BREAST CANCER DETECTION USING THERMOGRAPHY

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Abstract - *The International Agency for Research on Cancer (IARC) estimates that globally, 1 in 5 people develop cancer during their lifetime, and 1 in 8 men and 1 in 11 women die from the disease. These new estimates suggest that more than 50 million people are living within five years of a past cancer diagnosis. Ageing populations globally and socio-economic risk factors remain among the primary factors driving this increase. Breast Cancer represents 1 in 4 cancers diagnosed among women globally. Colorectal, lung, cervical, and thyroid cancers are also common among women.For the 1st time, female breast cancer has become the most commonly dignosed cancer, surpassing lung cancer, in particular due to high prevalence in low- and middle-income countries (LMICs). There are two early detection strategies for breast cancer: early diagnosis and screening. The thermogram is more proper screening and has lower cost than other types of screening methods like the mammogram, ultrasound, and magnetic resonance imaging depending on a temperature of breast and surrounding area by using a special heat-sensing camerato determine the heat in the region of breasts. To classify healthy and unhealthy cases of breast cancer, methods are divided into image acquisition, preprocessing, segmentation, feature extraction and classification. This paper focuses on reviewing detection and classification of the breast cancer using thermography images.*

***Key Words*:** Breast Cancer, Thermography, Image acquisition, Preprocessing, Feature extraction and classification

1. INTRODUCTION

From decades cervical cancer was the most common cancer in women in India, and more deaths in women in India were due to cervical cancer than any other cancer. However, over the last 10 years till now, breast cancer has been rising steadily and for the first time in 2012, breast cancer was the most common cancer in women in India, a step ahead of cervical cancer. This is partly due to an actual decrease in the incidence of cervical cancer. However, mostly due to a rapid rise in the number of breast cancer cases, the incidence of this disease has been consistently increasing, and it is estimated that it has risen by 50% between 1965 and 1985. The annual percentage change in the incidence ranged from 0.46 to 2.56 for breast cancer. In 2015, it is estimated 155,000 new cases of breast cancer and about 76,000 women in India died due to the disease. Breast cancer seems to be more common in the younger age group in India and 52% of all women suffering from breast cancer in Mumbai are between 40 and 49 years of age. A significant number of patients are below 30 years. The population-based registries show a significant rural/urban division in the breast cancer incidence. However hospital based registries may be biased due to varying reference patters/socioeconomic and other factors.

In order to improve breast cancer survival rate, early detection is critical. There are two early detection strategies for breast cancer: early diagnosis and screening. Limited resource settings with weak health systems where the majority of women are diagnosed in late stages should priorities early diagnosis programs based on awareness of early signs and symptoms and prompt referral to diagnosis and treatment. It takes years for most cancers to develop to the stage that they can be detected with mammogram or ultrasound

Hence DITI is ideally placed as a screening tool to identify changes over time in the 'early' development stages, before there is a more advanced pathology that can be known as 'Thermogram'. These thermogram are used to find certain heat patterns of interests. By using image classification algorithm (CNN) we can study these thermogram and make a statement about the probability that a certain host is infected by a certain disease. The use of thermography for detection of breast cancer has existed since 1950's. With the advancement in DITI the rate of false positives is diminishing so this technique has the potential to replace the old methods in near future.

2. LITERATURE SURVEY

1) Artificial neural network (ANN) with back propagation used as an evaluation criteria by the Koay et al. [4] in 2004 for study they analyzed thermal images of 19 patients with known clinical outcome taken from a database of 86 patients at Moncton Hospital's breast cancer screening clinic. Monique Frize and her team recorded the thermal images in 1984 byThermovision 680 Medical from Agatronics connected to an OSCAR 780 it is first generation thermographic camera. They extract Mean, standard deviation, median, maximum, minimum, skewness, kurtosis, entropy, area and heat content as feature for the analysis

2) In 2007, Ng and Kee investigates the analysis of thermograms in the technique proposed by Ng and Kee,

[1] they used comprising of Linear Regression (LR), Radial Basis Function Network (RBFN) and Receiver Operating Characteristics (ROC) as multipronged approach.

3) The research paper by Arora et al. [5] in 2008 used three way for evaluation an overall risk score in the screening mode, a clinical score based on patient information, and a third assessment by artificial neural network in which they found Digital infrared thermal imaging identified 58 of 60 malignancies, they had used of 94 biopsies in which 60 were malignant and 34 were benign and in result the 97% sensitivity, 44% specificity, and 82% negative predictive value depending on the mode used

4) A series of statistical features extracted from the thermograms quantifying the bilateral differences between left and right breast areas by Schaefer et al. [18, 19] in 2009, coupled with a fuzzy rulebased classification system for diagnosis. In this research work they extract Basic statistical features, moments, histogram features, cross co-occurrence matrix, mutual information, and Fourier analysis of thermograms of a large dataset of nearly 150 cases confirm and provides a classification accuracy of about 80%.

5) Kosus et al., 2010 [4] discussed pre-digital mammography (FFDM) and digital infrared thermal imaging (DITI) as imaging modalities that could overcome the limitations of mammography

6) The research base developed by Boogerd et al [6] on fluorescence imaging (FI), as applied to liver surgery, shows FI significance during laparoscopic resections of several liver tumors. It is unlike computed tomography and magnetic resonance imaging (MRI), which have low sensitivity for sub-centimeter lesions due to their limited spatial resolution. It therefore seems that FI is suitable for surgeons to identify small superficial tumors in the liver. Surgeons need a highly sensitive, real-time intraoperative imaging modalit.

7) Public finance expenditure for social insurance benefits to breast cancer sufferers ranged from 50.2 million EUR (2010) to 56.6 million EUR (2014), or 0.72–0.79% of the total expenses for all diseases. Loss of opportunity in public finance revenue amounted to 173.9 million EUR in 2010 and 211.0 million EUR in 2014 [28].

8) In 2011 Borchartt et al. [8] found average results of accuracy 85.71%, sensitivity 95.83% and specificity 25.00% for the extracted feature classification a supervised learning method based on support vector machine (SVM) was used. Extracted features were Range of temperature, mean, standard deviation and the last bin of a quantization of ten bins. In 2011 two more research papers are published one is by Zadeh et al. [8] in which for classification k-means and c-means is used where as in other paper SVM implementation present on WEKA software is used by Resmini [3]. In [3] obtained accuracy 82.14%, sensibility 91.7% and specificity 25%.

9) Unar-Mungu'ıa et al., 2017 [9] estimated that 245 million USD in medical expenses and income lost due to breast cancer could be spared over the life of a cohort of Mexican women. Medical costs account for 80% of the economic burden; loss of income and opportunity costs for carers represent 15% and 5%, respectively.

10) According to the study performed by Kandlikar et al., 2017 [10], the false positive diagnosis rate for women after having a mammogram each year for 10 years is 49.1%. Another study showed that when women were advised to do an NLS (Sentinel Lymph Node) biopsy, this reduced the risk of progression of the disease (breast cancer) ; moreover, other authors Kontos et al., 2011 have advised against taking breast cancer thermography results as sufficient information for decision-making.

2.1 BREAST CANCER

Breast cancer is a disease in which cells in the breast grow out of control. There are different kinds of breast cancer. The kind of breast cancer depends on which cells in the breast turn into cancer. Breast cancer can spread outside the breast through blood vessels and lymph vessels. When breast cancer spreads to other parts of the body, it is said to have metastasized. The most common kinds of breast cancer are-

Invasive ductal carcinoma- The cancer cells grow outside the ducts into other parts of the breast tissue.

Invasive lobular carcinoma -Cancer cells spread from the lobules to the breast tissues that are close by.

Factors responsible for breast cancer includes being female, obesity, a lack of physical exercise, hormone replacement therapy during menopause,ionizing radiation, an early age at first menstruation, having children late in life or not at all, older age, having a prior history of breast cancer.

2.2. WHAT IS THERMOGRAPHY?

Digital infrared thermal imaging also abbreviated as DITI is a totally non-invasive clinical imaging procedure for screening, detecting and monitoring a number of diseases and physical injuries .It works on the basis of thermal abnormalities present in the body. It uses the heat from the host's body to aid in making diagnosis of a host for health care conditions.

Thermography measures heat radiated from host's body. Metastatic cancers create heat which can be imaged by digital infrared imaging. This is due to two separate yet connected factors.

The first is the metabolic activity of the tumor tissue as compared with the temperature of tissues adjacent to the tumor. By comparing the host in question with the normal host, abnormal heat signatures associated with the metabolism of the tumor can be detected easily. These differences in temperature are referred for determining whether the host is affected or not.

The second method of detection is due to the angiogenesis of the tumor i.e. cancerous tumors produce a chemical which actually promotes the development of blood vessels supplying the area where the tumor resides .Also, normal blood vessels which are vasodilation, or an increase in size of the blood vessel. The increase in blood in the region due to angiogenesis and combined with the vascular dilation simply means more heat, recordable with thermal imaging procedures.

The diseases that DITI can detect include inflammatory pathology infection, lymph dysfunction, vascular changes and also any suspicious activity outside the range or scope of other tests, so again, there is no comparison competition between different tests.

2.3. PROPOSED METHODOLOGY

There are three main Methodologies

1) Image acquisition

2) Pre-processing

3) Feature extraction and classification

Image acquisition: In this step we use special type of camera which is use to convert the infrared radiation emitted from the skin into electrical pulses that are visualized in color on a monitor in an adequateroom with homogenous temperature. Captured images are converted to 24-bit RGB images.

Pre-processing stage: In this step, we remove noise using a median filter. The original images are converted into grayscale. Next we separate the regions of left and right breast from the human body.

Feature Extraction and classification: In this phase we perform feature extraction on the segmented thermogram. First and second order statistical features are extracted by histogram and gray-level Co-occurance matrices (GLCM) of the segmented image

Since the growth of the cancer in the breast is chaotic, we calculate the average value of features obtained from GLCMat the four directions.

These features are used to find the absolute difference between the left and right breast, which is then normalized to the feature vector and then fed to the convolution neural network (CNN) classifier.

In this case, we propose several CNN-based experiments for the diagnosis of breast cancer using thermal images using popular, free and public DMR-IR database, which is accessible through a user friendly online interface and some images of the currently scanned patients.

In first step we apply data preprocessing and data augmentation for each thermal image e.g. crop, resizing, and breast normalization.

In second step, we defined several sets of interconnected experiments that tested different CNN's architectures under different training frameworks based on the database split methodologies and workflow. As our study is based on CNN, the overview of a training process is:

Firstly, each thermal breast image is forwarded through a given number of hidden layers until a loss function is computed; secondly, the loss function is back propagated into these layers, modifying the weights in accordance with an optimizer e.g. Adam. Finally this procedure is looped for given N numbers of epochs until it reaches the desired performance metric value.

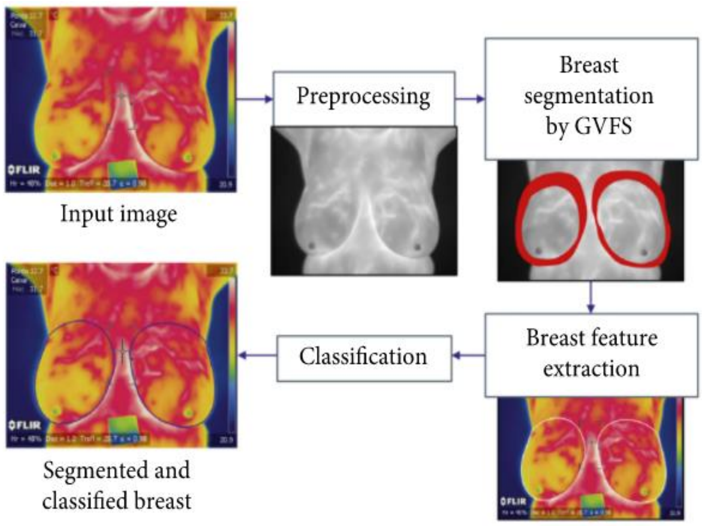

Fig -1: Proposed Methodology

3. CONCLUSIONS

Thermography technique in particular appeared to have a promising future, because of its non-immensive property and the significant amount of data that needs to be processed with more efficient techniques. Infrared imaging coupled with an agent previously administered to a patient can lead to a very accurate tumor detector. The main objective of this work is to make scientific contributions to a biomedical system for the acquisition of thermographic images of breasts via image processing. This work shows that a classification method that uses the combination of breast segmentation GVF and applying CNN classification can be robust and efficient.

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