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Survey on the Detection of Breast Tumour by Thermography

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Abstract*: Thermography or DITI is known as a possible breast cancer screening imaging modality with the help of high-resolution cameras, as it does not have the harmful radiation effects similar to that of mammography. The sensitivity and specificity of mammograms remain less than optimal, especially for patients with dense breast tissue. Thermal images of the breast are obtained with IR cameras and computational tools are used to represent heat transfer accurately within the breast have increased the accuracy of thermography. Recent advances and suggestions for future work in the field including using advanced simulation methods, inverse modelling, imaging protocols, and using artificial neural networks to better predict the location of the carcinogenic tumour are also presented. This paper gives the survey on some of the image processing methods or the processes that are involved in the breast cancer detection from thermal images.

Keywords: Artificial Neural Network(ANN), Breast Cancer, Image Processing, Infrared(IR) cameras , Mammography, Thermography, Thermal Images.

I. INTRODUCTION

The term “Cancer” is used to describe a group of disorders associated with dis-regulated cell growth leading to tumor formation, invasion into surrounding tissues and spread to other parts of the body. Some of the most common types of cancer originate in the breast, prostrate, lung, skin and pancreas. The exact reasons for developing cancer have not been determined [3, 6]. It is the second leading cause of death and is a major health problem in many parts of the world [30]. Breast Cancer is the most frequently diagnosed form of cancer among women and has highest mortality rate after Skin Cancer. It is estimated that the lifetime probability of being diagnosed with invasive breast cancer among women is 12.3% with 246,660 women expected to be diagnosed with breast cancer in the US in 2016 [34].

It occurs in both men and women although male breast cancer is a rare disease. Some works have reported that the growth rate of a tumor is proportional to its temperature [39]. Screening looks for cancer before a person presents any symptom. It can help to find cancer at an early stage. When cancer is found earlier, the healing chances are greater. If a screening test result is abnormal, more diagnostic tests are necessary to define whether the finding is a cancer [2]. Each type of test presents specific characteristics. The combination of different explorations is fundamental, because most of them are complementary. For instance, information obtained from Breast Ultrasound, dedicated Breast CT, Tomosynthesis and Mammography is morphological [39].

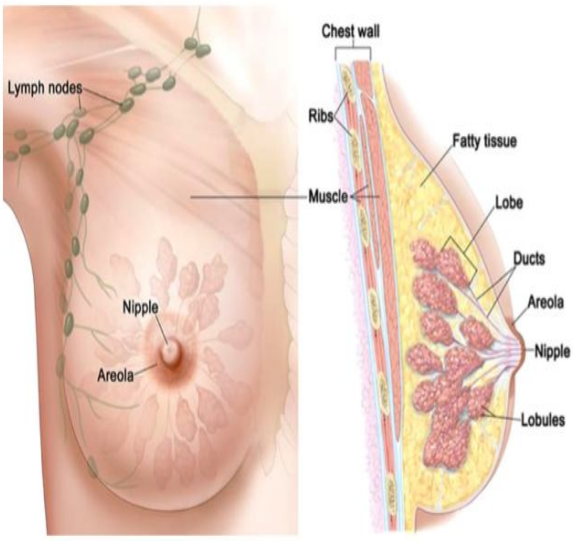

Fig 1: Anatomy of Breast [38]

Currently few Visualization Techniques and Non- Visualization Techniques are used in Breast Cancer detection and most popularly the following are used;

A. Visualization Techniques

1) Mammography
2) Ultrasonography
3) Magnetic Resonance, and

B. Non-Visualization Techniques

1) BiopsyZ
2) BRCA1/BRCA2 Gene Mutation Detection.

All listed Techniques require expensive equipment and cannot be executed at home [15, 31].

Mammography is the golden standard for Breast Cancer Screening and detection. Data from randomized controlled breast cancer screening trials has demonstrated a 25% reduction in mortality in women over age 50 and a 15% reduction in mortality in women aged 40-49 [26, 35]. Despite the value of most image detected lesions requiring biopsy are Histo-Logically benign [19]. In an attempt to minimize the number of false-positive biopsies, alternative imaging techniques continued to be investigated.

C. Infrared Thermography

Digital Infrared Thermal Imaging (DITI) or the Infrared Thermography works on the principle of measuring the Radiation emitted by a surface to determine its temperature [32].

Breast Thermography is an adjunct diagnostic tool, to Mammography for Breast Cancer screening. It is non-invasive, painless, and relatively inexpensive procedure for early detection of Breast Cancer since it does not involve compression of the breast into medicine after the observation that the skin temperature over a malignant tumour in the breast is frequently between 1 and 3°C hotter than the surrounding skin [18]. Thermography is a biological or a functional exam [39]. The Infrared Image presents Physiological information of normal and abnormal functioning of the vascular system, sensorial, and sympathetic nervous system and inflammatory processes [12, 40]. The concept of combined diagnostic, presented in the modern diagnostic centre, allows the achievement of a high degree of specificity and sensibility on such diagnosis [37].

Thermography is very useful for detecting non- palpable Breast Cancer that is those that cannot be detected by other exams. This also applies to non-palpable but histological advanced or those with fast and aggressive growth [40]. It is a complementary exam to detect Breast disease [38].

II. LITERATURE SURVEY

Dr. Ray Lawson (1956), [5, 16, 18, 22, 32], was one of the first researchers to report the use of surface temperature measurements as a possible tool for breast cancer diagnosis. And he pioneered the use of Thermography for breast cancer screening by performing the first infrared breast scan using a device called the thermo scan, which led to subsequent widespread acceptance of thermography.

Lawson and Chutgai(1963),[17] used IR scanners to determine that the surface temperature of the region surrounding a tumor is about 2°C higher than the surface temperature of the same region on the contralateral healthy breast.

Gautherie and Gross (1980), [9] reported the study of 1245 patients who were detected to have abnormal IR image profiles. They observed that IR imaging, besides to predict cancer, can identify rapidly growing neoplasms. Gautherie later in 1983,found that 35% of the patients with abnormal thermograms developed cancer during the next 5 years, therefore they stated that IR thermography can predict the development of breast cancer.

T.B. Borchartt et. al., (2012)[38] Breast Thermography from an image processing viewpoint: A Survey, explores and analyses these works in the light of their applications in computer vision. Consequently, the comments are organized according to the main steps of pattern recognition systems. These include: image acquisition protocols, exams storage, segmentation methods, feature extraction, classification or diagnostic and computer modeling and is summarized from several papers on the use of infrared imaging from breast screening can be found in the medical literature.

Prof Seema singh and Sushmita H (2014) [33], has presented An Efficient neural network based system for diagnosis of breast cancer. In this paper, author has implemented an efficient neural network for diagnosis of the breast cancer. They also have explained the supervised and unsupervised methods tested to develop the most efficient alternative for breast cancer diagnosis. They have used Back propagation algorithm. The comparison of different types of classifiers has been added.

B.M.Gayathri, C.P.Sumathi and T.Santhanam, (2013)[11], Breast Cancer Diagnosis using Machine Learning Algorithms –A Survey; paper summarizes the survey on breast cancer diagnosis using various machine learning algorithms and methods, which are used to improve the accuracy of predicting cancer. This survey can also help us to know about number of papers that are implemented to diagnose the breast cancer.

A. Image Preprocessing

Minavathi, Murali. S, M.S. Dinesh (2012) [20], presented the research on Classification of Mass in Breast Ultrasound Images using Image Processing Techniques. In the proposed method, ultrasound images are preprocessed using Gaussian smoothing to remove additive noise and anisotropic diffusion filters to remove multiplicative noise (speckle noise). Active contour method has been used to extract a closed contour of filtered image which is the boundary of the spiculated mass. Spiculations which make breast mass unstructured or irregular are marked by measuring the angle of curvature of each pixel at the boundary of mass.

APPROACH	EXPLANATION	MERITS
Global Histogram Modification Approach	Reassign the intensity values of pixels to make the new distribution of the intensities uniform to the utmost extent	Useful in magnifying the complete image with low contrast.
Local Approach	Feature-based or using nonlinear mapping locally	Effective in local texture enhancement

Table1: Presents Pre-processing Approaches

B. Image Segmentation

Motta.et.al (2010)[23], presented a fully automatic segmentation method. Such method is based on automatic threshold, automatic border detection, and extraction of infra-mammary folds by using mathematical morphology. The described approach seperates both breasts as much symmetrically as possible. There are two drawbacks in this method of automatic ROI Extraction. The first is that the detected ROI's upper limit. (i.e the lower line crossing the axilla) may exclude a portion of the upper quadrant of the breast. The second drawback is not including the lymphatic nodes of the mamma in the axillar regions (fig 1.1). Although both regions may presents cancer, the second is usually neglected by automatic segmentation techniques.

Motta [2010] [24] also improves a previous approach [23]. The new method has seven main steps: (i) a threshold is used ROI lower limit, (ii) Otsu's method [28] is employed to remove the background; (iii) ROI upper limit is obtained by detecting the axilla; (iv) arms and external objects are removed by detecting the largest object in the same image; (v) body central axis is used to separate the breast;(vi) infra-mammary fold is found; and (vii) a vertical displacement is performed to make each ROI more adequate for feature extraction based on the symmetrical analysis. Motta [24] applied his approach to 150 patients and compared them to manual (ground true) segmentation performed by 5 specialists. The resulting ROI's are available for public comparison [29]. Such automatic results were evaluated qualitatively and quantitatively considering the rates of false positives, false negatives, true positives and true negatives.

Jin-Yu et.al.,[2009][13], presented a genetic algorithm based on chaotic two-dimensional Otsu Method[28]. This algorithm can be used in generic IR thermal images, not only in breast thermo grams. The proposed method was designed to segment regions with higher temperature in thermal images presenting high levels of noise. It comprised of four steps: (i) use logistic mapping equations to initialize the population of the genetic algorithm, (ii) use the chaotic two-dimensional Otsu [28] method to calculate fitness of current population, (iii) when the end condition is achieved, the best individual in returned and the algorithm ends, otherwise the procedure continues,(iv) generate a new population by selection, crossover and mutation operations and return to step(iii). Each individual of population represent a possible ROI Segmentation. Authors report that average time of the segmentation to 10 thermograms with dimensions of 198x173 pixels is 4.83s.

Ashmitha khaleel khan & Noufal P (2014) [5], have presented, the Wavelet based automatic lesion detection using improved active contour method. In this paper, we have proposed a method- improved active contour method that helps in the segmentation process for lesion Detection. In this method before segmentation preprocessing and Dwt of image in done.in this mean filter or average filter has been explain to improve the image quality for human viewers, and the wiener filter is used for noise Suppression. The adaptive

median filter performs also mentioned about spatial processing used to determine which pixels in an image have been affected by impulse noise.

C. Feature Extraction

Sonal Naranje (2016)[36], This paper gives the automatic detection of Breast cancer using Image processing techniques and artificial neural network .The mammogram images have taken from MIAS(Mammography Image Analysis Society). Image processing includes various techniques to make the digital mammogram image perfect for artificial neural network. The input image undergoes through many processes which include preprocessing, image enhancement, noise removal, mass image, targeted image, segmentation, feature extraction. The statistical parameter is important step in mammogram classification. The best extracted feature is texture parameter, by which the abnormalities can be easily identified. Texture is a method of capturing pattern in the image. Statistical parameters include texture, entropy, mean, standard deviation, energy, co-relation. This parameter will be given as input to Classifier. ANN is used for classification between cancerous and noncancerous image. The design and implementation of the proposed algorithm is done in MATLAB using advance image processing toolbox.

R. Nithya, B. Santhi (2005-2011)[25] have presented the paper omn comparative study of feature extraction method for breast cancer classification. This paper presents three different feature extraction methods they are intensity histogram, GLCM (Grey Level Co-occurrence Matrix) and intensity based features for classification of normal and abnormal pattern in mammogram. This method comes under texture measure. The results are proving that GLCM features based neural network is giving higher classification rate of 98% a supervised classifier system based on neural network is used.

AUTHOR	FEATURE EXTRACTION	EVALUATION CRITERIA	SPECIAL CHARACTERISTICS
Acharya et al [1]	Homogeneity, Energy,Entropy,4 first moments, Angular second moment, contrast, mean, short, and long runs emphasis, run percentage, grey level and run length non-uniformity	Support Vector Machine(SVM)	Three-fold stratified cross validation was used to test the SVM classifier. 36 images for training (18 normal and 18 malignant)
Wiecek et.al[41]	Mean, Standard deviation, Variance, Skew-ness, Kurtosis, Energy, difference variance, correlation, inverse difference, and entropy.	ANN	Not Specified
Ng and Kee [27]	Mean, Mode, Points of temperature, median and biological data of patient	ANN,RNFN	Linear regression and correlation
Borchartt et al [38]	Range of temperature, mean, Standard deviation and the last bin of a quantisation of ten bins	SVM	Not Specified
Arora et al [4]	Proprietary System	Three way: Screening, clinical and ANN	Not specified

Table 2: Some Works Related On Feature Extraction

D. Classification

In Ng and Kee (2007) [27], gives the classification which was made using an ANN. Linear Regression was applied in date and a RBF network was used to decide the diagnostic in patient. The validation of the proposed approach was performed using ROC curves. The authors reported precisions of 80.95%, sensibility of 81.2% and specificity of 88.2% such values as much better than the typical ones achieved by human specialists, around 60 and 70%.

Acharya et al.,(2010)[1], train a support vector machine (SVM)[7] classifier. They apply cross-validation to discriminate between normal and malignant breast conditions. Their system produces an accuracy of 88.1 %, sensitivity of 85.71% and specificity of 90.48% applied SVM for automatic classification of images as normal and malignant breast condition.

Arore.et.al (2008) [4], has analyzed 92 patients, of whom 58 have some malignant tumor and 34 some benign tumor. Each patient underwent three types of analysis, named by the authors as (i) screening, (ii) clinical, and (iii) artificial neural network. In the first analysis the patients, where ranked according the risk of breast cancer from zero (without risk) to seven (very high risk). In the clinical analysis the authors used mammography and ultrasound images to verify the assessment as positive or negative for pathology. The neural-network based analysis applied an artificial intelligence technique to identify the presence of a malignant tumor in the breast.

Wiecek et.al (1999), [41] classify the thermal images as “with tumor” or “without tumor”. Their approach was evaluated using 30 images of healthy patients and co images of patients with malignant tumor. For each patient breast four thermogram were acquired with frontal and lateral views. The author claims that they use an ANN to analyze the extracted features. However, they report results only for the coverage of the temperatures.

Mital and Pidarati (2008) [21], combined ANNs, genetic algorithms and computer Simulations to relate the skin surface temperature with the tumor depth, diameter and heat generation. The ANN was trained with the tumor characteristics to predict the surface temperature distribution. A genetic algorithm received an experimental or numerical temperature to find the corresponding tumor parameters with an initial population conformed by the outputs of the neural network. The computational domain consisted of a layered semi-spherical breast. The surface temperatures found with the ANN showed good agreement with the numerical simulation. The genetic algorithm determined tumor depth and diameter within an error of 5mm and 2mm respectively.

III.CONCLUSION

Cancer is the most common disease in women in many countries. Early detection of cancer can reduce mortality rate.

The aim of this research is to make sure that it is possible to use breast thermograms for tumour detection. In this survey paper, several image processing methods or the approaches that are involved in the breast cancer detection from thermal images are discussed.

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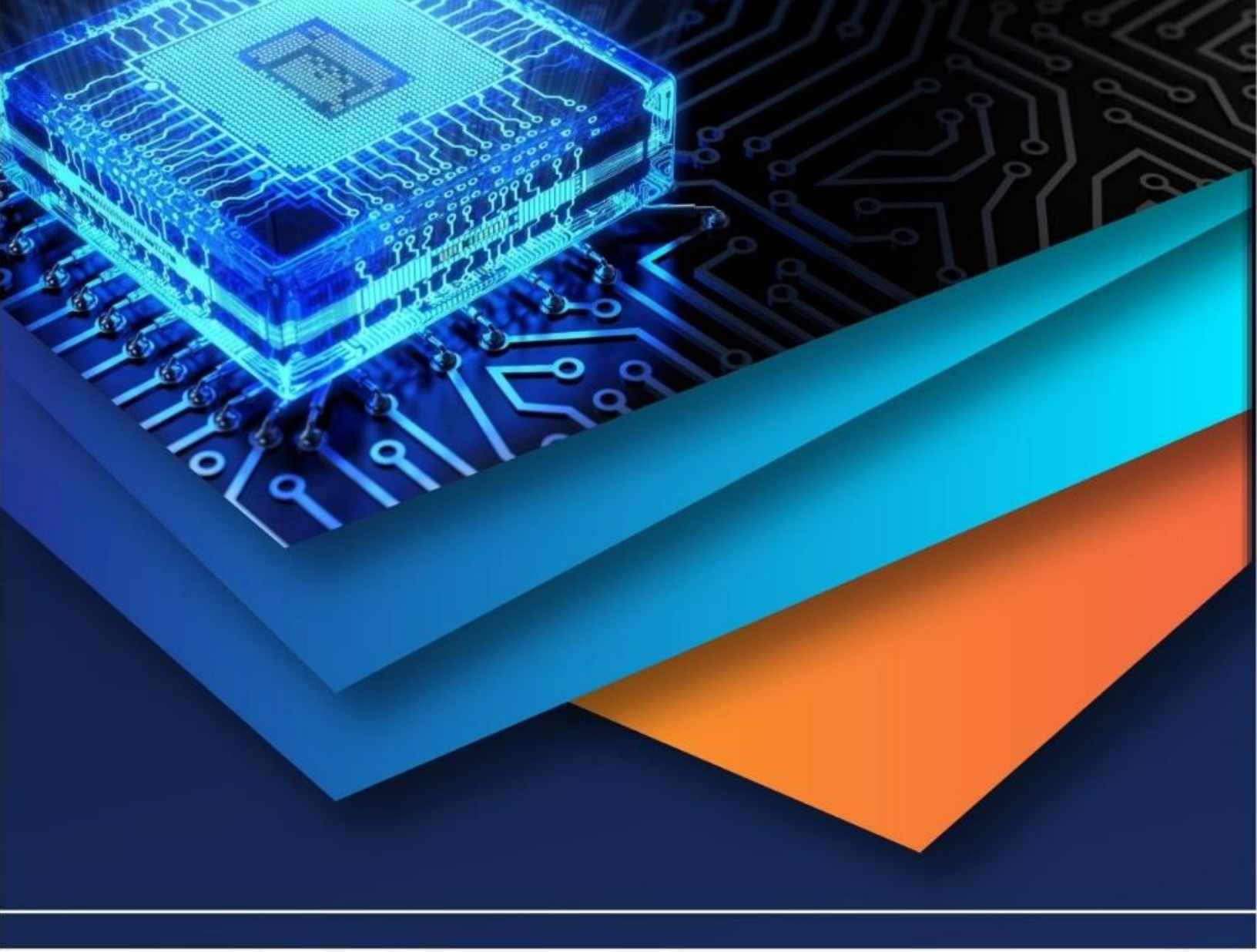

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