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A Survey of Image Processing Algorithms for Detecting Microcalcification in Mammogram Images

Savita A. Lothe*
Dept. of Comp. Science V.N.M.,
Jalna Road Aurangabad
Savi_lo@rediffmail.com*

Shobha k. Bawiskar
Dept. of Comp. Science V.N.M.,
Jalna Road Aurangabad
shobha_bawiskar@yahoo.co.in

Rupali P. Moharkar
Dept. of Comp. Science Dr. Sow I.B.P. Mahila College,
Aurangabad
moharkarrupali@rediffmail.com

Dr. Prapti D. Deshmukh
MGM, Dr. G.Y. Pathrikar
College of CS & IT, Aurangabd, MS, India
praptiv@rediffmail.com

Abstract: Breast cancer is one of the leading causes of death in women. The breast cancer can be detected through imaging exams as mammography, ultrasonography, magnetic resonance imaging, where mammography is the most common exam. Mammograms (either an analog x-ray film or a digital softcopy) are computationally empowered to extract significant information. It is used to detect and evaluate breast changes. Several computational techniques/algorithms process mammograms to highlight and reveal otherwise unseen features. Thus mammographic images are computationally unfolded to obtain appropriate information that can be used for further analysis. To help radiologists provide an accurate diagnosis, a computer-aided detection (CADe) and computer-aided diagnosis (CADx) algorithms are being developed. This paper gives a survey of image processing algorithms that have been developed for detection different lesions such as calcifications.

Keywords: Digital Mammography; CAD; microcalcification; wavelet; neural network; support vector machine**.**

I. INTRODUCTION

In the era computer and telecommunications, pathologist's still mount tissue slices on glass slides, treat them with appropriate stains and examine them through a microscope. Despite advances in staining techniques, it's a process that has changed little over the last twenty years. Interpreting what they see is a time-consuming process and requires a great deal of skill and experience. Imaging techniques can play an important role in helping perform breast biopsies, especially of abnormal areas that cannot be felt but can be seen on a conventional mammogram or with ultrasound.

The National Cancer Institute estimates that approximately 2.6 million US women with a history of breast cancer were alive in January 2008, more than half of whom were diagnosed less than 10 years earlier.3 Most of these individuals were cancer-free, while others still had evidence of cancer and may have been undergoing treatment [1].

Digital mammography is a technique for recording x-ray images in computer code instead of on x-ray film, as with conventional mammography. The images are displayed on a computer monitor and can be enhanced (lightened or darkened) before they are printed on film. Images can also be manipulated; the radiologist can magnify or zoom in on an area. From the patient's perspective, the procedure for a mammogram with a digital system is the same as for conventional mammography [2].

Digital mammography may have some advantages over conventional mammography. The images can be stored and retrieved electronically, which makes long-distance consultations with other mammography specialists easier. Because the radiologist can adjust the images, subtle differences between tissues may be noted [3].

Computer-aided diagnosis of breast cancer is potentially useful for reducing the number of lesions missed by radiologists at a reasonable cost.

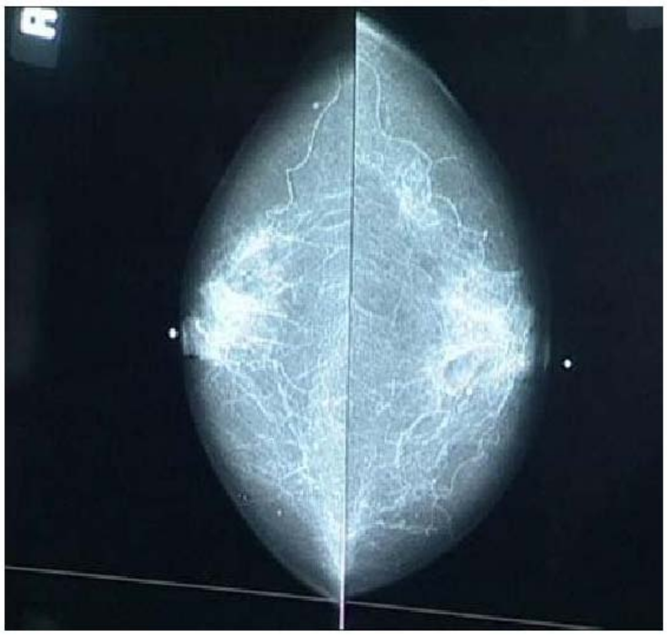

Figure1. Computer-aided detection (CAD) mammogram

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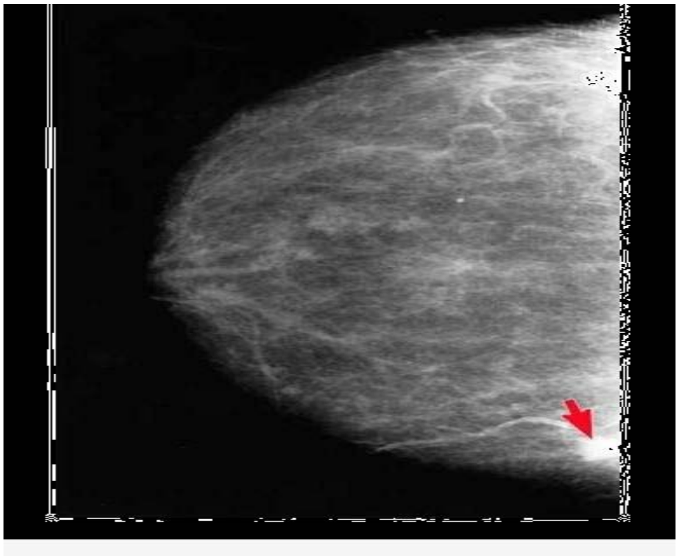

Figure 2. Whitest area indicating a Tumor (breast cancer).

II. SIGNS OF CANCER IN A MAMMOGRAM

a. ***Tumor:*** The attenuation of a tumor may vary depending on the type of tumor.
b. ***Asymmetry*:** Any asymmetry or irregularity between the parenchyma of the two breasts should cause suspicion, since it may be a sign of cancer.
c. ***Microcalcifications*:** Microcalcifications are microscopic grains of calcium produced by the cells as a result of some benign or malignant process. The calcifications have much higher attenuation compared to the surrounding tissues and absorb more radiation. Therefore the calcifications are visible as bright spots in a mammogram.
d. ***Skin Thickening*:** The radiologist compares the images of the left and the right breasts. Normally the two breasts of the same woman are like mirror-images of each other. If the radiologist discovers anything suspicious, more examination is performed [4].

This paper mainly focuses the image processing technique to find about Microcalcification in mammogram images.

The main characteristics to determine the level of MCs abnormality are :

a) ***Size:*** Larger than 2mm are classified as macrocalcifications and are usually benign. Microcalcifications are under 2mm length and are suspicious of malignant when they are small and grouped.
b) ***Morphology:*** Malignant calcifications usually are heterogeneous in form and size, namely, pointed, angular, and irregular, in "comma", graft and with form of point and ray. The benign ones usually are homogenous, round, and sometimes annular and with clear centre.
c) ***Quantity:*** A suspect of malignity is considered when there are five or more calcifications less to 1mm into an area of 1cm.
d) ***Distribution:*** Segmental distribution of calcifications, not random distribution, is indicative of biopsy.
e) ***Calcification time variance:*** Stable calcifications into a period of 1.5 to 2 years are benign whereas malignant calcifications vary in time.
f) ***Calcifications associated with breast tissue:*** These are the first sign of breast cancer in young women [5].

III. LITERATURE REVIEW

A. *Using Support Vector Machine:*

Sharkas et al have proposed method in CAD, which uses the discrete wavelet transforms (DWT), the contourlet transform, and the principal component analysis (PCA) for feature extraction; while the support vector machine (SVM) is used for classification. The best classification rate was achieved using the DWT features. The system classifies normal and tumor tissues in addition to benign and malignant tumors. The classification rate was 100%. The goal of this work is to detect the MCs in the breast and to classify the tissues by SVM technique. This CAD system can be applied for the detection of other abnormalities in the breast such as masses and architectural distortion [6].

Saejoon & Donghyuk et al used SVM-RFE and R-SVM for the first time as the classification technique in CAD to test their efficacy in digital mammography. Both SVM-RFE and R-SVM incorporate feature selections in a recursive elimination fashion to SVMs to obtain a "ranking" of the features that are particularly meaningful to SVMs. From this ranking of the features which may be different for SVM-RFE and R-SVM, only a certain number of top ranked features can be chosen for use in classification. Thus, SVM-RFE and R-SVM are performance enhanced versions of SVM and includes SVM as a special case [7].

B. *Dual-tree complex wavelet transform (DTCWT):*

Alarcon et al described a method to detect MCs in digital mammograms using the DTCWT to obtain a mammogram sub band decomposition, mammogram denoising by applying an optimal threshold at each decomposition level, suppression of mammogram low frequencies, application of morphological operators to enhanced MCs visualization. And it compares this techniques with SWT. Furthermore, tissue and breast glands are presented in the reconstructed mammogram. It is also observed that the results have variation that depends on breast tissue type. The best results to detect MCs are achieved with the proposed approach in Fatty tissue (F) mammograms, according to the MIAS database. On the other hand, with Glandular (G) and Dense-Glandular (D) tissues, due to the tissue nature the detection becomes difficult. Furthermore, to detect another kind of lesion, these could be classified into benign or malignant depending on shape and size characteristics [5].

C. *Combination of Wavelet and Neural Network:*

Gholamali et al has presents an approach for detecting microcalcification in digital mammograms employing combination of artificial neural networks (ANN) and wavelet-based subband image decomposition. The microcalcifications correspond to high-frequency components of the image

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spectrum, detection of microcalcifications is achieved by decomposing the mammograms into different frequency subbands, suppressing the low-frequency subband, and finally, reconstructing the mammogram from the subbands containing only high frequencies. These results use as an input of neural network for classification. The neural network contains one input, two hidden and one output layers. Layers have 30, 45, 20, and 1 neurons respectively. The proposed methodology is tested using the Nijmegen and the Mammographic Image Analysis Society (MIAS) Mammographic databases. Results are presented as the receiver operating characteristic (ROC) performance and are quantified by the area under the ROC curve [8].

D. Using Fractal model:

Deepa and Tessamma et al presented deterministic fractal model based on the mean and variance of the image blocks for detecting the presence of microcalcifications in mammograms are presented. Only those image blocks whose variance difference is between 0.01 and 1 are classified according to their mean value and used in the matching block searching process and therefore the time taken to model the mammograms was considerably reduced to about one third the time required to encode in the conventional fractal encoding scheme. The modeled image will be visually close to the original image and if the difference between the original and the modeled image is taken the presence of microcalcifications can be detected [9].

E. Using Neural Network:

Dheeba & Wiselin et al presents a new classification approach for detection of microcalcification clusters in digital mammograms. The proposed microcalcification detection method is done in two stages. In the first stage, features are extracted to discriminate between textures representing clusters of microcalcifications and texture representing normal tissue. The original mammogram image is decomposed using wavelet decomposition and gabor features are extracted from the original image Region of Interest (ROI). With these features individual microcalcification clusters is detected. In the second stage, the ability of these features in detecting microcalcification is done using Backpropagation Neural Network (BPNN) [10].

IV. CONCLUSION

This paper is all about Digital mammography with signs of cancer in mammogram image such as Microcalcification, Bi-lateral symmetry, Architectural distortion, and Masses. Here the main focus is on detection of subtle signs only using CAD techniques for detection of microcalcification is discussed. A number of CAD algorithms have been developed. CAD offers a suitable alternative in reducing errors in mammographic screening to a level comparable to that achieved with double reading. Here we reviewed the various techniques in CAD to enhanced the mammogram images.

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