor(a) malignant tumor(b)

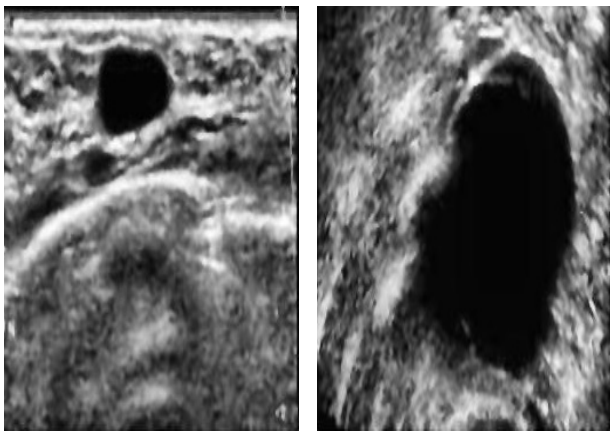

Fig 5. Hybrid filtered image of a benign tumor(a) malignant tumor(b)

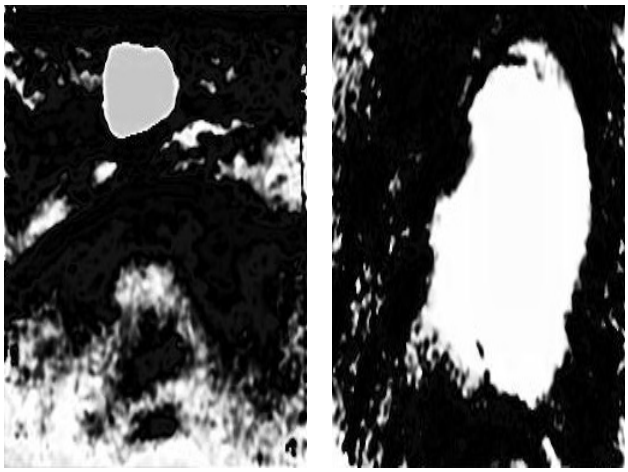

Fig 6. Fuzzy clustered images of a benign tumor(a) malignant tumor(b)

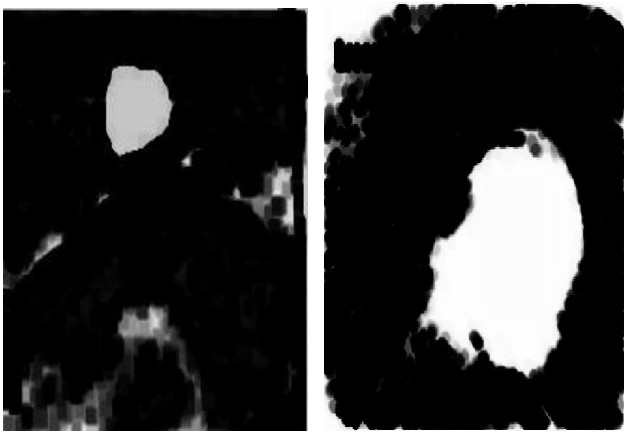

Fig 7. Eroded image of a benign tumor(a) malignant tumor(b)

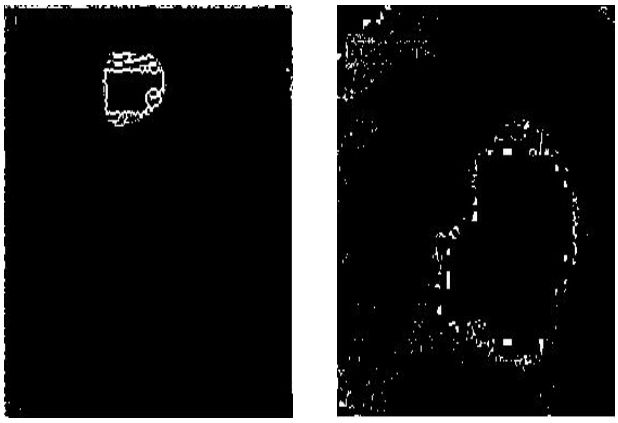

Fig 8. Boundary extracted image of benign tumor(a) malignant tumor(b)

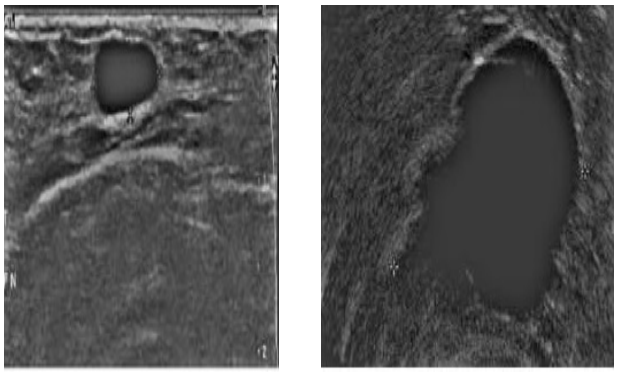

Fig 9. Homomorphic filtered image of benign tumor(a) malignant tumor(b)

The speckle noise present in the ultrasound is effectively reduced by hybrid filter. Probabilistic fuzzy diffusion reduces the error rate to .092 for benign mass and .000034 to malignant one. From the boundary extracted images it is clear that benign masses has well defined boundary and that of malignant mass is not properly defined. By comparing the hybrid filtered and homomorphic filtered image the results obtained are as follows.

TABLE 1. MSE AND PSNR COMPARISON OF MALIGNANT TUMOR

Filter	MSE	PSNR(db)
Hybrid	41.10	32.0267
Homomorphic	51.64	31.035

TABLE 2. MSE AND PSNR COMPARISON OF BENIGN TUMOR

Filter	MSE	PSNR(db)
Hybrid	3.21	43.0943
Homomorphic	74.06	29.4687

The results reveal that Hybrid filter is most appropriate to remove speckle noise than homomorphic filter.

IV. CONCLUSION

Ultra sound imaging methodology has significant advantages over other methods in terms of cost, size, safety and detection resolution. Hybrid filter is proved as an effective method to filter out speckle noises. Probabilistic fuzzy clustering method reduces the error effectively. Morphological operation effectively extract the tumor affected regions. With the help of boundary detection algorithm benign and malignant masses are distinguished. This paper can be further extended to finding out the area of the tumor as well as the distance.

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