A REVIEW OF IMAGE ANALYSIS TECHNIQUES USED IN BREAST CANCER DETECTION

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Abstract

Bosom malignant growth is one of the most dreadful and life threatening disease which these days is most commonly diagnosed among women. It occurs while cells are in the breast begin to multiply abnormally and attack neighboring tissues or spread all through the body. Early recognition of the malignant growth can only improve the success factor of the treatment. Hence, efforts were made to enhance the precise nature of breast cancer prognosis the usage of specific imaging modalities. Various methods and systems are proposed to early detect and diagnose the disease by many researchers and physicians. This paper presents an overview of methods that have been proposed for the detection and analysis of breast cancer, the methodology used by the researchers and their observation.

Keywords- Breast Cancer, thermography, thermoacoustic imaging, histopathology

I. Introduction

The present century is often called as the cancer century because more than 100 types of cancer have been identified in this century. Secondly, because of number of medical efforts made to detect and fight against all kinds of cancers in world. Breast cancer is the largest cause of death these days [1]. Figure 1 shows the estimated number of new cases of females of all ages suffering from cancer of all types worldwide in 2018. Breast cancer begins from different parts of the body. They are classified depending upon where they originate.

- **Ductal cancer**: A cancer that begins in the duct which carries milk to the nipple.
- **Lobular cancer**: A cancer that occurs in the milk producing glands of the breast.
- **Inflammatory breast cancer**: An uncommon type of breast cancer. It makes the skin red and feels warm. It makes the skin appear thick and pitted.
- **Paget disease of the nipple**: The cancer begins in the ducts of breast and spreads to the skin of the nipple and then to the dark circle around the nipple.
- **Phyllodes tumour**: This cancer develops in the stroma of the breast.
- **Angiosarcoma**: This variety of cancer begins in cells that line lymph vessels or blood vessels.

![Estimated number of new cases in 2018, worldwide, all cancers, females, all ages](image)

**Fig 1.** Estimated number of new cases in 2018, worldwide, all cancers, females, all ages [2]

There is no particular symptom of breast cancer, only early identification of malignancy can increase the chances of cure. Various medical imaging techniques are widely used by experts and researchers for explicit diagnosis and better treatment of diseases. The as of now utilized modalities to distinguish bosom malignant growth incorporate i. mammography, ii. breast ultrasound, iii. thermography, iv. magnetic resonance imaging (MRI), v. positron emission tomography (PET), vi. optical imaging, vii. electrical impedance based imaging, and viii. computed tomography (CT) [1]. According to the previous researchers the mammography imaging has a few disadvantages, for example, to be obtrusive, agonizing, and ill-advised for ladies with thick bosoms, inserts, fibrocystic bosoms, or on hormone substitution treatment. Nonetheless, specialists accept that electromagnetic radiation in view of the production of transformations in qualities can likewise be an activating component for cancerous growth. Accordingly, ultrasound strategy for such patients is prescribed. It is a non-intrusive imaging system that is helpful to decide type and type of mass; however this imaging relies upon doctor understanding and information. X-ray likewise as mammography cannot recognize the contrast between a cancerous lump and a considerate cyst. [3]. However these modalities provide antagonistic and complementary information in comparison to one other, hence the studies suggest the combined analysis of results can help in better diagnosis of results and higher accuracy. Which leads for the development of model called information fusion. Now a days, information fusion and Image registration are considered best companion for medical imaging experts contributing in better diagnosis and improvement of the results .The challenge in information fusion is to preserve all the information without introducing any artifact, noise,
blurring of image and inconsistencies. Information fusion sometimes can also be termed as Image fusion. Image fusion is divided into:

a) Spatial domain fusion  
b) Transform domain fusion

In Spatial domain fusion directly pixels of the input images is considered and processed. In Transform domain fusion the image is processed after transformation of image into frequency domain. Various types of image fusion techniques are Feature level fusion, Pixel / Data level fusion and Decision level fusion. Figure 2 represents various image level fusion techniques.

1. Pixel level fusion
Pixel level combination joins the crude information gathered from a few source pictures into one picture. In pixel level combination the pixel is gotten from the estimation of set of pixels in the various data sources. The advantage of pixel level combination is the immediate inclusion of the measured quantities in the fusion process.

2. Feature level fusion
Feature level combination manages the fusion of textual features or edges while in decision level fusion it results by joining choices from few specialists. In other word, before converging of highlights together there is the necessity of extraction of features from source information.

3. Decision level image fusion
Decision-level combination includes fusion of data by sensors that is preliminary resolute by sensors. Instances of decision level Fusion strategies incorporate Bayesian inference, Dempster–Shafer method, classical inference, and weighted decision methods. It is high level fusion in which actual level target is pointed.

![Image level fusion techniques](image-url)
A lot of research has been done but yet there is large scope to improve the result. There is a need to design good fusion technique or recognize fusion components that would result better. A hybrid feature extraction technique can be applied with classification to improve the diagnosis of malignant and benign breast. Discussion of this paper is as follows. Section 2 discusses about the various techniques and methodologies used by several researchers. Section 3 concludes the review.

II. Review of Literature

Rastghalam et al.[3] proposed a breast cancer detection algorithm which is based on asymmetric analysis. The paper tells the importance of thermography and defines a novel surface feature dependent on Markov Random Field (MRF) in which two modified versions of Local Binary Pattern (LBP) are used. The proposed technique aims to categorize the cancerous breasts from the non-cancerous breasts by implementing decision level fusion using Hidden Markov Model (HMM). The designed framework reduces the false positive error rate.

For the results the author has studied 65 breast thermography images which they divided into training dataset containing 33 images and test dataset of 32 images. The results gathered by the experiment shows that the proposed method was successfully able to extract useful features from the images which could help to differentiate between the normal and the abnormal breast. On the test image server, the false negative rate of 8.3% and the false positive rate of 5% were obtained.

Reis et al.[4] in the paper aims to sort and broadly classify the stromal regions according to the nature and maturity of tumor in the breast. For the detection and extraction of the features the author has used multi-scale Basic Image Features (BIF) and Local Binary Patterns (LBP) techniques and for the classification of tumor random decision trees has been used. For the dataset the author has acquired images from cases in the King’s Health Parter’s Cancer Biobank from where total of 55 H&E stained slides of patients detected with cancer was taken. The experimental results in the paper depicts that the proposed technique is comprehensively able to differentiate breast cancer stroma maturity level and the multi-scale approach used in the paper is able to achieve 84% accuracy.

Gao et al.[5] in the paper reports the investigation of distorted Born iterative method (DBIM) performance which is an iterative method exhibiting huge dielectric properties. The paper tells that prior guess of the dielectric properties of the breast are required in order to compare the sensitivity of DBIM imaging accuracy with the properties obtained by the homogeneous initial guess. The experiment was conducted for a multi-frequency formulation of DBIM and the parameters of the Debye model for the initial guess of breast tissue properties were used.

Being DBIM an iterative method, the number of iterations required were decided using 3D realistic breast phantoms. The results in the paper shows that the proposed method gives near
optimal performance and the images yield are nearly identical to the initial guesses obtained by accurate averages.

**Grzegorczyk et al.[6]** in this paper has discussed various obstacles at the hardware and software level in gathering correct and error free data of the patients suffering from cancer using Microwave breast imaging technique in which the time of tens of hours and even more was consumed in extracting a single 3-D tomographic image. Author in the paper has proposed the improvements that can be made at the hardware and software level in order to resolve the issue. The new system developed is based on a different synergy between hardware and software where the hardware is designed integrating features like cross-plane data gathering in MR chamber. In the proposed system hardware is able to measure signals which are well-matched with the sub-centimeter image keeping exam time below 2 min and the software develops the error free images in less than 20 min. For the results the dataset used in the paper has been taken from 400+ exams held at the Dartmouth Hitchcock Medical center.

**Li et al.[7]** in this paper proposed a method to identify breast cancer at an early stage by implementing ultra-wide band(UWB) micro imaging technique which is named as ensemble empirical mode decomposition(EEMD). In the previous methods implemented by various researchers the tumor response was obtained by subtracting the calibration waveform from the detected signals but in the proposed method the image for the tumor can obtained directly from the extracted signals as- detected waveforms without the usage of the tumor-free model. For the experimental results the two MRI’s from two different types of breast of two patients were taken and it is observed that the proposed method was able to effectively detect the tumor of 4mm diameter which is located inside the glandular region in the breast.

**Gorgel et al.[8]** in the paper presents the categorization of breast tumor as either benign(non cancerous) or malignant (cancerous). In order to categorize tumor three steps have been used by the author wherein the first step involves the usage of spherical wavelet transform (SVM) on the actual ROI. Secondly, the extraction of scaling coefficients and features of wavelet based on step, shape, boundary and grey scale is done. Thirdly, the categorization of the maturity level of tumor i.e. benign or malignant is done by providing the feature matrices to the support vector machine. The diagram presenting the diagnosis process used in the paper is depicted in the Fig 3. The paper-based dataset is taken from Turkey’s Istanbul University Hospital and the free mammographic image analysis society to apply the program. The results shows that the this study may prove to be helpful in early detection of cancer and may reduce the number of biopsies as the proposed method achieves 91.4% and 90.1% classification accuracy using the mentioned datasets.
Botterill et al.[9] in the paper describes a digital image based tomography (DIET) system to identify tumor in which 3-D surface motion of breast is imaged while being vibrated by inferring the internal stiffness of the breast. A model-based division is utilized to recognize the profile of the bosom in each picture, and the 3-D surface is recreated by fitting a model to the profiles. The surface movement is estimated utilizing a cutting edge optical stream execution altered to the application, and then trajectories of points on the 3-D surface are given by combining the optical stream with the reconstructed surfaces.

This procedure comprises of four stages. Firstly, each image is sectioned, to precisely localize the profile of the bosom. Secondly, a 3-D surface model of the bosom is assessed by fitting a model to the breast profiles. Thirdly, the skin surface movement between pictures from each pair of is figured with a thick optical flow algorithm. Finally, the 3-D surface motion is assessed by joining the optical stream fields with the reconstructed surfaces. The paper exhibits that the proposed framework can identify tumor of 10 mm in a silicone phantom breast.

Xu et al.[10] in the paper presents a real time monitoring strategy which depends on thermoacoustic imaging procedure. In this system, thermoacoustic imaging is joined with the compressive detecting to improve the observing proficiency. Demonstrating work is performed related to the numerical simulations to research the proposed methodology. In the paper simulation results of the displaying work portrays the viability of the observing technique.

Abbosh et al.[11] in the paper presents a microwave imaging based technique for recognizing breast cancer dependent on the closeness between the left and right bosoms of a person. In the strategy utilized the two bosoms are all the while examined utilizing two balanced antenna arrays and all together assemble the mirror-imaged direction of the two bosoms, one of the gathered information as matrix is then flipped. The two matrices are then properly oriented utilizing cross-correlation to take any asymmetry in the area of the bosom as for the pertinent antenna array exhibit. The two matrices are prepared to frame two individual pictures. An examination between the dispersing powers of the two bosom pictures at the area of the maximum intensity in the differential picture chooses which bosom incorporates a tumor.
According to the results of the proposed method presented in the paper, depicts that it enhances tumor detection and diminish the plausibility of organs and different tissues delivering bogus positive targets.

Hossain et al.[12] A new Coherent-Beamspace-Time Reversal-Maximum Likelihood (C-B-TR-ML) method for acquiring accurate tumor areas with reduced computational weight was proposed in the paper. The technique relies on time-reversal (TR) microwave imaging in beam space to identify and locate different tumors in extremely dense, 3-D phantoms of the bosom. Time Reversal Operator (DORT) and Time Reversal MUSIC (TRMUSIC) algorithms were stretched out for regular decomposition to compare the results. The results according to the paper demonstrates the prevalent abilities of the proposed C-B-TR-ML microwave imaging method in identifying and restricting various tumors inserted inside profoundly thick bosom phantoms.

After literature survey we found some of the research gaps. A research gap is characterized as territory for which absent or lacking data restricts the capacity to arrive at a decision for an inquiry. Following are some research gaps which have been identified in detection of Breast cancer.

1. Current tumor segmentation and visualization techniques are still insufficient in efficiency and reliability. Techniques which could increase the accuracy rate of detection of cancer in normal and dense breast need to be implemented.
2. Majority of the recognition conspire have underlined on its microwave innovations and its produced restorative pictures. In any case, the significant confinement will be the lesser degree of benchmarking and less viable relative examination. Thus, more accentuation on Signal Generation Process is required.
3. Existing component selection procedures are not so much advanced as iterative, causing little effect on the recognition procedure's expanding accuracy. For the process of extraction of features, transform-based techniques are needed.
4. Use of computational system is very less with regards to grouping procedure of bosom malignant growth. So, more optimized frameworks are required.
5. The majority of the existing work discusses less about the practical applications of the proposed techniques for detecting breast cancer rather than the mathematical and theoretical explanations.
6. In the current techniques the false negative rate is considerably higher, new method need to be implemented to decrease the false negative rate.

III. Conclusion
Current breast imaging systems assume an imperative job in helping specialists in the essential screening of disease, in the analysis and portrayal of sores, arranging and restaging, treatment determination and treatment progress observing and in deciding malignant growth repeat. We explored the capabilities of the various breast imaging techniques suggested by different researchers in this paper. In spite of many techniques are developed, not all techniques are
valuable for all types of cancer images. Still there is a need to design good fusion technique or recognize fusion components that would result in better and timely detection of normal and malignant tumor.

References