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Review Article

Analysis of Breast Cancer and Image Processing Techniques

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Abstract *- A rapid increase in the number or amount of cells in their growth and the structure is a cancer cell. Prior detection of cancer can reduce the demise rate. A radiologist can miss the abnormalities due to inexperience in the field of mammography to detect cancer. Many people have been cured of it due to early detection. Still, the automated classification of Mss is a complex task. Dense tissues may easily be confused as calcification results in high false positives. So, pre-processing to enhance the images places a vital role to adjust and make the correction by avoiding the unwanted part of an image. The success of segmentation and classification depends upon the accuracy of pre-processing. The aim of this process is to enhance the quality by removing the unrelated and surplus parts in the background of a mammogram. Different types of abnormalities, patterns and the features of BI-RADS and various techniques to evaluate the mammogram using image processing were discussed. This paper concludes with the need for pre-processing techniques to get the best accuracy.*

Keywords *- Full Field Digital Mammography, Computer-Aided Detection, Breast Imaging-Reporting and Data System, Region of Interest, Medio Lateral Oblique, Cranio Cauda.*

I. INTRODUCTION

Collection of cells that have the proliferation of growth and the change in structure is a cancer cell. The cell that is eventually formed as a mass or lesion is named a tumour. Early detection of cancer can reduce the mortality rate. Presently Breast cancer is a life-threatening disease. Most women and a few men are affected by this type of cancer. A radiologist can miss the abnormalities due to inexperience in the field of mammography to detect cancer. A cell can be categorized as Normal, Benign or Malignant. Identifying and classifying the cell is vital processing. Due to inefficient clarity of images, there may be a miss classification of the cell. This may lead to unnecessary problems and a waste of money and time.

Many people have been cured of it due to early detection. Still, the automated classification of mass is a complex task. Because the structure or shape of cancer cells remain different structure and each requires customized medication to be cured. The challenge in the classification of a cancer cell is that object of Interest is extraordinarily small, inciting probable misidentification. The unique size, different shapes and variable appropriation of microcalcification in mammogram images are very difficult for matching with a template. Region of Interest (ROI) might be of low contrast. The refinement between suspicious reaches and their enveloping tissues can be thin, skin thickening, especially in young women case suspicious territories to be practically undetectable. Dense tissues may easily be confused as calcification results in high false-positive cases. So, pre-processing to enhance the images places a very important role to adjust and make the correction by avoiding the unwanted part of an image. The success of segmentation and classification depends upon the accuracy of pre-processing. The main goal of this process is to give the improvement in the quality by removing the unrelated and surplus parts in the background of the mammogram. Breast border extraction and pectoral muscles suppression is also part of pre-processing.[1]Pre-processing involves resampling, grayscale conversion, contrast enhancement, Noise removal, Morphological operations and manual correction [2].

II. DETECTION OF BREAST CANCER FROM MAMMOGRAPHY

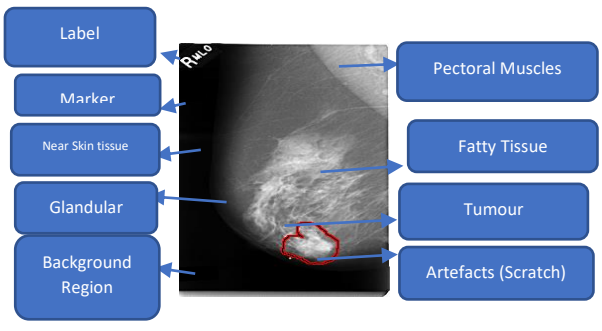


Fig. 1 Original Image

Digital mammography, also called Full-Field Digital Mammography (FFDM), is a mammography system in which the X-ray film is replaced by solid-state detectors that convert X-rays into electrical signals. It is particularly

suited to woman breast to detect nodules whose presence may indicate the existence of breast cancer. It should be noted that mammography does not always provide a definitive diagnosis on the presence or absence of cancer. It allows doctors to see if there is an abnormality in the breast. Computer-aided detection (CAD) systems use a digitized mammographic image that can be obtained from either a conventional film mammogram or a digitally acquired mammogram. The computer software then searches for abnormal areas of density, mass, or calcification that may indicate the presence of cancer. The CAD system highlights these areas on the images, alerting the radiologist to the need for further analysis. The radiologist is consequently led to analyse the mammogram and perform a physical examination (appearance of the skin and nipple). Other tests are then necessary to establish the diagnosis (breast ultrasound, breast MRI and sampling of tissues). Fibrous tissue and fat give breasts their shape. When breasts are dense, they have more fibrous tissue and less fat. Breast density is a normal and common finding on a mammogram, but breast density may make it harder for a radiologist to see cancer. If the breasts are dense, the person wants to undergo other health care professional testing in addition to mammography.

Early-stage breast cancer can be found by clusters of microcalcification not more than 3 cm per square on a mammogram. And the women may be at high risk of breast cancer when they have the following history such as genetic tissues, ovarian cancer or other inherited types of cancer such as BRCA 1, BRCA2 mutation, high radiation test treatment on the chest at a young age. The type of cancer can be found in the particular cell which is affected by cancer. The most common types of cancer are ductal carcinoma in-situ, invasive ductal carcinoma and invasive lobular carcinoma. Most breast cancers are carcinoma types of cancer. The cancer cells spreading from the lobules of the breast are infiltrating lobular carcinomas. The most harmful type is metastatic cancer. When breast cancer spread from the nodules to the lymph node bone, liver, lungs and, it affects the brain. The beginning stages of breast cancer is from milk-producing ducts (invasive ductal carcinoma). It can also start from the glandular tissue called lobules (invasive lobular carcinoma) or in other cells or tissues of the breast.

III. DIFFERENT PATTERNS OF ABNORMALITIES IN BREAST CANCER

Breast tissues were affected by various types of abnormalities. Normally when the radiologist finds the abnormalities in the cell's mammogram, finding requires some more analysis and follow-ups. It usually involves a greater number of imaging studies such as MRI and ultrasound in the breast. If there is a suspicious type of lesion, a breast biopsy may be necessary.

The abnormalities are often classified as,

- Asymmetric Breast tissue
- Asymmetric Density
- Architectural distortion mass
- Microcalcification
- Adenopathy

A. Asymmetric Breast tissue:

It is a position of the breast tissue that is present in the same area of the opposite breast. So, the same area of the breast is compared and note if there is any difference in the tissues. This is a vague finding in which there is no focal mass, no distorted architecture, no central density and no associated breast calcification. Only about 3% of mammogram screenings show this asymmetric breast tissue. And few are advice for breast biopsy.

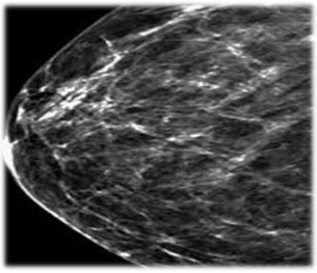


Fig. 2 Asymmetric Breast Tissue

B. Asymmetric Density:

This type of mammogram results in clinical abnormalities or lesion mass. In some cases, the asymmetrical breast density is pseudo- Angiomatous stromal hyperplasia. This condition is mostly benign. It is the first mammogram finding that refers to our opacity (observe the view in the part of the breast) which is visible on only one projection or one view angle in x-rays. But the radiologist requested additional views from other x-ray angles and immediate follow-ups. It can be a result of other benign causes such as post-surgical scaring, a simple cyst, fibrosis, sclerosing adenosis, focal fibro glandular tissue growth that may develop as a supplement.

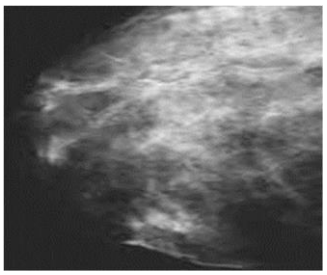


Fig. 3 Asymmetric Density

C. Architectural Distortion:

It is basically a structure seen on an x-ray of the breast. It has a pattern that is random curvilinear, and fine linear radio-opaque structures are normally seen on the x-ray of the breast. The architectural distortion on mammography is most commonly due to benign conditions in the minimal margin. Architectural distortion on mammography is likely to have positive margins. Tumours presenting as architectural distortion on mammography are also significantly larger than tumours presenting in the other abnormalities in breast tissues. It could be the result of benign. Some architectural distortion is associated with Ductal carcinoma in situ (DCIS)

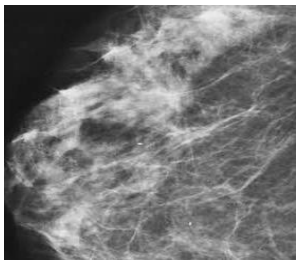


Fig. 4 Architectural Distortion

D. Microcalcification

It is one of the important ways to direct breast cancer on mammograms at the early stage of Ductal carcinoma in situ (DCIS). There are tiny specks of calcium deposits. The distribution of the calcification is scattered throughout the breast tissue. They often occur in a cluster. Most microcalcification deposits are benign. Some features and presentation of microcalcification are associated with malignant.

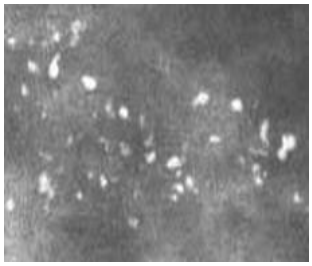


Fig. 5 Microcalcification

E. Adenopathy

Enlargement of lymph glands is called adenopathy. A few percentages of women who have undergone a breast cancer screening mammogram will present with these features. Sometimes the mammogram delicts enlarge axillary lymph nodes but no breast mass. This is called axillary primary breast cancer that can be developed in a different region of the breast. An axillary lymph node that seems enlarged on a mammogram could contain cancer, but in some cases, the lymph node is large normally. Mammographically features of benign and malignant lymphadenopathy are quite often indistinguishable. When the size of the lymph node is greater than 2 cm, it is suspicious. The lymph node has a fatty hilum visible in the outer cortex that has to be 5 mm thick, but mostly it is less. When it is more than 6mm or thicker, there is a chance of cancer that to be spread into the lymph node. If there is no fatty hilum visible, then the entire lymph node measured across its smallest short-axis width should be no larger than 10 millimetres.

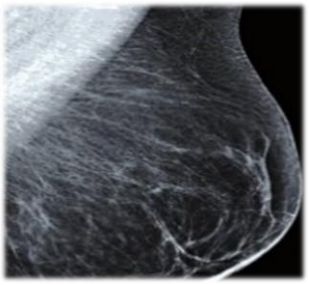


Fig. 6 Adenopathy

IV. DENSE BREAST AS PERIL FACTOR

Identifying mammograms is highly dependent on the density of the tissues. Contrast is mainly due to the difference between two types of tissues, dense and fatty. Fatty tissues are in a dark colour on mammograms. When the level of fat tissue is low, then it is dense breast, which is hard to diagnose. The structure of the breast varies naturally. After menopause, the breast acquires a fat structure. The relationship between breast density and risk of developing cancer is the first study of Woye et al. [3]. He managed to classify mammographic images into four classes depending on the density and distribution of connective tissues as,

N1- fat with few dense tissues

P1- Dense elements occupy less than a quarter of the breast area.

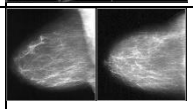
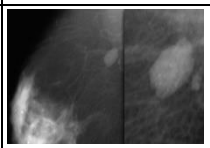
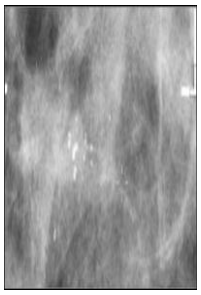
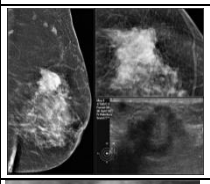
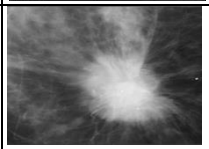
P2- Dense elements occupy over a quarter of the breast area.

DY- The area is basically dense.

P2, DY are diseases, according to Woye. The new classification is the Breast Imaging Reporting System and Data System. (BI-RADS) which is a quality assurance tool originally designed for use with mammography.

The different categories are,

Table 1. Different categories of BI-RADS

S.NO	TYPES	FEATURES	IMAGES
1	BI-RADS 0	i) Incomplete It needs additional imaging evaluation. ii)Previous images not available at the time of reading.	
2	BI-RADS 1	i)Negative ii)No abnormal mass, Suspicious calcification on architectural distortion.	
3	BI-RADS 2	i)Benign ii)Zero probability of malignancy.	
4	BI-RADS 3	i)Probably Benign ii) Low-grade probability of malignancy. iii)Short interval follows up suggested	
5	BI-RADS 4, BI-RADS 4A, BI-RADS 4B, BI-RADS 4C	i)Suspicious of malignancy. ii) High-grade probability of malignancy It has low suspicious of malignancy (2%-9%) It has modern suspicious malignancy (10%-49%) Highly suspicious for malignancy (50%-94%)	
6	BI-RADS 5	i)Highly suspicious for malignancy greater than 95% probability of further malignancy treatment should be taken.	
7	BI-RADS 6	i)Known biopsy-proven malignancy.	

V. TECHNIQUES TO EVALUATE MAMMOGRAPHY

The evaluation of mammography images undergoes the following processing to improve the accuracy is,

- pre-processing
- Segmentation
- Characterization and
- Classification

After the enhancement of images is submitted for diagnosis and for further treatment.

A. Pre-Processing

In order to facilitate its exploration, the mammographic images are done pre-processing and to improve their quality. The important defect against a better classification of mammographic images is that of contrast enhancement. There are three different techniques analysed for the enhancement of mammogram images.

a) Conventional techniques

It is a widespread technique that to be used such as histogram stretching, histogram equalization and convolution mask or with a window of fixed size or adaptive size or adaptive enhancement techniques such as Sobel operator [4]

b) Region-Based techniques

It consists of applying the Region growing algorithm from each pixel of image [4], which includes region transformation based such as Region growing, region splitting and merging, watershed Region and threshold-based such as global, local and dynamic thresholding.

c) Feature-Based techniques

It takes the characteristics of an image. This method is the easiest to understand. It finds the features such as image edges, corners and other structures that are well localized in two dimensions and tracks these moves from frame to frame. The performance assessment of these contrast enhancement techniques remains a challenge because it largely depends on mammograms resolution.

B. Segmentation

Its goal is to identify the possible happenings in the Region of Interest (ROI). It allows identifying the abnormal mass that exists on the mammographic images. The segmentation can be done from two different views. i) unique view of the breast or ii) Multiple views to be considered.

a) Single view mass detection

It is used to view the single mammogram to detect the abnormalities. This can do by Region-based approaches such as watershed for analysing the Region growing procedures and split and merge techniques for Edge detection-based approaches. These techniques are based on the detection of component edges or clustering-based approaches. It is used to detect the appearance of a cluster that may represent the focal tumour. Model-based approaches are used to compare with the previously known images for healthy and pathological cases.

b) Multiple views of mass detection

In this, they examine the two mammographic images that are the right and left breast. The radiologist seeks and compares the two sides of the breast to know the abnormalities. Another one is two different views of the same breast images were taken as Mediolateral oblique (MLO) and cranio cauda (CC). Within the interval of time, the mammogram images were taken to detect the evolution of possibilities in the abnormal growth of tissues. This mammography could be redone after a certain period of time. In the segmentation, they have some limitations, such

as in the Region-Based approaches, depending on the selection of the correct seed region and the termination condition. Suppose fractal model techniques are used for the classification of textures to determine the shape from texture. It is expensive in computational time.

C. Characterization

In this, the primitives that extract from ROI, which are already detected in the previous process, are taken to classify the area of the tissues is at benign or malignant. Cheng et al. have alleged the different primitives that to be used in the characterization of masses detected in mammographic images are,

a) Co-Occurrence of Matrix the primitives that are extracted from the grey level of a matrix are used to characterize the ROI, such as energy, contrast, entropy.

b) The extraction directly from mammograms is the area of spread of cancer cells, perimeter, compactness, eccentricity, thickness, elongation, direction, orientation direction, line, background, distance, foreground and contrast.

c) Surround region dependence matrix is that every ROI is compared with the surrounding neighbours.4)Grey level run length is statistical primitives used to characterize the mammograms texture which is extracted from GLRL.

d) Grey level differences which are extracted from the matrix that characterizes the variance of grey level between the ROI

e) Gabor filter banks which are extracted from the Gabor filter which characterize the grey levels frequencies.

f) Wavelet decomposition provides many characterizing grey levels frequencies from different orientations.

g) Space scale is to represent the different image scales. This can be done by a Gaussian Laplacian filter.

h) Fractal dimension shows the fractal dimensions of the images.

i) Characteristics of a cluster, which describes the weight distribution, the areas and the number of microcalcifications. These primitives related to identifying and detecting the lesion can offer almost perfect results.

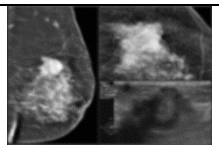
D. Classification

Several types of classification were used to differentiate the tumour as benign or malignant. Most neural networks that were used for classification are K-Near neighbour, Quadratic classifier, Bayesian Classifier, Linear Classifier, Binary decision tree, Expert system, Fuzzy decision tree, Genetic algorithm adaptive thresholding. These classifiers are categorized as supervised and unsupervised or non-parametric and parametric or object-oriented, per-pixel, sub-pixel and per field or spectral classifiers, contextual classifiers and spectral contextual classifiers or hard and soft classifiers. [5].

VI. RESULT AND DISCUSSION

Cheng et al. has evaluated the accuracy after the image of mammography were pre-processed. It gives 87% to 90% for a neural network to identify the malignancy analysis from 71.08% to 83.13% for KNN, from 94% to (&.3% with decision tree [6]. When the mammogram images undergo the image enhancement process before the classification and categorization, it gives the best accuracy when compared to the raw images. The image is taken from the mammogram, and the pre-processing steps were applied as the first step is to convert the image to a greyscale image which is to reduce the complication for extracting features of images. The second step is applying to filter using the Gaussian filter. In Images, Gaussian filter is widely used to reduce image noise by convolving the original image with a mask that represents a low pass filter or smoothing operation. This convolution brings the value of each pixel into closer harmony with the values of its neighbour. In this approach, a Gaussian blur has used an effect of reducing the high-frequency image components. Noises are removed to improve the clarity of an image. This can be done using the filters.

Table 2. Techniques for Image Enhancement

S.NO	TECHNIQUES FOR ENHANCING IMAGES	IMAGES UNDERGONE IMAGE ENHANCEMENT
1.	Image Acquisition	
2.	Greyscale	
3.	Applying filter	
4.	Edge detection	
5.	Binarization	
6.	Skeletonization	

Before filtering the noise, the image should convert into 8- bit greyscale image. Then noise can be removed using Gaussian blur, and then segmentation can be done on the image. Canny edge detection is used to find the boundaries of the object in images. The Canny edge detector is an edge detection operator that uses a multi-

stage algorithm to detect a wide range of edges in images. Edges typically occur on the boundary between two different regions in an image. After detecting the edge, the image is converted into a binary (Black & white) image. From that, extracting lightness as a feature amount from the image. In Binarization, there are global and local binarizations. The local binarization method is calculating Region by Region or pixel by pixel. Global Binarization uses a single threshold value for the whole image. After that, apply skeletonization which is to reduce the foreground region in a binary image to a skeletal trace. It can also call as a thinning process which is an important step in the pre- processing phase. It provides a region base shape feature. After enhancing the image, it is further taken for characterization and classification. It gives the best result

VII. CONCLUSION

In this paper, various types of analysis regarding Breast cancer are studied, and the different stages and categories of tumours were analysed. And the different Image enhancement techniques are used to make the image a sharp one and makes the diagnostics perfect and accurate for the radiologist. The different types of techniques in image processing were compared with each other to get better accuracy for diagnosis. It reduces the false positive in identifying the Malignant type of breast cancer

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