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Detecting Breast Cancer using Neural Networks

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Abstract: ***The goal of this paper is to detect the breast cancer using neural networks. Image processing techniques play an important role in the diagnostics and detection of diseases and monitoring the patients having these diseases. Breast Cancer detection of medical images is one of the most important elements of this field. Because of low contrast and ambiguous the structure of the tumor cells in breast images, it is still a challenging task to automatically segment the breast tumors. Our method presents an innovative approach to the diagnosis of breast tumor incorporates with some noise removal functions, followed by improvement features and gain better characteristics of medical images for a right diagnosis using balance contrast enhancement techniques (BCET). The results of second stage is subjected to image segmentation using Fuzzy c-Means (FCM) clustering method and Thresholding method to segment the out boundaries of the breast and to locate the Breast Tumor boundaries (shape, area, spatial sizes, etc.) in the images. The third stage feature extraction using Discrete Wavelet Transform (DWT). Finally the artificial neural network will be used to classify the stage of Breast Tumor that is benign, malignant or normal. The early detection of Breast tumor will improves the chances of survival for the patient. Probabilistic Neural Network (PNN) with radial basis function will be employed to implement an automated breast tumor classification.***

Keywords: Breast Cancer detection, balance contrast enhancement techniques (BCET), DWT, Breast Tumor, Probabilistic Neural Network (PNN), Fuzzy c-Means (FCM).

I. INTRODUCTION

Breast Cancer is a general term that refers to cells that grow larger than 1.5 mm in every 3 months and multiply out of control and spreads to other parts of the body. Breast Tumor (BT) is the first cancer and the second element of death among women. Since the reason of breast cancer is unknown, the methods for preventing of this disease are not specified. Recognizing of being tumor and the type of cancerous tumor would have a very important role on getting decision of doctors for applying the methods of true treatment and therefore reclaim the life of people (more than 40%).Cancers are groups of abnormal cells that form lumps or growths. They can start in any one of the trillions of cells in our bodies. Tumors grow and behave differently, depending on whether they are cancerous (malignant), non- cancerous (beningn) or precancerous. In Cancerous tumors cancer can start in any part of the body. When cancer cells form a lump or growth, it is called a cancerous tumor. A tumor is cancerous when it :

1) Grows into nearby tissues;
2) Has cells that can break away and travel through the blood or lymphatic system and spread to lymph nodes and distant parts of the body;

Cancer that spreads from the first place it started (called the primary tumor) to a new part of the body is called metastatic cancer. And when cancer cells spread and develop into new tumors, the new tumors are called metastases. In Non-cancerous tumors the tumors that aren't cancerous are called non-cancerous tumors:

a) Stay in one place and don't spread to other parts of the body;
b) Don't usually come back after they are removed;
c) Tend to have a regular and smooth shape and have a covering called a capsule
d) May be moved easily in the tissue

In determining type of the Cancer is much more challenging. Some of the characteristics of malignant tumours are clustered, isolated ducts poorly defined mass and etc. A good classification process leads to the right decision and facilitates provision of good and appropriate treatment. Machine learning can help medical professionals to diagnose the disease with more accuracy. Where deep learning or neural networks is one of the techniques which can be used for the classification of normal and abnormal breast detection.Artificial Neural Networks (ANNs) are one of the most widely used models for the classification of tumor cells. An ANN consists of a network of neurons that learn from experience.Preparation process, light or electron microscopes are used to take digital histological images on the stained sections.Masses and micro calcification clusters are an important early signs of breast cancer.

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II. LITERATURE SURVEY

Several researches have been done to develop CAD system to detect breast cancer. The references for this paper are taken from journal, books and conferences regarding the mammogram image and thermal image.

A. *Image Processing Technique*

Alasdair McAndrew (2004) entitlement, image processing is used to change the nature of an image to improve and enhance the image for human interpretation. Image processing also used to render image for machine perception. In his module, he explains on how to use matrix capabilities of MATLAB to investigate images and its properties. The image processing operations are explained in term of chapters. Image display chapter explain on how to use *imshow* function to display image and how spatial resolution and quantization affect the display and appearance of the image. Another chapter explain on point processing and the sub-chapter are arithmetic operation, histogram and thresholding. This sub-chapter discuss on how to modify image (enhance and blurring image) using MATLAB function that show how each operation work. For example, *imadjust* function which indicate histogram stretching is use to enhance image. The next chapter teach about spatial filtering. This chapter is also explaining on how to enhance and blurring image but using different operation. The operation discuss in this chapter is by filtering image using frequencies (low and high pass filter), Gaussian filter and non-linear filter. Types of noise, cleaning salt and pepper noise and cleaning Gaussian noise are explain in the next chapter which is noise chapter. Noise is degradation in the image cause by image disturbance during transferring and during image acquisition. Cleaning noise is important to restore image to its original state and to analyze the image. The type of noise discuss in this module are salt and pepper noise and Gaussian noise

B. *Mammogram Image Analysis*

Jelene Bozek, Kresimir Delac and Mislav Grgic (2008) entitlement, mammography is the best method to detect early signs of breast cancer such as masses, calcifications, bilateral asymmetry and architectural distortion. However, due to human limitation computer system have to take the major role in detecting abnormal tissue. The challenges that have been faced by the system are the wide range of abnormalities features and the indistinguishable from surrounding cell. Most of system developed involves algorithms which consist of two stages. The first stage is to detect suspicious lesion and second stage is to reduce the number of false positives. In BI-RADS system which discussed in this paper, the detected lesions are classified as masses, calcifications, architectural distortion and bilateral asymmetry. Masses are classified as benign or malignant based on density (fat containing, low density, isodense and high density), margins (circumscribed, microlobular, obscured, indistinct and spiculated) and shape (round, oval, lobular and irregular). Calcifications classified as beningn, malignancy suspicious and malignancy highly suspicious based on the distribution of cluster, size, shape, and variability. For architectural distortion, the lesion classified as malignant when integrated with other lesion such as masses and classified as beningn when scar and self-tissue damage due to trauma detected. Bilateral asymmetry analysis based on its texture, shape measurement, topology, brightness distribution, roughness, pattern asymmetry and directionality.

III. PROPOSED METHODOLOGY

To detect and classify the type of breast tumor of each patient, doctors usually refer to image and make the report about the image analysis of the patient. The method we have proposed will help the doctor in diagnosing breast tumor patients. And with the existence of proposed system, doctor can train the system with some known data and then use this system to generate the image report of the patient after testing the data.

The quality of images obtained from medical devices can influence the result of processing (analysis) when solving diagnostic medical problems. In most cases, obtained images (or an image sets) have noticeable noise caused by technological features of devices operation. Considering this, authors suggest the following procedure to process the medical images (Fig. 1).

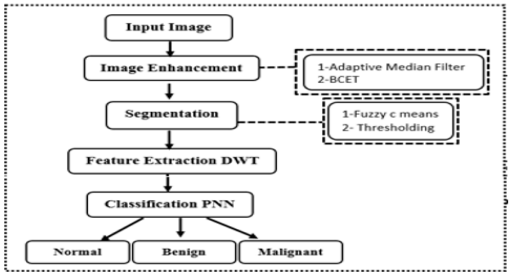


Fig.1. The Block diagram of the proposed system

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The obtained images are converted to grayscale format. Then the list of computational steps are performed:

1) Image enhancement (applying Adaptive median filter to remove noise and Balance contrast enhancement using (BCET)).
2) Applying Thresholdin & Fuzzy C-Means (FCM) Segmentation methods.
3) Applying Feature extraction by using Discrete Wavelet Transform (DWT).
4) Tumor detection and classification using Probabilistic Neural Network (PNN).

A. List Of Performed Computational Steps

1) *Image Enhancement:* The primary purpose of these filters is noise reduction, but a filter can also be used to emphasize certain features of an image or remove other features. We have used adaptive mean filter to remove noise from image. Since it is better among all the spatial filters and distinguishes fine details from noise. The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter (AMF) classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels. The size of the neighborhood is adjustable, as well as the threshold for the comparison.

2) *Segmentation:* In this method we have used two types of segmentation; the first is Fuzzy C-Means segmentation that to segment the out boundaries of the breast, and the second is Threshold segmentation that used to locate objects (breast tumours) and boundaries (shape, area, spatial sizes, etc.) in images. Fuzzy C-Means segmentation: Fuzzy C-Means clustering performs clustering by iteratively searching for a set of fuzzy clusters and the associated cluster centres that represent the structure of the data as best as possible. It allows splitting an existing set of points of power n by a given number of fuzzy sets. Threshold segmentation: Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Thresholding technique segments the MR images by a binary partitioning of the image intensities.

I (p) = 1; if it's gray level > T =0; if it's gray level < T. (9)

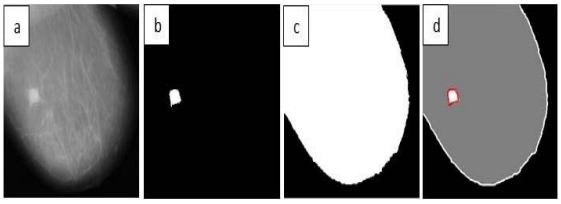


Fig. 2. Example of the segmentation methods: a) original image, b) Result after Thresholding, c) Result after Fuzzy C-Means, d) Final result of segmentation

3) *Feature Extraction Scheme using DWT (Discrete Wavelet Transform):* The proposed system uses the Discrete Wavelet Transform (DWT) coefficients as feature vector. The wavelet is a powerful mathematical tool for feature extraction, and has been used to extract the wavelet coefficient from medical images. The main advantage of wavelets is that they provide localized frequency information about a function of a signal, which is particularly beneficial for classification. The continuous wavelet transform of a signal x (t), square integrable function, and relative to a real-valued wavelet, $\Psi_{a,b}$ (t) is defined as:

$$W\Psi(a, b) = \int_{-\infty}^{\infty} f(x) * \Psi_{a,b}(t)\, dx$$

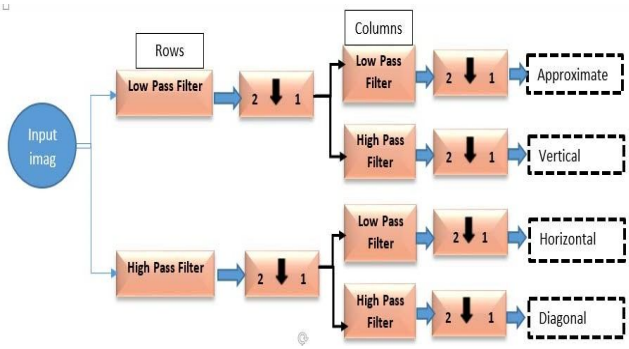


Fig. 3. Diagram of Discrete Wavelet Transform (DWT)

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IV. CLASSIFICATION

Artificial neural network (ANN) classifier is used for classification in the proposed system as it is state of the art tool for pattern classification and widely used in similar applications. ANN is trained to perform a specific task by adjusting weights between the elements. ANN classifier involves two operations: training and testing. A well-trained network is likely to produce better classification accuracy on unseen data. The functional diagram of a neural network is shown in Fig. 4.

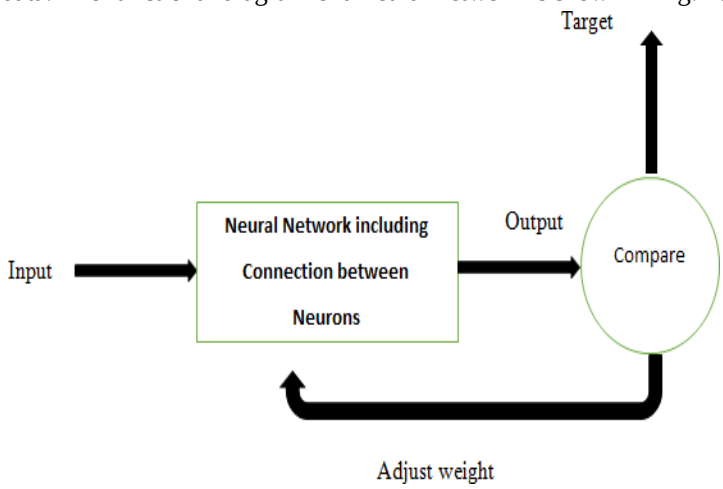


Fig 4 Neural Network Functional Diagram

V. RESULTS AND DISCUSSION

For the experimental research 75 images were selected. Examples are shown in Fig.14. Medical images contain difference breast tumors that are characterized by different locations and different types of pathologies, shape, size and density, as well as the size of the area of the affected tissue near the tumor space.

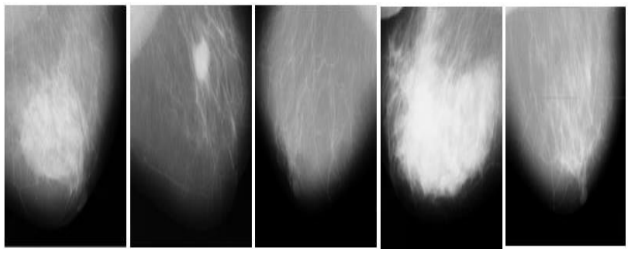


Fig.5. Experimental data set images of tumor detection

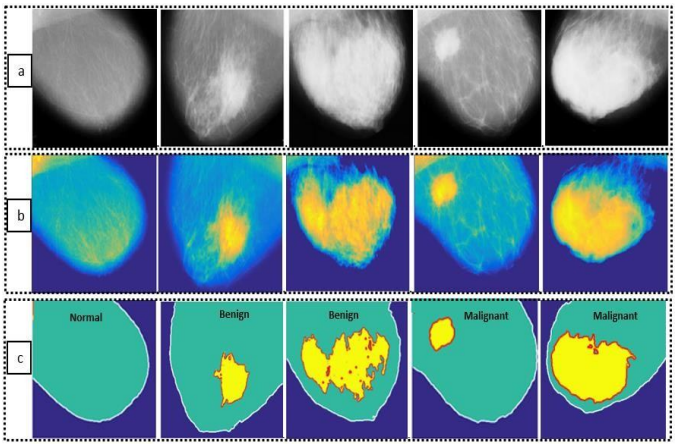


Fig.6. (a) Input images, (b) Pre-processed images, (c) Results of segmentation and classification of different types of Breast tumor

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A. Advantages

1) It has quality improvement over other methods.
2) This method suffers from no noise compared to other existing methods in the market
3) This method suffers from no data loss compared to other methods.
4) This method has high accuracy compared to other methods available in the market.

B. Applications

1) It is used in Bio-medical purposes.
2) It is used in Medical Imaging as a substitute of X-Ray.

VI. CONCLUSION

This proposed paper has discussed the designing of an accurate system for detection of breast cancer tumor as standard procedure for breast cancer diagnosis. Digital mammography is currently as standard procedure for breast cancer diagnosis, various techniques are used for classification problem in the area of medical diagnosis. Feature extraction of image is important step in mammogram classification. These features are extracted using image processing techniques. Area of tumor is calculated by the DWT (Discrete Wavelet Transform) tumor affecting portions are denoted. Probabilistic Neural Network has been proposed and developed. This system classifies mammogram images into 3 categories: normal, benign and malignant with high rate than 90%. The system which can assist and help the doctor or specialist nurse to speed diagnosed the mammograms.

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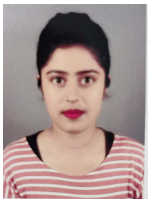
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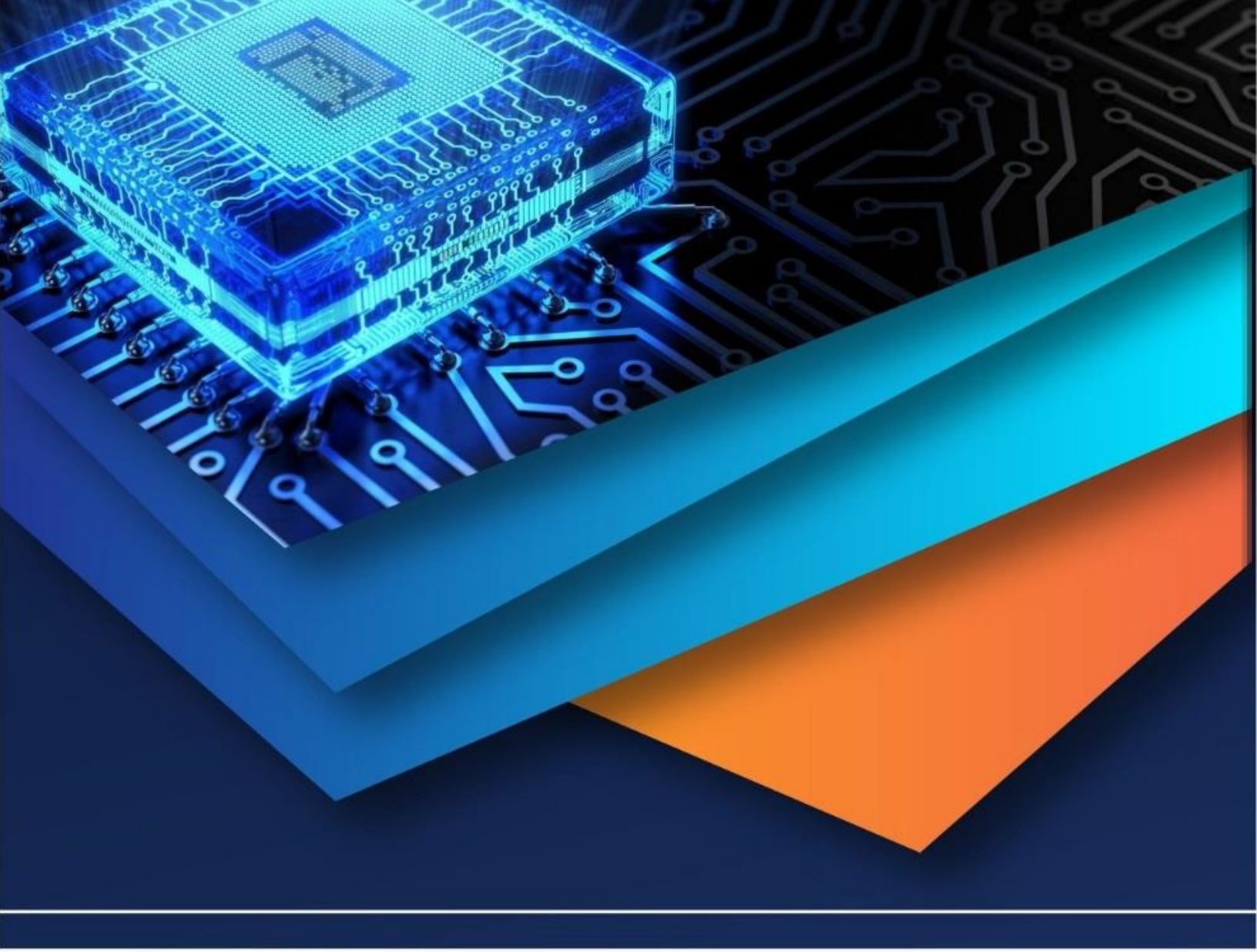
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