Breast Cancer Detection Using Thermography

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Abstract - *Breast cancer is one of the crucially prevailing cancers among women. Early detection and diagnosis of breast cancer can also be done with the help of mammography which is the most common method, cost effective and provides good chances of recovery. However due to some weakness in mammography; another method called as Infrared Breast thermography is used. Infrared breast thermography is an imaging technique which detects based on thermal changes in the body. This information acts as an indicator that a tumor may be present in the body. Survival rate is improved due to early detection with the help of thermography. Due to increased blood vessel circulation and metabolic activity, the radiations emitted from the human body are higher around the regions where a tumor is present. The thermal information which is shown in a colored image where specific range of temperature is represented by a color assigned to it representing the variations observed throughout the part. The heat patterns as a visual aspect can be used to primarily categorize the clinical interpretation of breast thermogram. This study essays to present color analysis as per the classification on the basis of segmentation. The distinguishable features which are used to detect abnormalities are based upon the variations shown as per the image shape of the hottest regions and it is confirmed by comparing with doctors diagnosis. Hence suitability of infrared thermography as a diagnostic tool in breast cancer detection is established through this study.*

***Key Words*: Breast Cancer, Color Analysis, Infrared Radiation, Infrared Thermal Imaging, Thermography**

1. INTRODUCTION

Breast Cancer is the most common cancers among women. The breast cancer in India is rapidly becoming the number one cancer in females. In India nearly six percent of deaths are due to breast cancer. One out of every 22 women in India is diagnosed with breast cancer. Earliest detection of breast cancer can increase the chance of successful treatment and also survival rate. Currently the Doppler Ultrasonography, Magnetic Resonance Imaging (MRI), Computed Tomography Laser Mammography (CTLM), Positron Emission Mammography (PEM) etc. This paper is organized as follows: Section 1 Presents Introduction. Section 2 presents Methods for Diagnosis of Breast Cancer. Section 3 describes the Breast Thermography. In section 4 the proposed method for the segmentation of hot region based on color using K-means clustering technique.

2. METHOD FOR DIAGNOSIS

Medical imaging techniques started with X-rays for viewing internal structure of the body especially the bone structure. With the advancement in science and technology many medical imaging techniques such as MRI, Ultrasound, CT, PET and few others were discovered. Medical imaging techniques are having two broad categories Invasive, Ionizing and Non-Invasive, Non-Ionizing. Medical imaging techniques which are Non Invasive and Non-Ionizing are safe for human beings and this type of medical imaging techniques can be repeated a number of times. However these techniques only provide information on the anatomical structure which depends primarily on anatomical variations of the tumour from the surrounding breast tissue, lacking functional information. All above methods are often too costly, in accessible or invasive methods to be used as first line detection modalities. Thus, Digital thermal imaging is one of the most accurate and suitable modalities for preliminary screening.

2.1. Digital Infrared Thermal Imaging

Infrared Thermography is a noninvasive and a non-ionizing method for studying the internal structure, especially a cancerous tumour as it relates temperature. Such an imaging technique provides physiological information. Thermography shows heat patterns which may indicate cancer infection, inflammation, surface lesions and more. Thus Digital Infrared Thermal Imaging is a test and it is sensitive to Physiological changes that are precancerous indications that may lead to tumours. Infrared cameras can detect radiation in the infrared range of the electromagnetic spectrum (roughly 0.9to14μm) and produce images of that radiation, called thermograms[3]. Since infrared radiation emitted by all objects depends on their temperatures, according to the black body radiation law. The amount of radiation emitted by an object increases with temperature; thus thermography allows variations in temperature.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 04| Apr -2016 www.irjet.net p-ISSN: 2395-0072

Principle of Thermography

"All objects above zero Kelvin emits infrared radiation. The Stefan-Boltzmann law gives the relationship between the infrared energy and temperature. Emissivity of human skin is high (within1 percent of that of blackbody) therefore measurements of infrared radiation emitted by skin can be directly converted to temperature. This process is known as Infrared Thermography".

3. BREAST THERMOGRAPHY

Breast Thermography is a diagnostic process that takes images of the breasts for early detection of breast cancer. It is an important tool in Breast cancer Screening. The procedure uses the principle that chemical and blood vessel activity in both precancerous tissue and the area surrounding the tissue in breast cancer is almost always higher than in the normal breast. However precancerous and cancerous masses are highly metabolic tissues and they need a large amount supply of nutrients to maintain their growth. So to do this they increase circulation of their cells by sending out chemicals to keep existing blood vessels open and create new ones (neoangiogenesis). This process results in an increase in surface temperatures of the breast[4]. Breast Thermography uses an infrared camera and computer to detect analyse and produce high resolution images of these temperature changes in the breast[5].

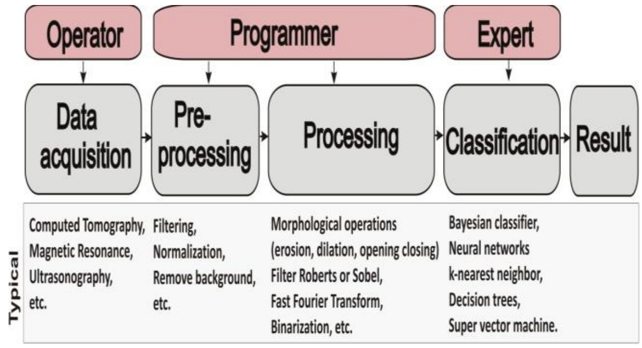

Fig-1: Block diagram for analysis of thermographic images

Pre-Thermographic Instructions

Imaging Instruction Skin surface temperature is greatly affected by various conditions. In order to reduce the errors due to thermal artifacts, above images are taken using a recommended set of instructions to ensure the usefulness and consistency of thermal images. For Thermal Breast Scan, certain protocols must be followed in order to ensure that the images convey accurate information is mentioned below.

1. No prolonged sun exposure to the chest and breast areas 5 days before the scan.

2. Use of lotions, creams, powders, or makeup on the breasts should be avoided, and there should be no use of deodorants or antiperspirants on the day of exam.

3. No shaving (or other types of hair removal) of the chest, breasts, or under arms for 24 hours before the scan.

4. No exercise before 6 hours prior to the scan.

5. No physical stimulation of the breasts before 24 hours of the scan.

Thermographic Procedure

1) Breast Thermography is a 15 min non-invasive test. It is an important procedure for alerting the Doctor to the changes that can indicate early stage Breast cancer.

2) The chest area must be cooled with an air conditioner for approximately10-15 minutes during the process.

3) The room temperature is adjusted approximately 22 degrees Celsius and darkened during the test.

3.1. IMAGE ACQUISITION

Thermogram is an infrared thermal image. The images are taken using FLIRE30 Infrared Camera having a spectral response of8m to 14m and 160X120 IR resolutions. The images are obtained in JPEG Format.

Sample Thermograms

Fig. 1 (a) and (b) show the Thermograms of Volunteers with Normal Breast and with Abnormal Breast respectively. The Thermograms are taken by following the previous PreThemographic Imaging instructions. The Color bar present on the Thermograms provides the temperature distribution indicating the coolest part (blue); intermediate temperature (yellow and red) and the warmest part of the image as white.

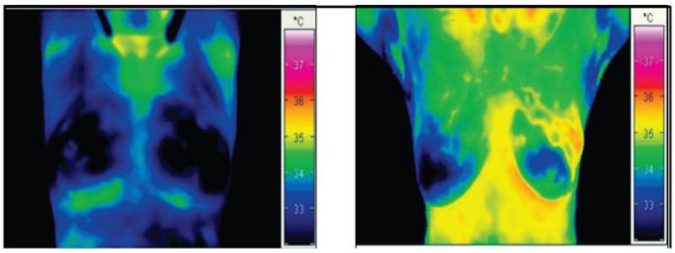

Fig -2: (a) Healthy subject-Symmetrical temperature
(b) Cancerous patient-Abnormal thermogram

3.2. PROPOSED METHOD FOR ANALYSIS OF THERMOGRAPHIC IMAGES

This study presents an efficient image segmentation approach using K-means clustering technique based on color features from the images. Segmentation[2] of hot region is carried out into two steps. In first step, the pixels are clustered based on their color and spatial features, where the clustering process is carried out. Advantages of Proposed Method: 1) It can segment the cancer regions from the image accurately. 2) It is useful to classify the cancer images for accurate detection. 3) Early stage Detection of cancer from images.

3.3. Color Analysis

Currently Doctors visually check the thermograms for lumps, tumors, asymmetry between breasts. This process is done manually, so results are not accurate as well as time consuming and requires an expert for diagnosis. The proposed method provides an automated approach for abnormality detection of breast thermograms. Color Analysis is done to check Abnormality from the Thermograms. The Color based abnormality separation can be done by following three methods: 1. K-Means Clustering. 2. Fuzzy C Means. 3. Level Set Method.

3.3.1. K-Means Clustering

Clustering technique classifies the objects into different number of groups, or partitions a data set into clusters.K-means is a clustering algorithm[2]. In an image K-means finds the natural groupings of pixels present. It is straight forward method and it is generally very fast. It separates the input data set into k clusters. Each cluster is represented by changing cluster centroids, starting from some initial values. K-means clustering determines the distances between the data points and assigns inputs to the nearest cluster.

Let X = {x1,x2,x3,……..,xn} be the set of data points in an image and V = {v1,v2,…….,vc} be the set of centres.

1) Randomly select 'c' cluster centres.

2) Calculate the distance between each data point and cluster centres.

3) Assign the data point to the cluster centre whose distance from the cluster centre is minimum of all the cluster centres.

4) Recalculate the new cluster centre using:

$$v_i = (1/c_i) \sum_{j=1}^{c_i} x_i$$

Where, 'ci' represents the number of data points in i th cluster.

5) Recalculate the distance between each data point and new obtained cluster centers.

6) If no data point was reassigned then stop, otherwise repeat from step 3).

3.3.2. Segmentation of Hot Region:

Image segmentation[3] using k-means algorithm is very useful for the image analysis. An important aim of image segmentation is to separate the object and background clear. The basic aim of the proposed method is to segment colors automatically using the K-means clustering technique. The introduced framework of hot region segmentation operates in six steps as follows:

1) Step 1: The input image of breast thermograms.

2) Step 2: Transform Image from RGB color space to L*a*b*Color Space. The L*a*b*color space consists of a luminosity layer in 'L*'channel and two chromaticity layer in 'a*' and 'b*' channels. In a* and b* only the color information is present.

3) Step 3: Classify Colors using K-Means Clustering in 'a*b*'Space. Euclidean distance metric method is used, to measure the difference between two colors.

4) Step 4: Label Each Pixel in the image from the Results of K-Means. For every pixel in our input, K means calculates an index corresponding to a cluster. Every pixel of the image will be labeled with its cluster index.

5) Step 5: Generate Images that Segment the Input Image by Color. We have to separate the pixels in image by color using pixel labels, which will result different images based on the number of clusters.

6) Step 6: K-means does not return the same cluster index value every time. But this can be done using the center value of clusters, which contains the mean value of a*'and b*' for each cluster. Following is the Flowchart of K-means:

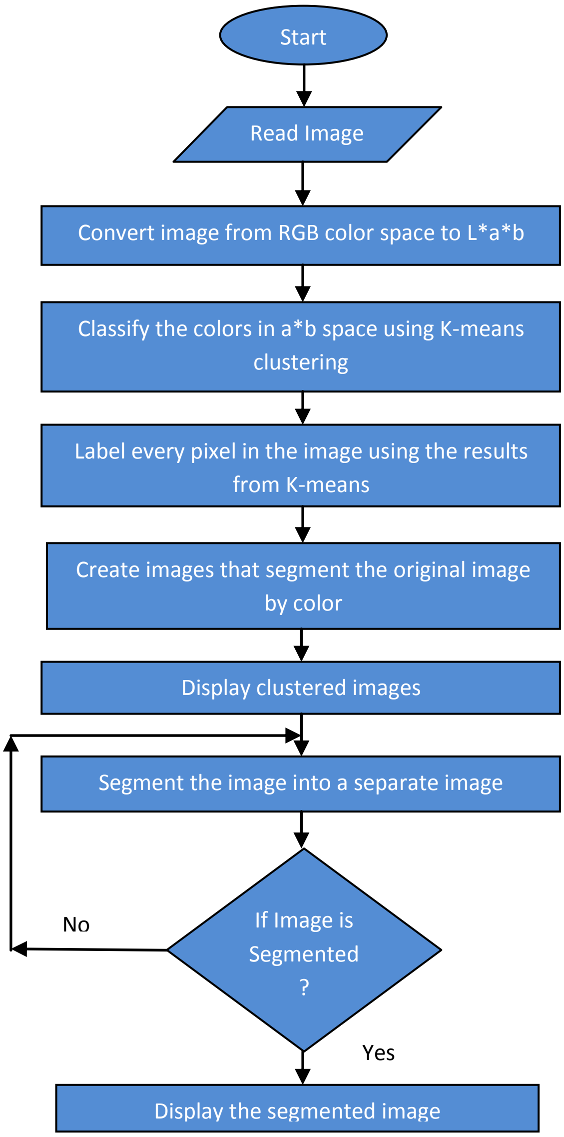

Fig-3: Hot region Segmentation

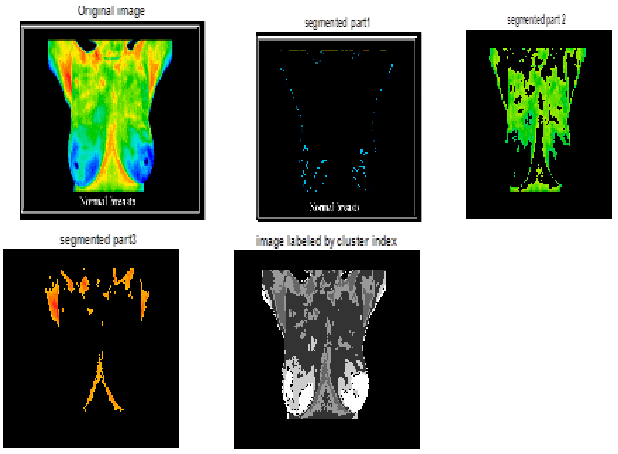

Fig-4: Hot region segmentation of normal breast

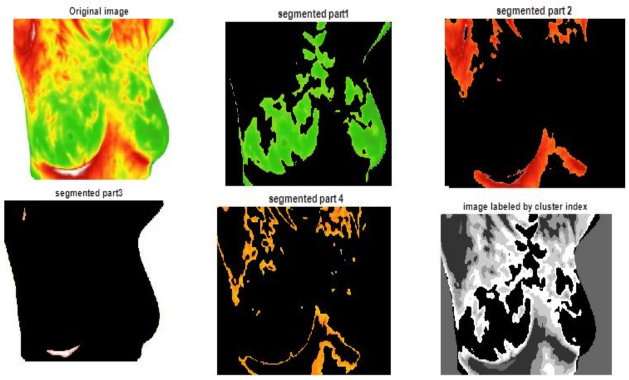

Fig-5: Hot region Segmentation of abnormal breast

4. CONCLUSION

This work presents an approach which deals with Analysis of Breast Thermograms based on Color analysis for Abnormality Detection based on K-Means Clustering. Thus it can be concluded for a Thermogram as normal/abnormal indicating cyst, lump, or an infection for an abnormal Thermogram. A framework for the Color Analysis of Breast Thermograms is pro- posed and evaluated in this paper. The proposed approach used K-means clustering technique for segmenting hot region using three clusters. Experimental results suggest that the proposed approach is able to accurately segment the hot regions in the image. But there are several limitations of K-means clustering like 1) Difficult to predict K-Value 2) It does not yield the same result with each run. 3) With global cluster, it didn't work well. 4) It does not work well with clusters (in the original data) of Different size and Different density. 5) Empty clusters can be obtained if no points are allocated to a cluster during the assignment step. So to overcome these limitations of k-means the future work includes development of Fuzzy C Means[2] and Level Set Methods for segmentation of breast thermograms accurately.

ACKNOWLEDGEMENT

We are highly indebted to our project guide Prof. Priya Hankare for her guidance and constant supervision for providing us necessary information and constructive ideas regarding this project. Our special thanks to her for giving us her attention and time and providing us invaluable support in understanding various aspects of image processing.

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