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A Review on Breast Cancer Detection Using Ultrasound Images

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ABSTRACT

In order to diagnose the breast cancer radiologists prefer to use mammogram and breast ultrasound imaging techniques. To identify cancer, the Region of Interest (ROI) is mapped in the tumor location. The segmentation process becomes difficult if the image is noisy, blurred and of low contrast. Pre-processing is the first step done to enhance the contrast and to remove the unwanted information from the image. Various segmentation techniques have been proposed in the literature to identify the Region of Interest (ROI) and to analyze the size and the shape of the tumor. This paper provides a detailed review of these techniques, particularly for ultrasound images.

Keywords : Breast Cancer, Classification, Segmentation, Region Of Interest

I. INTRODUCTION

Breast cancer is a disease in which abnormal cells form in the tissues of the breast. According to a survey in 2019, an estimated of invasive breast cancer was 268,600 new cases and non-invasive was62,930 new cases in U.S. Although rare, men get breast cancer too. The lifetime risk for U.S. men is about 1 in 1,000[22]. According to the cancer society, 14.5% population in India are affected with breast cancer.
Radiologists use different imaging modalities such as Computed Tomography (CT),Ultrasound, Mammogram (low energy X ray of breast) and Magnetic Resonance Imaging (MRI) for screening and early diagnosis. Out of all these modalities Ultrasound and Mammographic techniques are used to detect breast cancer.The advantage of ultrasound over the breast mammogram is that the sensitivity of the ultrasound is high in the case of young women whose breast density is high. Mammogram uses a low level radiation and in ultrasound, no radiations are used as it employs sound wave propagation. An ultrasound is useful to obtain additional characteristics of the area of concern in order to determine if the lump/change are benign or cancer.

In this paper different types of segmentation and classification techniques for early diagnosis of breast cancer are reviewed.

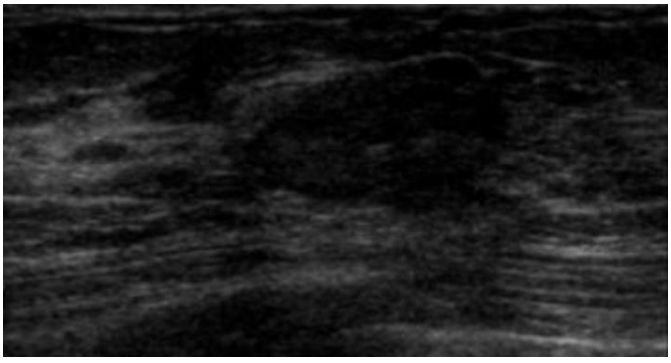

Fig 1: a) Breast Ultrasound Image

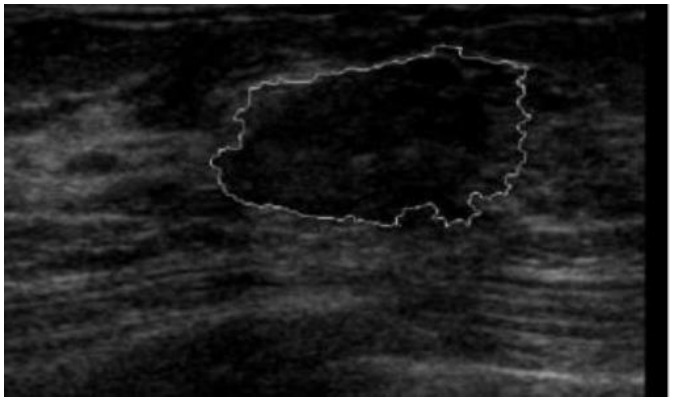

Fig.1: b) ROI of tumor [21]

II. LITERATURE SURVEY

Zhincheng et al., [1] proposed a method in which a Convolutional Neural Network (CNN) serves as a feature extractor and Support Vector Machine (SVM) as a classifier, and the accuracy was found to be 97% using Digital Database for Screening Mammography (DDSM) dataset.

Yousif et al., [2] proposed a system for image enhancement was done using Adaptive Mean Filter (AMF), Balance Contrast Enhancement Technique (BCET)and segmentation using Fuzzy C Means clustering. The Feature extraction was done using Discrete Wavelet Transform (DWT) and the area of the tumor was calculated. The classification was done using Probability Neural Network (PNN), and the accuracy of the system was 90%

Mahendra et al., [3] used a Radial Based Function Neural Network [RBFN] as an image analysis tool to classify the image as "benign" or "malignant". The automatic analyses of the stained breast cancer histopathological images are done. All the parameters which are extracted are converted to computational representation from the image. The correlation based feature subset selection algorithm was used to uncorrelate the parametric values. This uncorrelated parameter was used to stimulate RBFN to classify the input features.

ParvinYousekamal [4] used level set algorithms on Fuzzy C Means clustering and classification was done using CNN. Block Matching and 3D filtering (BM3D) algorithm was employed to reduce the noise during the second stage. An accuracy of 90% was achieved using Naïve Baves classifier which is better when compared to other classifiers.

Karthikeyan et al., [5] the Watanabe's Ugly Duckling algorithm was proposed for the feature selection. An accuracy of about 90-94% was achieved as a result of the use of combined classifier's – SVM, Linear Discriminant Analysis (LDA), Eigen faces approach, Decision trees and Markov random model.

John Arevalo et al., [6] extracted the ROI by using Local Contrast Normalization (LCN) and the supervised learning algorithm was carried out by CNN. The classification was done using the Support Vector Machine (SVM)

LotheSavitha [7] used a Computer Aided Diagnosis (CAD) in the pre-processing step, the noise was removed using the median filtering, the contrast was enhanced using Adaptive Histogram Equalization Enhancement with Discrete Fourier Transform (DFT) and region growing method was done for the segmentation of the mass. The SVM showed a sensitivity of 92.3%, specificity of 62.5% and accuracy of 86.84%. The disadvantage observed was that it was a time consuming error work.

Varsha J. Gaikwad [8] used SVM classifier for classification of the breast lesion and the Watershed transform was applied, light pixels were marked as high (1) and dark pixels as low (0). The system provided with an accuracy of 83%.

Vishrutha et al., [9] in the first step the region of interest was found, followed by wavelet and feature

extraction of ROI. The classification of the extracted feature was done by SVM classifier. The method was evaluated using Mini Mammographic Image Analysis Society (Mini – MIAS) dataset. An Accuracy of about 92% was achieved.

Abdul Kadir Jumaata et al., [10] used active contour to identify the boundaries and they adopted mathematical concepts for energy minimization. Balloon Snake algorithm is used as a segmentation tool for the ultrasound breast images. The accuracy of the Balloon Snake algorithm was calculated by comparing the masses between the radiologist's observation and the Balloon Snake model and it was found to be 95.53%.

J.Arevalo et al., [11] used a combined method of Unsupervised Feature Learning (UFL) and BOF (Bag of Feature) representation as an image classification technique. Scale Invariant Feature Transform (SIFT) and Discrete Cosine Transform (DCT) were used as descriptors to represent BOF as patches. UFL was trained to represent the patches, by topographic UFL method. An accuracy of 93% was achieved.

Geoff Curie et al., [12] explained about the basicconcepts of Convolutional Neural Network (CNN), Artificial Neural Network (ANN), and application oriented explanation was provided. The emergence of these neural networks has the potential to enhance the ecosystem and biodiversity. It was concluded that implementation of AI must follow ethics and patient centered approach.

M Shen et al., [13] employed lesion segmentation in ultrasound images using SVM with Radial Basis Function(RBF) kernels. Media Access Control (MAC) model was employed for bidirectional force. The disadvantage of this model was that it has the interference of speckle noise. This model caused leakage when dealing with the weak edges because the pressure force may push the snake curves out of the boundary.

Valraprakash Gurursamy et al., [14] the methods employed are edge detection, thresholding and segmentation. Segmentation was done by three methods namely i) region based (single seeded region growing)ii) adaptive thresholding iii) feature based clustering (k-means clustering). On observation, edge detection yields better result. Thresholding technique is suitable for images that have few specific features. Clustering is used to segment the color portions of the image, typically known as the grouping. Thus after analyzing the results, thresholding yields a better result compared to edge detection and clustering.

Anuj Kumar Singh et al., [15] used simple image processing techniques like thresholding and averaging,Max-Mean and Least Variance technique for tumor detection. The computational speed was fast and simple. The disadvantage of this method was that the threshold parameter and the size of the averaging filter has to be manually selected.

A.D.Belsare et al., [16] the features such as GLCM (Gray Level Co-occurrence Matrix), GRLM (Graph Run Length Matrix) and Euler number were extracted. The methodology employed here was that the breast histology images were extracted and the epithelial lining surrounding the breast lumen were studied. LDA (Linear Discriminant Analysis), spatio-color-texture graph segmentation was used for the classification of the histopathological images. The classification was done using LDA and the effectiveness was evaluated and compared using kNN (k- Nearest Neighbors) and SVM (Support Vector Machine). This comparative study revealed that, LDA performs better.

Swetha et al., [17] employed the use of combination of Hybrid image segmentation and Otsu's thresholding technique for identifying the size of tumor. The results obtained were comparatively more accurate than from the segmentation method used individually. It has reduced the cost of computing.

Suying Lee et al., [18] employed a graph based segmentation method for detecting the breast tumor in ultrasound images. The automatic detection of tumor and the segmentation of lesions were based on the minimum spanning trees in a graph which has been generated from the image. The proposed method was much more robust to noise and the accuracy has also increased.

Minavathi et al., [20] used Gaussian smoothing, anisotropic diffusion filters for pre-processing to remove the multiplicative noise. Spiculations which constitute the breast mass have irregular boundaries so in order to detect the boundary, receiver operating characteristic curve was used. A sensitivity of 92.7% and 0.88 area under curve. The measure of curvature at each angle was measured.

Peyman Rahmati et al., [23] The Computer Aided Diagnosis (CAD) was presented to segment suspicious lesions based on novel Maximum Likelihood Active Contour Model using Level Sets (MLACMLS). The algorithm separates the lesion from the background by using gamma distribution. The Adaptive Level Set-based Segmentation Method (ALSSM) and the Spiculation segmentation using level sets (SSLS) approach showed higher segmentation accuracy. The results were compared with Active Contour Without Edge (ACWOE) and it showed a better performance.

III. CONCLUSION AND FUTURE SCOPE

In this paper, different techniques for diagnosis of breast cancer were studied. Various imaging techniques have been analyzed and the result proves that ultrasound images are useful in the diagnostic procedure. In future an intelligent system can be developed by using SVM and Neural Network along with AI which would provide a better insight about the size, location and the nature of the tumor.

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