DIAGNOSIS OF BREAST ABNORMALITY USING TENSORFLOW INFRARED THERMAL IMAGING

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Abstract- Breast thermography is considered particularly valuable for early breast tumours detection. The fast-growing tumour has a higher metabolic rate and associated increase in local vascularization. It will cause the occurrence of some asymmetric heat patterns. Clinical interpretation of a breast thermogram is primarily based on the asymmetry analysis of these heat patterns visually and subjectively. In this paper, a new approach of asymmetry analysis of breast thermograms was proposed. The heat patterns are first segmented with mathematical morphology. The asymmetry analysis is performed both qualitatively and quantitatively according to the extracted features. The abnormality of a breast thermogram is clearly indicated by the features.

Keywords- Breast Cancer; Infrared Thermal Imaging; Thermography; Asymmetry Analysis, tensor flow

I. INTRODUCTION

Breast cancer is one of the most common cancer-related diseases among women worldwide. There were about 1.4 million occurrences of new cases in 2008, more than 100% increment compared to cases reported in 1975. The traditional method for diagnosing the disease relies on human experiences to identify the presence of certain pattern from the database. Other than that, this age-old method is subjected to human error, is inaccurate, time-consuming, and cause unnecessary burden to radiologists. By the time it is detected, it may already be at a critical stage.

The probability of developing breast cancer increases with age and the large risk factors associated with its development, specifically age and gender, are not modifiable. Despite advances in treatment that have reduced breast cancer mortality over the past two decades, next to lung cancer, this disease remains the second leading cause of cancer induced death in women. [1]

The average size of tumours undetected by thermography is 1.28cm, while 1.66 cm by mammography. The result of thermography can be correct 8 - 10 year before mammography can detect a mass. Combining thermography with clinical exam and mammography can increase the relative sensitivity of breast cancer detection to 98%. These heat patterns will occur asymmetrically. We propose a new approach of asymmetry analysis in this paper. The heat patterns are first segmented from the breast thermograms with mathematical morphology. The asymmetry is analysed according to the features extracted from the segmented heat patterns. “All objects above zero Kelvin emit infrared radiation. Emissivity of human skin is high (within 1 % of that of black body) therefore measurements of infrared radiation emitted by skin can be directly converted to temperature. This process is known as Infrared Thermography” [2].

II. IMAGE ACQUISITION

A Thermogram is an infrared thermal image. The images are taken using FLIR E30 Infrared Camera having a spectral response of 8μ m to 14μ m; and 160X120 IR Resolution. The images are obtained in JPEG Format. Skin surface temperature is greatly affected by numerous conditions.

Prior to the Thermo Breasts can, certain protocols must be followed in order to ensure that the images reflect accurate information. The patient is normally asked to avoid alcohol, caffeine and stop smoking two hours before the test and avoid use of lotion, cream on the body area to be imaged. The chest area is cooled with an air conditioner for approximately 10-15 minutes during the image capturing process. The room temperature is adjusted approximately 22º C and darkened during the test to minimize infrared source interferences.

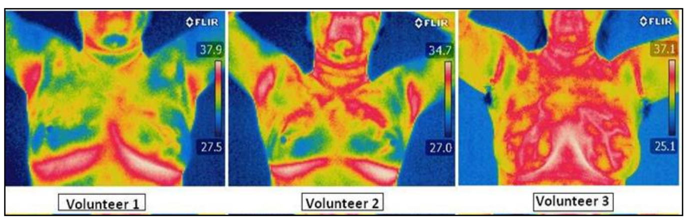

Fig 1. Thermograms of normal breast

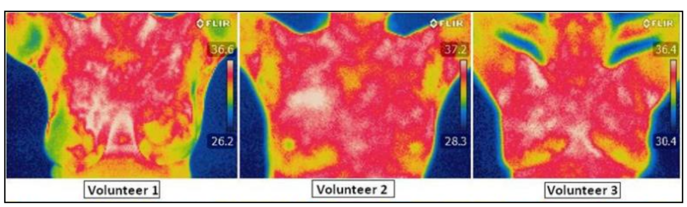

Fig 2. Thermograms of abnormal breast (tumour is present).

III. LITERATURE

The traditional method for diagnosing the disease relies on human experiences to identify the presence of certain pattern from the database. This age-old method is subjected to human error, is inaccurate, and time-consuming, By the time it is detected, it may already be at a critical stage. The most popularly used method presently is X-ray, biopsy and mammography. The drawbacks of these techniques is that it is invasive and experts believe that electromagnetic radiation can also be a triggering factor for cancerous growth.

i. MAMMOGRAPHY

Mammography is the process of using low-energy X-rays to examine the human breast, which is used as a diagnostic and screening tool. The goal of mammography is the early detection of breast cancer, typically through detection of characteristic masses.

ii. BIOPSY:

A breast biopsy is a test that removes tissue or sometimes fluid from the suspicious area. The removed cells are examined under a microscope and further tested to check for the presence of breast cancer.

DISADVANTAGES OF BIOPSY:

- In the event of a positive mammogram, a woman must undergo a secondary assessment phase involving needle or open surgical biopsy to establish a definitive diagnosis. Exposure to unnecessary biopsies is a real danger.
- Biopsy rates for suspected cases of breast cancer vary considerably among countries, indicating that the technical limitations of mammography are only part of the reason for biopsies.

iii. THERMOGRAPHY

Thermography is used in allergy detection and veterinary medicine. It is also used for breast screening, though primarily by alternative practitioners as it is considerably less accurate and specific than competing techniques. Government and airport personnel used thermography to detect suspected swine flu cases during the 2009 pandemic.

ADVANTAGES OF THERMOGRAPHY

- Thermography possesses many advantages, such as non-invasive, innocuous, non-contact, non-radiation, risk free, and considerably less expensive.
- The Food and Drug Administration (FDA), Bureau of Medical Devices has already approved the thermography procedure of screening for breast cancer. In the recent reappraisal of its usage in medicine, it is considered particularly valuable for early breast tumours detection[2].
- It shows a visual picture so temperatures over a large area can be compared.
- It is a non-destructive test method.

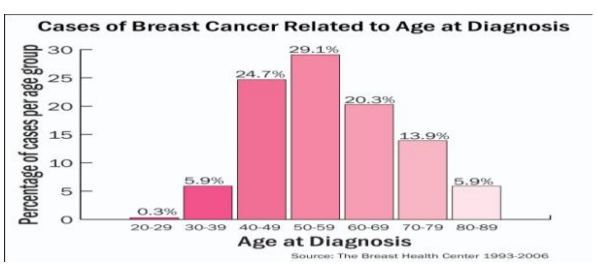

Fig 2.1: Graph showing cases of breast cancer

IV. METHODOLOGY

Clinical interpretation of Breast Thermograms can be done by Asymmetric Analysis of Thermograms [3]. Fig.3 shows an outlined approach for the Asymmetric Analysis of Breast Thermograms. It includes the following steps

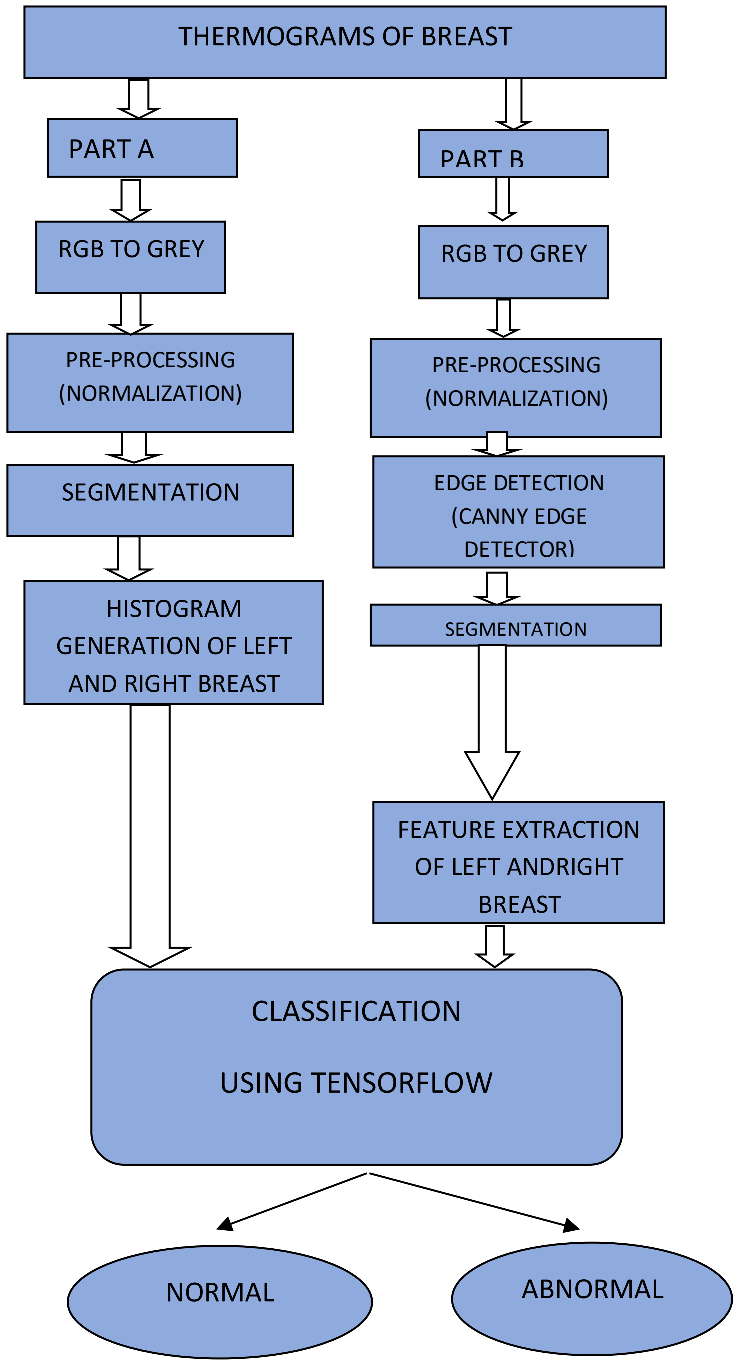

Fig 3. Flow for Asymmetry Analysis of Breast Thermograms.

i. *Pre-Processing*

Pre-Processing is Background removal and then resizing the image to remove the undesired body portion; followed by Normalization.

Normalization is the process of reorganizing data in a database so that it meets two basic requirements

- There is no redundancy of data (all data is stored in only one place).
- Data dependencies are logical (all related data items are stored together). Normalization is also known as contrast stretching

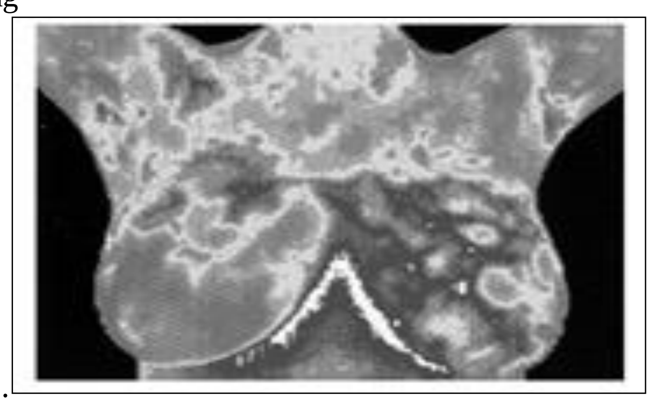

Fig 4. Pre-Processing of Breast Thermogram.

ii. *Edge Detection*

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. As a result, it is robust to noise and implements Gaussian function to smooth the image and to obtain the magnitude and orientation of the gradient for each pixel**.** We have performed edge detection using prewitt and sobel edge detector, but results obtained by canny edge detector are more prominent and appropriate. Hence canny edge detector is used for edge detection purpose [1].

Fig 5. Canny Edge Detection

iii. *Segmentation*

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels).

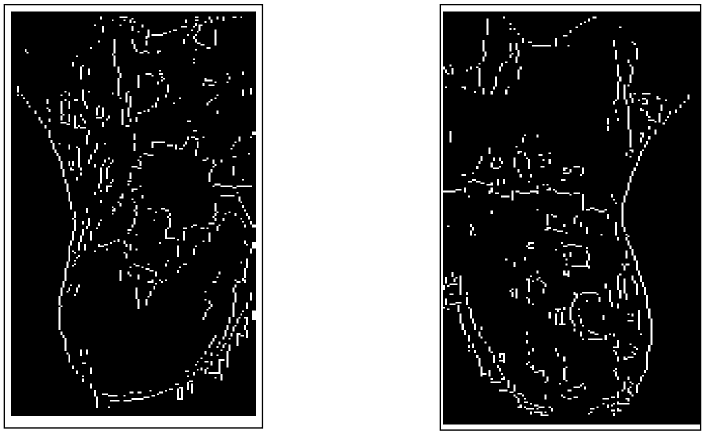

Fig 6.a LEFTBREAST Fig 6.b RIGHT BREAST

Fig 6. Segmented ROI of Thermogram

V. TENSOR FLOW

OBTAINING AND CLEANING THE DATA

I will be assuming you have TensorFlow and the SciPy stack already installed and are using Python version 3.For our imports, we have tensor flow to build our neural network and numpy and pandas for some useful data manipulations.

- **Data Overview**

The raw dataset (courtesy of iSono Health) contains 2,684 labeled 2-D breast ultrasound images in JPEG format:

- **Data Preparation**

Applied a 3x3 median filter to remove the speckle noise on ultrasound images. I also normalized the pixel values on each image so that they had zero mean. It is worth mentioning that 1920 images as a whole is still a relatively small dataset for such a complicated image classification problem. Data augmentation is an attractive solution to reduce overfitting and increase the generalization of the model. I first split the data randomly into 75% training, 12.5% validating, and 12.5% testing datasets.

We now have all of our data in one large ".csv" file. From this combined data file, I have gone ahead and split the data into two separate files, one for training our neural network, and one for testing the accuracy of our model.

TensorFlow know how many rows, columns (excluding the column we are trying to predict), and list of potential outcomes for our model. My method was to simply pick 6 random examples from the combined data set, and place them into the cancer_test.csv file. The remaining elements from the combined data set comprise the cancer_training.csv file.

- **Building the neural network**

Using the steps argument, we specify that we want to train our network for a total of 2000 steps. Note that the target_dtype = np.int signals to TensorFlow that the predictive element that our neural network wants to compute is an integer–either 0 or 1 to denote either benign or malignant.

- **Fully Connected Neural Network**

In a fully connected neural network, each neuron is connected to all the neurons in the previous layer, and each connection has its own weight. However, the information of the weights are not shared by the neurons. Before implementing a fully connected neural network, there was an extra step of converting each 2D image into a 1D array with a size of 1600.

The constructed fully connected neural network has one input layer, three hidden layers that have 512, 256, 128 nodes respectively, and one output layer that has two outputs. The detailed diagram is shown below.

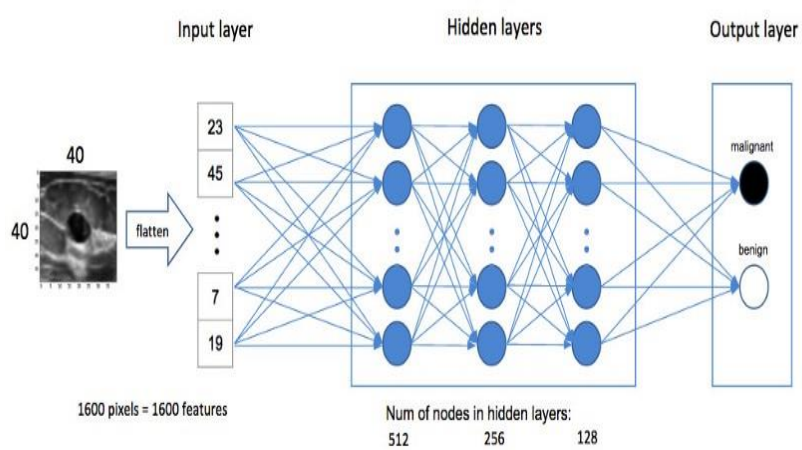

Fig 7. Fully Connected Neural Network

CONCLUSION

Digital Infrared Imaging's ability to detect thermal signs that may suggest a pre-cancerous state of the breast, or signs of cancer at an extremely early stage, lies in its unique capability of monitoring the temperature variations produced by the earliest changes in tissue physiology (function). However, DII does not have the ability to pinpoint the location of a tumor nor can it detect 100% of all cancers. DII does not replace mammography and mammography does not replace DII, the tests complement each other. Since it has been determined that 1 in 8 women will get breast cancer, we must use every means possible to detect cancers when there is the greatest chance for survival. By using the asymmetrical analysis, we can find the cancer at an early stage with an efficiency of 88.24% as trying it on the 20 images. Proper use of breast self-exams, physician exams, DII, and mammography together provide the earliest detection system available to date. If treated in the earliest stages, cure rates greater than 95% are possible.

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