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Low Cost Mammography Image Enhancement and Analysis Mechanisms

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***Abstract* — In this paper we have focused a on reasonable mammography analysis to cater people at large based on wavelet image processing, Neural Network and Edge detection methods with a minimum computing requirements. The paper analyses the mammogram images and delivers a report on the image details for an early detection of the cancerous development in human. The idea is to provide lower cost of the patient treatment with simple algorithms. In the existing scenario, there is a consistent increase in the cost of treatment to the patients owing to the requirement of the complicated computing hardware and Computer Aided Design Tools. The methods presented in this paper are simple and with achievable results and claims to be faster for early detection of breast cancer. Hence, the proposed algorithms have low cost approach and would benefit to the human society. In this paper we have focused on three vital methods of detection and extraction from mammographic images and the output images are given for further analysis for detection and possible diagnosis.**

***Keywords* — Mammogram, Micro Calcification, Wavelet, Neural Network, Cancer.**

I. INTRODUCTION

Breast cancer has been on the rise across the world rapidly and has become menace for the female population pushing the cervical cancer to the subsequent position as shown in figure 1. Death toll in India is increasing due to the breast cancer at a rapid pace. This motivates the investigators to focus on early detection and diagnosis of the dreaded ailment. The major challenge in India is to control the breast cancer mainly in case of poor women. It is felt that there is a huge need for breast cancer cases to be detected at a very early stage to proceed for proper advice and therapy. This is attributed to the lethargy of the Indian women towards the health care and usual check-up. The expensive health care system in Asian countries, especially in breast cancer treatment, puts enormous financial load on the poor women. A much simplified technology measures to be provided to the medical professionals to cater to the rural areas to help the marginalized women. Even in this era the classical and traditional methods are being used to detect the cancer and are not being fully able to meet the actual requirements. This area has become an interdisciplinary for research, the mammograms and their analysis by the way of image processing, encompass many disciplines such as diagnosis, statistics, mathematics, computer and medical professionals. Plenty of pioneering work has been done so far in this area by applying the computer-aided detection of the breast cancer. Subsequently the techniques were improvised by the usage of methods like heuristics, fuzzy logic, neural networks etc. The research work seems to be falsified on several directions such as conceiving improved algorithms, development of novel analytical framework, development of hardware based on programmable logic design and application of new tools such Simulink etc . Despite great deal of research work in this area, there are still challenges ahead due to inherent restrictions of the tools in detecting the calcification patterns heterogeneous in several dimensions. The size, shape and limited contrast from surrounding normal tissue, micro calcifications can occasionally be hard to detect in computer-aided detection systems. The conventional imaging systems are slow compared to image mammography mechanisms.

The speed and unit cost compel the medical professionals to go for simple yet faster computing system for diagnosis. At present, mammography test is performed by specialized doctor and is the most effective method for early detection of breast cancer [2]. The main objective of mammography test is the early detection of breast cancer through the detection of characteristic masses and micro calcifications, which is considered as an important indication of breast cancer. Mammography is used as a breast assessment where the patient is undressed and exposed to the X-ray machine. Then each breast is compressed between two plates to take two images of each breast by using a brief X-ray pulse. Clinical Breast Exam (CBE), Computer Aided Detection (CAD), and the blood test are the other tests to detect breast cancer.

In the process of micro calcification detection, wavelet based methods are being frequently used. Proposed methods work more or less in the similar way and give acceptable results. Micro calcifications are very tiny objects and to detect them it is necessary to pull out high frequency components. Also there have been proposed some other methods for micro calcification detection but their number are significantly smaller. Those other methods presented in this paper are similarly aimed for noise estimation and some use combination of two or more approaches. Automatic classification is another issue that needs to be resolved. Figure 1a. and 1b. showcases cancerous images for one side (1a) of breast detailing the presence of lymph and figure 1b clearly highlights the disparity among both the breast witnessing cancerous formation.

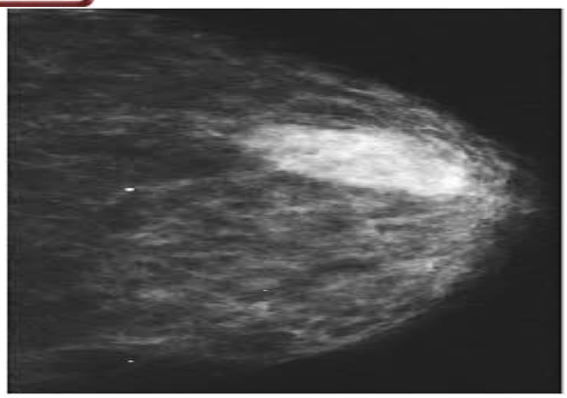

Fig.1a: A generic mammographic image one side

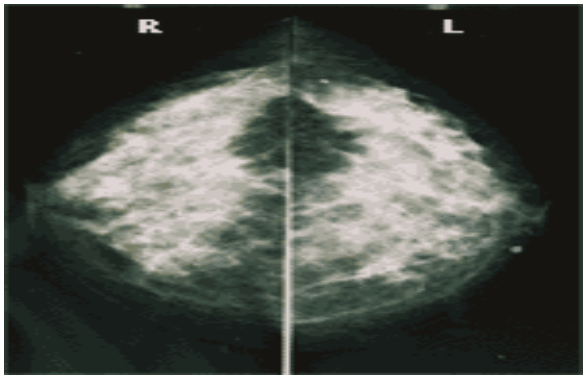

Fig.1b. A generic mammographic image with both left and right side breasts.

There have been some dissimilar approaches using different classifiers. This paper presents a simple for Mammographic Image Processing using algorithms through the tools such as Matlab and Simulink, which requires less sophisticated computing hardware [6]. Most mammogram images are large size and high-resolution images that require specialized computing facilities to enables competent processing [10]. To assist the transmission of these images over computer networks image compression techniques are usually applied. In this paper, we present algorithms that can be implemented on most mammogram images as a pre-processing step to decrease their size without distressing their quality [4]. We have examined 40 sample mammographic images to analyze and subjecting them to the three algorithmic approaches detailed in this paper.

II. Review of Literature

The use of image processing is a physical process used to alter an image signal of the breast into a physical image. As it is known, this image signal is a digital signal or analog signal, and the real output can be either an actual physical image or the characteristics of this image. In diverse spectrum of human activities, there are a large number of applications of image processing, from remotely sensed scene interpretation to biomedical image interpretation [7].

As presented in 2010 the review a classification system for the analysis of mammographic tumor by using machine learning techniques. It provides only the first stage of mammogram mass segmentation outcome [12]. A study reveals 2010 a model that effectively classifies breast cancer tumors as either malignant or benign, named as a benign/evil breast cancer classification model based on a combination of ontology and case-based reasoning [11]. The classification system makes use of clinical data i.e. based on case based reasoning (CBR) object-oriented frameworks based on ontology are COLIBRI and myCBR. They build a breast cancer diagnostic prototype [1]. These make an examination during prototyping to examine the use and functionality of the two focused frameworks.

Inspite of great deal of research work in this area 2006 there are still challenges lying ahead due to inherited from the limitations of the CAD tools in detecting the calcification patterns heterogeneous in several dimensions [2]. As reported in a study (2002) focusing on size, shape and limited contrast from surrounding normal tissue, micro calcifications can irregularly be hard to identify in CAD systems[11] . These CAD systems can also be sluggish compared to a radiologist's performance when reviewing film-screen mammography. In general program size of the CAD tools compel the medical professionals to go for sophisticated computing system and thus tend to increase in the unit cost of the treatment.

A new method for medical image enhancement which is based on the idea of fractal derivatives and selecting image processing techniques such as segmentation of an image with self alike properties [8]. Different alternatives were tested in the algorithm. It is found that the outcomes of the experiments were significantly different from each other. That was helpful for the segmentation of a mammogram image and it may be used for developing an expert system to detect the breast cancer at a premature stage [1]. Mammographic images to make the dealing with these images by retrieving or analyzing intelligently and efficiently [9]. They designed the architecture for the CAD/CADx system and then focused chiefly on the design and modeling of the mammography database. Abnormal areas that cannot be felt but can be evident on a conventional mammogram. Before any image-processing algorithm of mammogram pre-processing steps are very significant in order to limit the search for abnormalities without undue influence from background of the mammogram. These steps are needed only on digitized screen film mammography (SFM) images because digital mammography devices to carry out this step automatically during the image storing process. Breast segmentation consists of breast border contour extraction, pectoral muscle extraction and nipple identification etc. On images obtained directly from the digital mammography devices segmentation process is easier.

A new presented newly a Binary Homogeneity Enhancement Algorithm (BHEA) that detects the abnormal masses by anatomical segmentation of Breast Region Of Interest (ROI) [12]. They used a Medio-Lateral Oblique (MLO) sight of the mammograms, the Pectoral Muscle Detection Algorithm (PMDA), the Anatomical Segmentation of Breast ROI (ASB) algorithm, and the Seeded Region Growing Algorithm (SRGA). These algorithms are a fully autonomous, and are able to separate many types of abnormalities [4].

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III. MECHANISM USED

In this paper, we have proposed three methods that would bring about the best and cheaper means to deal the study and analysis of mammographic images. The methods are:

A. Wavelet Method

The wavelet transform of an image is computed by decomposing the given image using wavelets, and can be viewed as a decomposition using a set of frequency channels having a spatial orientation tuning. Unlike the traditional Fourier transform, this has no spatial resolution, and the windowed Fourier transform, which has a permanent resolution in the spatial and frequency domains [3]. The resolution of wavelet transform varies with a scale factor. As a result, wavelet representations lie between the spatial and frequency domains and provide a simple and efficient hierarchical framework for interpretation of image information from both the spatial and frequency domains. The figure 2 and 3 clearly illustrate the steps involved in the mammographic image analysis using wavelets. For mammographic images, generally, the structures such as micro calcifications that we wish to recognize have different sizes. There are several distinct characteristics of the wavelet filtered sub images that can be exploited in the design of an incorporated adaptive enhancement algorithm. Once these characteristics are carefully explored and the information from different channels are integrated, we expect to achieve improved performance in image enhancement.

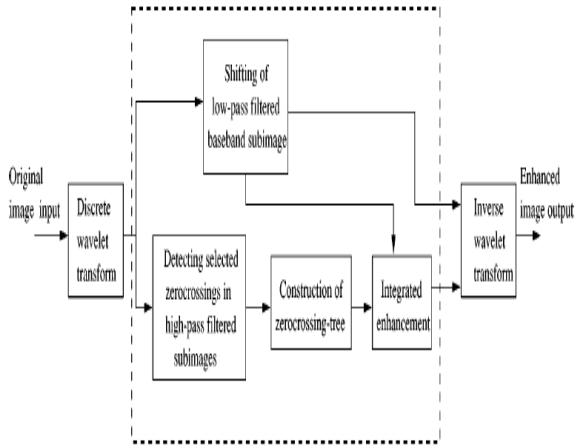

Fig.2. Wavelet based feature enhancement approach.

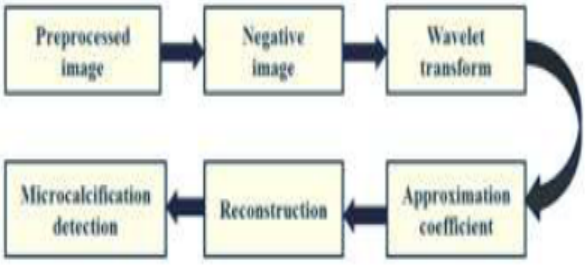

Fig.3. Wavelet transforms steps mammographic processing

B. Artificial Neural Networks Method

The algorithm uses a feed-forward back propagation network with three hidden layers, consisting of 50, 10, 50 neurons for the first, second, and third layer respectively. During training, the features are extracted from the images in which the diagnosis is known [5]. From here, each phase of cancer was linked through the neural network training. After training, the trained networks are stored to be used in the algorithm further. Whenever an image is taken as input in the algorithm, it is simulated with the trained networks and from the results, a percentage can be given to which diagnosis should be taken from the mammogram. Matlab can be used as a good programming tool package that provides functional software environment for creating neural network. The main goal of this package is to provide users with a set of integrated tools neural networks to create models of biological and reproduce them easily, without the usage of extensive coding.

Artificial Neural Networks (ANN) ”are nonlinear information processing devices, built from interconnected elementary processing devices called neurons inspired by the biological nervous systems” [5]. It is an effectual method to solve a intricate problems such as the data mining problem and the NP-problem. Inspiring the biological neural networks, Artificial Neural Network consists of compositions of single, non-linear processing units which are called neurons that are organized in an interconnected graph by a weighted connections each connection has a parameter[12] . These weights are updated until the neural network reached the target output to turn out to be a trained neural network. The use of image processing is a physical process.

The images shown below i.e. Figure 4 and 5 represent histogram input image and modified Image post Enhancement. This output image has produced additional details to display a possible early detection of cancer in the breast.

Fig.4. Histogram Representation of original image

Fig.5. Modified Histogram post Image enhancement

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IV. IMPLEMENTATION AND RESULTS

C. Wavelet Methodology

Wavelet transform, as mentioned before, also gives the spatial information of the detected object and that is the main reason why it is so successful in this area. The methodology comprises of the following sequence of steps:

Step 1: The test mammograms are taken from the database available at a cancer treatment hospital.

Step 2: The test images passed through the High Pass and Low pass filters implemented using the Matlab to extract detailed coefficients and approximate coefficients respectively.

Step 3: The de-noised image is then reconstructed by using two methods. In the first, only approximate coefficients were used while in other the threshold method is used.

Step 4: The calcified portion of the mammogram was extracted by using the edge detection method and the same is presented on the monitor.

Step 5: The mammogram is processed and it's horizontal and vertical gradients are used to extract horizontal and vertical features and details as shown in the figure 6.

The Figure 6. Is produced post enhancement through wavelet method for the input mammographic image.

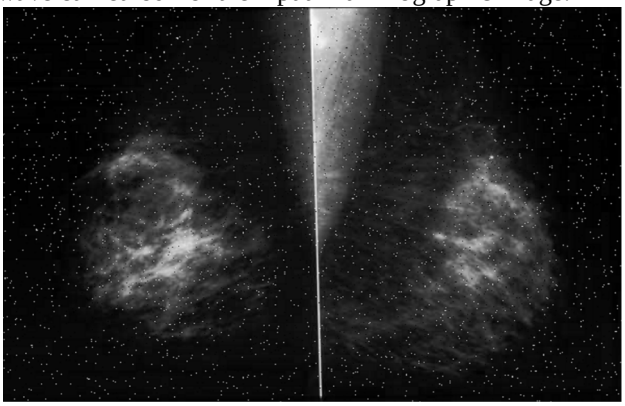

Fig.6. Image Enhancement using wavelet method

D. Neural network Method

The following is the function and its own parameters below are used to create and define our neural network:

net = newff (inputs, targets, num-Hidden-Neurons):

The arguments of this function are arranged as follows:

Step 1: The inputs of neural network where in it contains three important features i.e intensity spread and lymph that is drawn from the image.

Step 2: Stated target for each stage performed by one dimensional binary array i.e. One element of this array has value'1' and other elements are assigned to zero that's to split the desired target from other ones.

Step 3: The number of neurons in the three hidden layers fixed i.e. 50 for the first layer, 10 for the second one, 50 for the third.

Training and Testing stages: The function and its own parameters below a r e used to train our neural network

net = train(net, inputs ,targets);the function parameters are:

1. net: the neural network which created previously.
2. Inputs: inputs of the created neural network as defined before.
3. Targets: stated target the neural network.

Steps in the Algorithm:

Step 1: input Image.
Step 2: Scale the image to a appropriate Size.
Step 3: Filter the image from noise and unwanted objects.
Step 4: Identify ROI – Region of Interest.
Step 5: Extract ROI.
Step 6: Apply Artificial Neural Networks.
Steps 7: Show Output Images and analysis the difference.

The Figure 7. Show case input and enhanced output image post neural network implementation. The region of interest and lymph is easily detected in the image analysis as shown in figure 8.Thus it is easy to further diagnose and analyze the out image for a medical expert for review on state of the ailment.

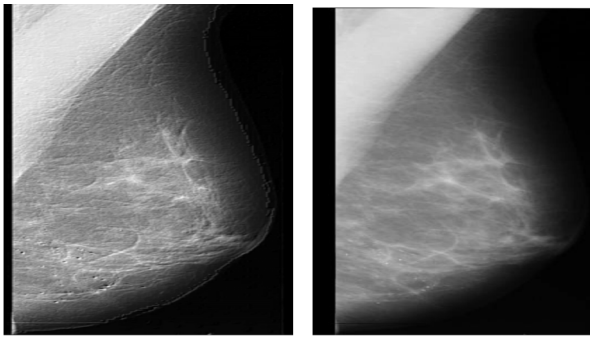

Fig.7. Neural network enhanced output and input image

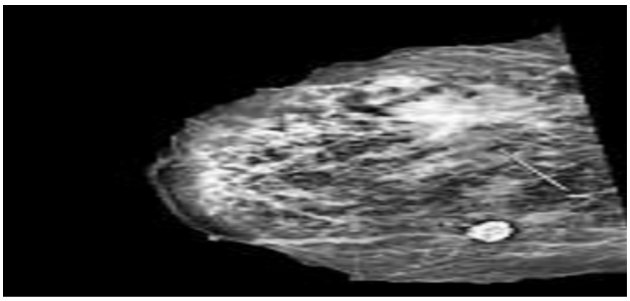

Fig.8. Region of interest

C. Edge Detection Method

Edge detection has a primary significance in image analysis. An edge of a image characterize object boundaries and therefore useful for segmentation, registration and identification of objects in a Image. Edge detection is one of the most commonly used operations in image analysis. An edge is defined by a discontinuity in gray level values. An edge can be understood as the boundary between an object and the background. The shape of edges in images depends on many parameters i.e. the geometrical and optical property of the object, the lighting conditions and the noise level in the images [11]. The importance of the classification is that it simplifies quite a few problems in Artificial Vision and Image Processing, by correlating specific processing rules to each type of edges [10] [5]. The edges are more closely modeled as having a ramp like profile. The slope of the ramp is inversely proportional to the degree of blurring in the edge. The blurred edges are likely to be thick and sharp edges tend to be thin. Figure 9 clearly exhibits the lymph in the output image witnessing the presence of

cancerous formation . The common classification is based on the behavioral study of these edges with reference to the popular differentiation operators like sobel, robets, Prewit, LoG and canny etc.

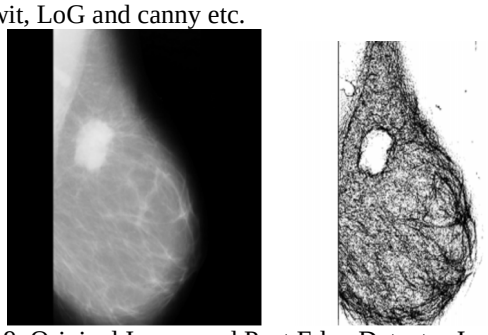

Fig.9. Original Image and Post Edge Detector Image with [canny image]

V. CONCLUSION

Deprived and developing countries where in the price of medical facilities especially for the breast cancer detection are barring the women patients to undergo for routine health check. Such grim state of affairs left many under privileged women in to care attitude towards cost centric health care. In this paper we have focused on cheaper and fastest methods to elicit analysis for early breast cancer detection report. We have focused and were successful to expose possible detection of masses and lymph is which appear during the initial stages of the breast cancer cases. The additional advantage of these techniques is that it separates the breast boundary from the exterior non breast region with clarity in visibility. The methods illustrated in this paper are efficient as it does not require convolution and can also be made useful for other medical imaging processing incident with simple modifications in the algorithm.

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