An Artificial Neural Network for Digital Mammography image Analysis

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***Abstract*-Mammography is the leading method for breast imaging today. Breast cancer is caused due to uncontrolled growth of cells in the breast. Cancer has the potential to break through normal breast tissue barriers and spreads to other parts of the body. While cancer is always caused by a genetic "abnormality". Only 5-15% of cancers are inherited from your mother or father. Instead 90% of breast cancers are due to genetic abnormalities that happen as a result of the aging process and life in general.**

A computer-Aided Diagnosis(CAD) algorithm identifying breast nodule malignancy using Ultrasonography(US) features and Artificial Neural Network (ANN) classifier was developed from a database of histologically confirmed cases containing Benign and Malignant[4][6]. An artificial Neural Network then distinguished malignant nodules in US images based on the morphological features representing the shape, edge characteristics, and darkness of a nodule [2]. Our approach to an neural network and expert system.

Keywords: Mammography, Computer Aided Diagnosis, Breast Nodule, Artificial Neural network, Ultrasonography.

I. INTRODUCTION

Breast cancer is frequent form of cancer among women all over the world, and the early detection of the cancer provides a better chance of proper treatment. The emphasis on the early detection of breast cancer, the desire not to miss a malignant lesion in the early stage of disease and the current medical environment encourage an aggressive Biopsy approach to breast problems. Although well tolerated, biopsy is a typical invasive procedure having some risk, inducing patient discomfort and anxiety, and increasing costs in terms of both patient recovery and overall health care expense. Moreover, the positive biopsy rate for cancer is low, between 5% to 30%, which means 70% - 90% of breast biopsies are performed in women with Benign disease [1]. Therefore, both mammography and sonography methods[3] have been used in attempts to reduce the negative to positive biopsy ratio, and therefore, the cost to society by improving feature analysis and refining criteria for recommendation for biopsy.

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 and darkened) before they are printed on film. Images can also be manipulated; the radiologist can magnify or zoom in on the area.

Ultrasonography (US) is a convenient and safe tool in classifying tumors [5], yet its application has been limited only to determine whether a lesion is cystic or solid. The main reasons for this limited application are the considerable overlap of benign and malignant lesion characteristics and subjective, operator-dependent interpretation in diagnosis.

II. AN ENGINEERING APPROACH

The image is preprocessed before extraction to find the edge of the breast nodule. The Region of Interest (ROI) if the tumor area was first segmented out manually by breast radiologist. This ROI was processed to extract the following features.

Features are identifiable components of images. Features can be detected in normal grey scale or color images, in intrinsic images, in transformed images or even in derived data such as histograms. Features are manifestations of objects in the original scene. They are used to deduce the presence of objects and often to infer position, orientation and size information. The following features help in categorizing the nodules as malignant or benign.

A. Speculation

Speculations mean the variation of boundary pixels from the centre of the image. The speculations of the benign masses should be less. We calculated the

speculations by calculating the variation of the boundary pixels from the center of the image. If these speculations are large then it is an indication of malignant nodule.

B. Ellipsoid shape

Ellipsoid shape means that an object has greater sagittal and transverse dimensions than that of anteroposterior. This is a feature of benign nodule. On the contrary, malignant nodule has taller than wide shape. If any part of all of a nodule has grater anteroposterior dimension than that of either sagittal or transverse, the nodule can be considered malignant. Therefore, the ratio of the maximum height to the maximum width of a nodule was calculated as one feature, showing elliptic shape. Maximum height was determined as a maximum distance between two points on edge having the same vertical coordinate.

- *Branch Pattern*

Branch pattern is defined as multiple projections from the nodule within or around ducts extending away from the nipple. If these patterns are fewer than the nodule is benign otherwise it can be considered as malignant.

- *Relative Brightness of Nodule*

Malignant nodules are darker when compared with the surrounding isoechoic fat or hyper echoic parenchyma. To calculate the value to brightness, the method of dilation was used. From the detected edge of the ROI, we thickened the boundary of the image. A 10 pixel wide layer was used for the surrounding. The ratio of average gray level of the detected region to the average gray level of the surrounding represents the relative brightness value.

- *Number of Lobulations*

Lobulations are the irregular areas in the image. In solid breast nodules, gentle lobulations defined as fewer than two have been regarded as a sign of Malignancy in Table1. The Table1 gives the summary of the above mentioned features:

TABLE1
Summary of Features

Feature	Numerical expression of feature	Benign	Malignant
Speculation	No. of Variations	Smaller	Larger
Ellipsoid shape	Maximum height/Maximum width	Smaller	Larger
Branch pattern	Number of local extreme in low pass filtered r (theta)	Fewer	More
Brightness of nodules	Average darkness of nodule/Average darkness of surroundings	Larger	Smaller
Number of lobulations	No. of intersections with the image	Fewer	More

III. NEURAL NETWORK APPROACH

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly inter-connected processing elements (neurons) working in unison to solve specific problems.

- *Perception Layer Network*

This is one of models in the design of neural networks. The model contains input layer, hidden layer, output layer. The hidden layer is optional. The input layer receives the input. The output is obtained from the output layer. The inputs are multiplied by appropriate weights [2]. This value is checked against a large set of images, if any weights adjustment as to be made it is done and once again we will compute a new threshold value. Finally we obtain the desired result.

IV. MAMMOGRAPHY

Mammography is an X-ray test of the breasts (Mammary glands) used to screen for breast problems such as a lump, and whether a lump is fluid-filled(a cyst) or a solid mass. The resulting X-ray picture is called a mammogram. A mammogram is done to help screen for or diagnose breast cancer. Many small tumors can be seen on a mammogram before they can be felt by a woman or her health professional. Cancer is most easily treated an cured when it is discovered in an early stage. Mammograms do not prevent breast cancer or reduce a woman's risk of developing cancer. However, regular mammograms can reduce a woman's risk of dying from breast cancer by detecting a tumor when it is more easily treated. We develop the algorithm, biopsies can be avoided, diagnosis is faster than the present system and accuracy is the result is more. The some of the limitations are software can't be directly used on the original ultra-sound images and MRI images, image should be of size 500x300,we can load only BMP images.

V. ALGORITHM

Load the image and detect the edge using Prewitt algorithm in MATLAB, Check whether the edge-detected image is of size 500*300.If it is more, then print the error message.

To load the image, use the field's height, width, color, and pixel and skip the remaining fields.
After the image is load, store the image in a buffer.
Find the center point of the image using the formula.
X-mid=(x-min+x-max)/2,
Y-mid=(y-min+y-max)/2
Extract the features speculation, ellipsoidal and lobulation.
To extract speculation: The radial distances from the center of the image are calculated, with a gap of 20 pixels. If the difference between the consecutive radial distances is more than increase the malignant count.
Then calculate the normalized input1.
To extract the ellipsoidal feature:
Calculate:
Width=x-max-x-min
Height=y-max-y-min,
Then calculate height/width.
Calculate normalized input2
To extract the lobulations, draw the Horizontal scan lines, then if it intersects the image more than twice, then it is a malignant feature calculate normalized input 3.
Repeat the above steps for different set of images and train the neural network to identify correctly the pattern.
Multiply all these inputs with a weight 0.5 to get accurate classification the weight 0.5 is standardized after trail and error method for different input images.
Calculate the summation of all the products of weights and normalized inputs.
If the calculated value is less than 0.65, then it is Benign else it is Malignant.

VI. OUTPUT SAMPLES

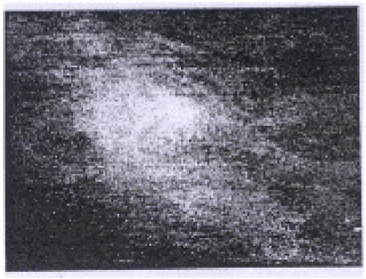

Fig.1: Original Mammography Image

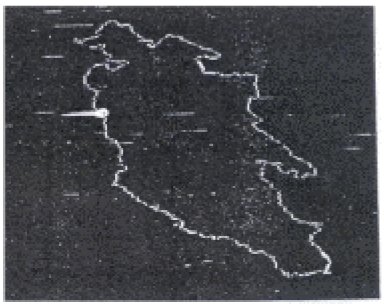

Fig.2: Image after Edge Detection

Fig. 3: Extracting Speculations

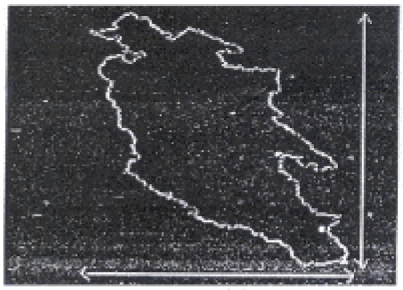

Fig.4: Extracting Ellipsoidal Features

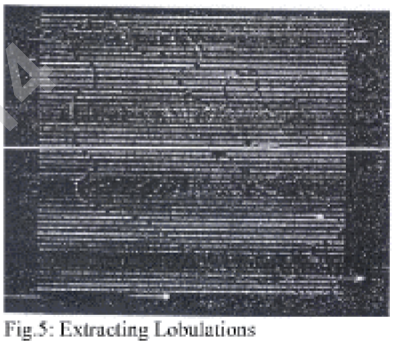

Fig.5: Extracting Lobulations

VII. RESULTS

TABLE 2
The table shows the values for malignant tumor in the Neural Systems.

Neural Network Analysis			
Threshold	Benign Value	Malignant Value	Test Value
0.65	<=0.65	>0.65	1.08
			Result:Malignant
0.65	<=0.65	>0.65	1.04
			Result:Malignant

VIII. CONCLUSION

Diagnosis is faster than the present system, accuracy in the result is more and biopsies can be avoided. Some of the limitations are software can't be directly used on the original ultra-sound images and MRI images and we can load only BMP images.

Future scope:

We are thinking of developing to work on real time images and also implement to load other type of images like JPEG and GIF.

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