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Classification of Breast Masses using Shape and Texture Features

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***Abstract*— Breast Cancer is one of the 2nd most type of dangerous disease which leads in resulting deaths among women's due to the production of extra amount of proportion of cancerous cells which replaces neighboring non-cancerous cells or cover all over the body. There are various techniques and methodologies present which helps in identifying the presence of cancer and also multiple ways to detect it in proper time so that the person affected by it could not leads to death. This review paper presents the different techniques to develop a gray scale image to view whether the cancer exists or not. Most common, safe and cheap methodology suggested is mammography whose standard image database could be used for training the learning machine. This paper also elucidates the numerous segmentation approaches to define the ROI. The outcome of ROI is further used for extracting valuable shape and textural features for classifying the cancer through the machine learning approach i.e. ANN (Artificial neural networks) which also helps in eradicating the overlapped pixels which obtain after segmentation. Hence, ANN is used to evaluate the performance through defining Accurateness (precision), Sensitivity and Specificity.**

Keywords- Mammography; ROI; ANN; segmentation

I. INTRODUCTION

Breast cancer is nearly becoming the largest dangerous diseases whose proper treatment is still not available. Breast has become one of common occurring forms of cancer in women. As per the data yet collected it is found that there are 2000000 new breast cancer cases are spotted and out of them 4000 leads to death. It is found that one in 20 women in India are suffered from the breast cancer in her lifetime and also some of them lead to their death due to improper treatment or late diagnosis of presence of cancer. While in America the growth rate of cancer is one in eight women. Thus, early detection of breast cancer results in timely diagnosis of disease and providing better chances of survival. A Cancer is a tumor that grows within the cells and then multiplies out of control. Breast cancer grows or begins inside breast tissue and first spread itself to entire region and then other parts of the body, like breast cancer also spreads up to lungs too. This review paper is all about the different techniques and methodologies of indentifying presence of cancer and also the different ways to extract it to obtain the ROI (region of interest) so that further classification could be done to find the sensitivity, Specificity and accuracy of the proposed algorithm.

To identify the presence of cancer there are different techniques available, one of them and most common and effectively used technique is Mammography, it is a low-dose x-ray technique used for examine the occurrence of any abnormality in breast cancer. This technique helps in detection of cancer at early stage and provides more chances of successful treatment. As far as mammography is concerned there are other techniques available which helps in cancer detection as mammography is inefficient to identify the denser abnormalities. There are different types of abnormalities present which results in cancer; they are: Masses, micro classification, architectural distortion and bilateral asymmetry. These types of cancer could be detected easily at early stage i.e. Benign stage and if the abnormality gets denser and spreads in a large area it becomes Malignant. This review paper explains and differentiates the different techniques available for detecting cancer and also presents the number of ways of segmenting the region of interests from the database of images to perform the classification through removing the overlapping to find accuracy.

II. REVIEW LITERATURE

Extensive literature review has been carried out for defining the research problem. Most of the work carried out is by reading and examining the research papers based on the breast cancer detection techniques and methodologies and find out more easy way to locate and identify the presence of cancer.

1. **EDDIE et al, "Breast Imaging : A Survey", April 10 2011:-** This paper describes the different types of modalities used for screening and detection of breast cancer, such as, Mammography used as one of the most effective and popular technique used for detection of cancer which are at low risk. Another technique named Ultrasound and MRI used when the patient cancer is at high risk and also when the condition of cancer is dense which cannot be detected in mammogram. Likewise some more various methodologies are used to detect cancer such as: - Breast thermography (is a technique in which cancerous and non-cancerous cells have higher metabolic rate resulting in the growth of new blood cells providing nutrients to the cancer

cells for faster growth. Thus the temperature covering the surrounding area of non-cancerous and cancerous breast tissue are different when compared and comes to be higher than normal tissue), PET(Positron Emission tomography is a nuclear medicine imaging technique which is used to produce 3D images), Scintimammography (this technique used the radio isotropic to view the lesions of breast. As mammography yields wrong result in dense breast cancer, so for better precision Scintimammography is used for dense breast when multiple tumors are suspected), Electrical impedance based imaging (also used for comparison between normal and cancerous breast tissue as they have lower impedance as compared to normal tissue). Thus this paper concludes that the different techniques provided containing some advantage and disadvantages in order to detect cancer and explains and suggests moving towards new technique such as CAD for better analyzing.

2. **R.Bhanumathi and G.R.Suresh, "Latest Advances in Computer-Aided Detection of Breast Cancer by Mammography", November 2013:-** This paper describes that the detection of cancer at early stage is the best way to cure it. So a new system named as CAD (Computer-Aided-Detection) plays an important role in early detection of breast cancer and helps in reducing death rates. This paper deals with the description of all the abnormalities that could occur as a breast cancer and the ways to detect it using CAD techniques. Here the Abnormalities explained are Detection of masses, Classification abnormality, architectural distortion, and bilateral asymmetry.

3. ***Shilpa kamdi, R.K.Krishna, "Image Segmentation and Region Growing Algorithm":-***
This paper deals with the different techniques used in image processing which involves image segmentation as it is a wide topic for research. Also explains techniques that can be used for segmentation are Threshold based, Edge based and region based. The main concern is made upon region growing approach in which segmentation is done through adding the neighboring pixels when examined to the pixels which posses same behavior likewise the whole image is segmented. The threshold based technique partition the image pixels on the basis of predefined threshold value through comparing the value with the pixels. The edge based segmentation involves the position of the pixels at the boundary of the region in the image e.g. in case of breast cancer the boundary of the cancer present inside the breast mammogram. So edge detection works by comparing the perimeter of boundaries must be equal to the regions or objects present inside the input image. Now the next approach is region based in which a seed point is initialized and it starts adding neighboring pixels which comes as similar to that pixel on comparison and thus increase the size of the region. Hence, the iteration continues till all the regions are not segmented. There are some methods available of region growing they are:- Uniform Blocking, Merge-split blocking, region growing by mean, region growing by min-max, dissolve. These methods and there are more methods through which regions could be extracted or segmented.

4. ***Hilary Alto et al, "content Based Retrieval and Analysis of Mammographic masses", April-June 2005:-*** *This paper explains the experiment investigated upon patient's mammogram on their shape, edge sharpness and texture features. The experiment was conducted upon 57 regions in which 20 are malignant and 37 are benign. They used 3 shape features like:- compactness, fractional concavity, and speculation, 14 textural features and 4 edge-sharpness features were computed to detect mass regions. Then out of these features some features are selected and using them classification is done.*

5. **Chia-Hung et al, "Mammogram Retrieval on Similar Mass Lesions", 2012:-** This paper provides the knowledge about the content-based mammogram retrieval systems, which helps to seek the mass lesions in breasts. This paper deals with the shape and margin features of mass lesions to identify the characteristic of cancer. The database used is DDSM for image retrieval also a very important feature used is Zernike moments which are used for specifying the round shape out of all other mass shapes named round, oval , lobulated and irregular and circumscribed –margin out of other margins like circumscribed(well-defined), obscured, microlobuated, indistinct, spiculated. Through the use of Zernike moments the system achieves the highest precision among all the masses lesions. This paper explains all the features that are used to differentiate between shape, texture, margin, density. According to this research the shape includes features like compactness, fractional concavity, speculation index. The texture features include 14 features include gray level co-occurrence matrix which involves energy, contrast, correlation, variance, entropy, inverse difference moment, sum average, sum variance, difference variance, inertia, sum entropy, difference entropy, representing the texture property.

6. **Weiying Xie, Yunsong Li et al, "Breast Mass classification in digital mammography based on extreme learning machine", 2015:-** This paper deals with the CAD (computer-aided diagnosis) technique which helps in the diagnosis of the Breast cancer with the help if extreme learning machine (ELM). This whole paper is divided into various sections in which each section corresponds to the one step ahead to get the final result. 1st section involves segmentation of the mammographic image by removing the interference and provide image enhancement then followed by the ROI extraction on which features are collected and extracted. In this, feature selection is obtained through the combination of SVM and ELM. This proves the CAD technique not only provides the effective result but also achieves considerable reduction time in training time.

7. ***Sri Hartati et al, "Selection Mammogram Texture Descriptors Based on Statistics Properties Backpropogation Structure", May 2013:-*** According to this paper the benign masses mammogram also have different texture patterns. The researcher used fifty mammogram images and divides them into training and testing samples. So to determine the full accuracy using texture feature, so methods used for feature extraction are first order statistics and second order statistics. In this the textures are classified into nine groups using Backpropogation learning including two types of multi-layer perceptron. The database used is MIAS which consists of 322 images out of which 54 are benign and 39 are malignant. The feature extraction is carried by first order statistics and then second order statistics where first order deals with the method of retrieving image from image histogram using parameters like- Mean, Variance, skewness, Kurtosis, Entropy. 2nd order deals with calculating the relation between using two pixels using 6 parameters like- entropy, contrast, correlation, ASM, IDM, variance. The technique used for classification is Backpropogation which is a type of artificial neural network.

III. DIFFERENT TECHNIQUES USED TO DEETCT CANCER[1]

There are several modalities which help in detecting cancer in breast cells using the enhanced gray scale-images. Some of them techniques are:

A. Mammography

Mammography [1] is one of the most familiar methods of breast imaging. This type of imaging technique consists of low dose x-rays which are used to examine human breast, due to this the mortality rate decreases by 25-30%. The main problem is noticed that it is hard to detect cancer at early stage in screening process. Thus it scientifically proved to be more suitable for screening and identifying cancerous lesions. Mammography screening could be done again and again as it does not harm the human body but conventionally it is not very sensitive in detecting cancer in dense breast tissues.

B. Breast Ultrasound

Breast ultrasound [1] imaging modality is a type of detection technique which uses the very high frequency or rate of sound waves inside the breast tissues and helps in detecting the presence of cancer lesions through the reflected sound waves. These detected waves are used to display 2d images, as the sensor moved over breast continues images are obtained. As mammography misses the many cancers in dense breasted women, so ultrasound is used to identify cancer lesions if not detected in mammogram imaging. In the studies, it is found that 68% of cancer present in women's with dense/ very dense breast. The combination of ultrasound and mammography results in more accurate detection of cancer. Ultrasound technology is improved as 3D ultrasound in which the sound waves projects the 3D images for diagnosis.

C. Breast thermography [1]

As we know the cells inside the human body posses same metabolic rate but when the cells reflects different properties means they are different. As a result the affected cells and the cells which show some symptoms of cancer i.e. premature cells have higher metabolic rate than the normal ones resulting in the growth of new blood vessels which supplies nutrients to help the cells grow faster. Therefore, the temperature of the area surrounded by the cancerous and pre-cancerous cells is higher than the normal ones. Through the breast thermography quantifiable changes are observed in the skin temperatures between healthy and unhealthy breasts. The cyclic variation in temperature is of breast thermogram is studied to obtain results which depict the difference between normal and abnormal cells.

D. MRI

MRI is Magnetic Resonance Imaging [1], it uses a single proton i.e. Hydrogen nucleus for imaging purposes because it is rich in fat and water. Because the hydrogen nucleus used in MRI possesses magnetic property, its utilization produces detailed images from any part of the body.The patient when examined using MRI is placed under magnetic field and a radio frequency wave is applied to produce highly contrast images of breast. It is a popular diagnosis, used for tumor treatment. The patients who are at risk, MRI screening is broadly used for premature detection. MRI is useful for women with higher risk of breast cancer, it has good resolution and effective to detect dense breasts and also it has no side effects as it has no radiations. The drawback of this technique is that sometimes it may lead to the false positive results; it is slow, and very expensive to use.

E. PET

PET [1] is Positron Emission Tomography, is a nuclear medicine imaging technique used to produce 3D images. In this type of technique, pair of gamma (γ) rays is detected which are emitted by radionuclide that are produced into human body. The difference between malignant tumor and normal one is detected through the increased glucose metabolism in malignant tumor, thus results in producing good contrast between cells in PET images. It is an expensive technique and gives poor resolution of images plus patient's body is exposed to radiations.

F. Optical imaging

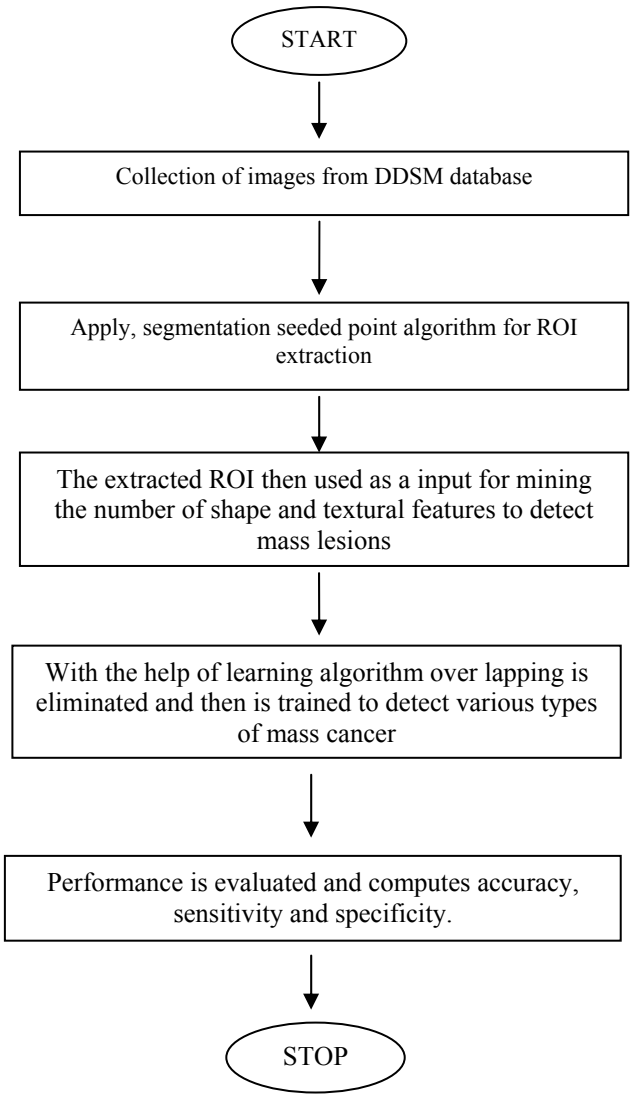
Optical imaging [1] uses near infrared (NIR) wavelength light to detect lesions inside the breast. There are different types of optical imaging techniques which are differentiated

with each other through the wavelength of light they uses to identify the lesions, those types are: Diffuse optical imaging (uses NIR), diffuse optical tomography (uses NIR wavelength light of 700nm-1000nm. Optical imaging provides some extra features to radiologic imaging techniques.

G. Electrical impedance imaging [1]

There is interesting piece of information that the human's body proffers the impedance to the surge of electric current. It is found in experiments that the cancerous breast cells comprise lower impedance as compared to normal ones. EIT (electrical impedance tomography) and EIS (electrical impedance scanning) are two types of electrical impedance techniques available. In EIT, 2D and 3D images are produced from a large number of impedance values while in EIS a planner electrode array is and there is no need to develop an algorithm as used for EIT.

IV. METHOD TO SHOW THE PROCESS OF DETECTION [3][4]



V. DIFFERENT SEGMENTATION TECHNIQUES

One of the most difficult tasks is to extract the particular region or call it Region of interest from the obtained image. The ROI is the affected area which possesses different properties as compared to the other body tissues; in case of breast cancer it is compared with breast tissues. The image segmentation is a primary step to separate and to develop multiple segments. While segmenting image, it is a process of assigning labels on the basis of similar pixels.

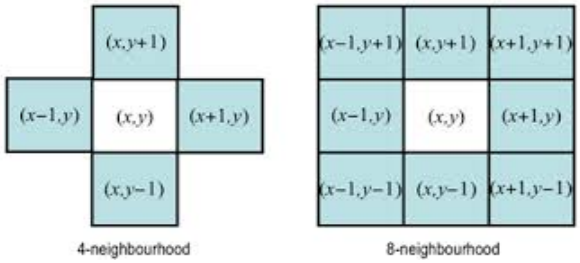
There exists several approaches to achieve image segmentation, they are:-

- Threshold based [5][6]
- Region based
- Boundary or edge detection, and
- Hybrid approach

[6]Under threshold approach, segmentation if image is done through defining a threshold value and on the basis of that value the image is partitioned. This approach is not very good with noisy and blurred images. [7]The boundary or edge approach determines the edge of the available cancer through the use of gradient operator. Whereas another approach is region based, in this approach the image is determined directly i.e. each pixel is compared to its neighboring pixel. The region based approach is performed either region growing method or clustering of pixels or splitting & merging method.

There is an algorithm proposed for segmentation is Seeded region growing based segmentation [8], which is controlled by set of pixels, called seeds. This approach starts with the allocating a seed point, and further exceeds by merging the neighboring pixels into growing region. Then, the neighboring pixels are merged on the basis of similarity criteria. Then another seed point is selected and same processing is continued until the whole image is divided into regions. But the hardest part of this algorithm is selecting a reliable seed point. The region growing algorithm using seeded growing method is computed through either by 4-connectivity and 8-connectivity i.e. in 4-connectivity the neighboring pixels are connected horizontally and vertically only, while in 8-connectivty the diagonal pixels are included with horizontal and vertical pixels and they represents similarity between pixels.

III.1 figure illustrates the working of 4-connectinvity and 8-connectivity of pixels [9]



The simplest way is to measure the difference of intensity value of a pixel. If the difference is less than specific threshold then the pixel belongs to the particular region and gets labeled. Thus, the criteria of image segmentation helps in extracting the interested or affected region on which further classification could be determine to obtain greater result of early detection of breast cancer.

VI. CLASSIFICATION AND ANALYZING THE PRESENCE OF CANCER

As far this review paper is concerned, to achieve the proper result to detect the cancer accurately at early stage and to do that certain steps must be followed :-

i. This review paper deals with the detection of benign masses which shows several features through the extraction of those features it confirms that the extracted ROI is mass type of cancer abnormality.

ii. The masses abnormality can be examined through the extraction of appropriate features such as this research paper deals with the Shape and Texture features.

iii. The mass cancer remains at the benign until it has the shapes like circle and oval and hence shape descriptor defines several features through which extracted ROI's shape could be defined. Some of these features [10][11] are: - Margin, density, circularity, Zernike moments, convexity etc. These features helps in defining the edges of the region extracted whether it is circumscribed (well defined) or obscured (broken edges) and to check density is low or high. Also, the Zernike moments are the features which represent accurate descriptor using few points only.

iv. The another feature [20] i.e. texture descriptor is also used to identify the cancer type as it analyzes the pattern of pixel intensities, their correlation, entropy, mean, angular second moment, skewness and many more. Through the extraction of these features from ROI makes it similar to identify the presence of mass lesions.

v. [21] Thus, from the earlier studies it is obtained that the shape and texture features are very useful and most significant features to use so therefore this research relates with the use of both features together to detect mass lesions using the learning method that is deep learning artificial neural network.

vi. ANN [25][26] deals with the learning mechanism in which the machine or nodes learns itself from the provided patterns and inputs and then produces the result based on the learning. Deep learning mechanism used for images in ANN this helps in eliminating the overlapping of the affected cells with the unaffected ones who comes along with the segmented image.

vii. Thus, [26] the ANN learning method helps in evaluating the performance through providing some training samples for learning and further tested for performance using new problems which is one of the main objectives of this review paper i.e. to evaluate accuracy, sensitivity and specificity percentage through the calculation of false positives, false negatives, true positives and true negatives values.

VII. SUMMARY

As we know that the breast cancer is one of the 2nd dangerous cancers caused among the women of age 40-65. From above details it has been obtained that the identification and extraction of breast benign mass are done through the use of different techniques most common of them is mammogram and using distinctive features i.e. shape, texture etc but in this paper deals with the objective to show the comparison between techniques which is able to detect early breasts masses disorder collectively with the help of shape and the texture feature after the suitable ROI extraction using appropriate seed point algorithm. Thus to carry out the research the main aim behind the whole detection of mass lesions is to obtain the greater accuracy during the early stage of cancer so as the cancer would be detected soon and the increase in death rates would become decrease in number. Also there is a new proposal is proposed in which with the use of more than one features and deep learning ANN method whose performance could be tested over the existing database i.e. DDSM standard database of mammographic images and later can be used if comes to be effective and useful.

The whole summarization of this review paper is listed in the below table.
Table VII.1

Types of Detection Techniques	Approach used	Advantages	Dis-advantages
Mammography	Through retrieving X-rays	Easy to diagnose and un-harmful	Could not able to detect the denser breasts.
Ultrasound	Using high frequency sound waves	Improved than mammography, used for denser breasts	Harmful for patients when used more than once
Thermography	Comparing temperatures of normal cells and affected ones	Used in very early diagnosis also	Widely used. but only in cases if there are prior symptoms of cancer
MRI	Uses hydrogen particle to produce images	Good and helpful approach. Gives accurate result	Very costly to afford.
PET	Show contrast between normal and cancerous cells	Uses at the higher risks	Detection of cancer is 50% using this technique
Optical Imaging	Uses near infrared wavelength light	Reduces patient exposure to harmful radiation, used for visualizing soft tissues etc.	Could be used for early detection

These techniques help in detecting various types of breast cancers like:-

Table VII.2

• **Breast Masses**	**It is of 4 types:-Benign- round & Oval Malignant- lobulated & irregular**
• **Breast Micro Classification**	Occurs in the form of small deposits of calcium creates a cancer.
• **Architectural distortion**	Appears no visible mass but radiated speculations. It is malignant type of cancer and harder to detect.
• **Asymmetry breast tissue**	Checks the symmetry between both the breasts to verify the difference and detect changes

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