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Semi - Automatic Segmentation of Human Breast from Thermal Images for Analysis of Human Breast Cancer

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Abstract: ***Breast cancer is a dreadful disease in woman and it is very common between the age group of 25 - 40, above 40 it becomes more malignant and also difficult to diagnose as it spreads at a faster rate and it cannot be treated. Infrared Thermography (IR) is preferred as one such technique for diagnosis, as it has the ability to detect the temperature variations which differentiates between hot spots and cold spots. The hot spots are likely to be the cancer area. This paper proposes a technique for segmentation of breasts into left and right respectively. An infrared image is taken and the breast segmentation is carried out semi - automatically. Segmentation is a crucial step for analysis purposes. The original contribution of this work is to separate the breast by segmentation and thresholding techniques for further analysis.***

Keywords: Image Processing, Thermography, Semi - Automatic Segmentation.

1. Introduction

Breast cancer occurs very common during the early age at menarche and late age at menopause. The primary reason for breast cancer is hereditary and some other secondary reasons are life style and reproductive factors which play a large role. More than 1.6 million people are affected as per the statistics of 2010. In India the statistics from 2007 to 2010 it has doubled from 48, 170 to 50, 000, so the figure has put at 50, 821. The incidence varies between developed and under developed countries. The developed countries are likely to be affected because of the lifestyle, but in under developed countries there are no proper screening tools so it was detected only during later stage, but the incidence of breast cancer in India is much lower compared to the western countries. This statistics also varies between urban and rural women; in Mumbai are about 27 new cases per 100, 000 women per year while in rural Maharashtra it is only 8 per 100, 000. A tumor is generally been formed when there is development of new cells surrounding the breast tissues. These new cells are supplied with blood supply and nutrients, which is been produced by the "BAD" cells. The vascular beds in the breast tissue supply the nutrients and blood to these pre - cancerous and cancerous cells, there is also release of chemicals from these cells. This is called as "hot spots". The "hot spots" are produced due to the additional activity in the cells creating increase in temperature. The role of thermography comes here, it is a non - contact, non - invasive, non - contact, passive, radiation free techniques, so the use thermal images has grown in medical applications. Thermography can easily differentiate between the "hot spots - cancerous area" and "cold spots - non cancerous area" [1], [2], [3], [4], [5]. Due to additional activity in cancerous area there will be change in temperature. Thermography is a best screening tool for early detection of breast cancer based on temperature distribution [6] and variation on the breast tissue. Segmentation is a crucial step for analysis purposes. In existing methodologies, [7], [8], [9], [10], the analysis are carried out either by direct cropping of breasts into left and right, or by automatically segmenting the breasts. The disadvantage in direct cropping is the cropping area of left and right needn't be same since it is done manually, a fixed ratio for cropping both the breasts cannot be used as the anatomical structure of both the breasts may vary [11], [12]. The difficulty in automatic segmentation is again the anatomical structure of breast varies in length, size and these parameters vary from person to person [13], [14], [15], [16], [17]. This paper proposes a method where it overcomes all these discrepancies by segmenting the breasts semi - automatically, in which the pixel values are fed to find the lower and upper contour detection. Hence this is an efficient, as well as a common technique which can be used for different women irrespective of their anatomical features.

2. Proposed Approach

The original image undergoes two types of threshold one is normal thresholding as shown in Figure 3.1. a, to achieve lower contour or edge detection, the second thresholding to the original image is Otsu's thresholding to achieve upper contour detection as shown in Figure 2. After the normal thresholding, morphological operations [18], [19], [20] and thinning filter should be performed to the thresholded image, this gives the lower contour or edge as shown in Figure 3.1. b. Similarly after performing Otsu"s thresholding [21], contour detection must be done to detect the upper contour or edges as shown in Figure 3.2. Overlapping of the contours should be done on the original image and central coordinate are found as shown in Figure 3.3. Now the image is segmented keeping the centre coordinate as reference and the image is cropped into left and right breasts as shown in Figure 3.4. a and3.4. b.

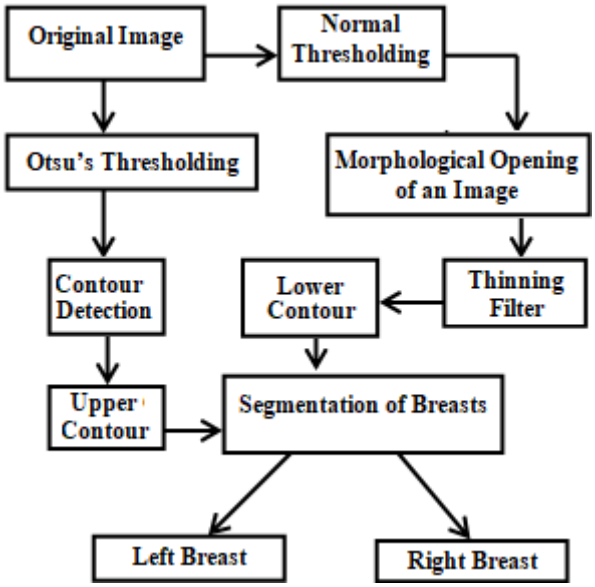
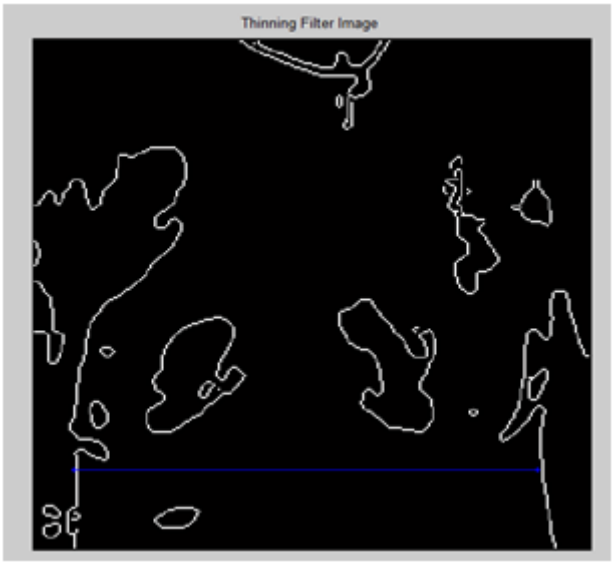


Figure 2: Block Diagram of Semi - Automatic Segmentation

3. Results

a) Normal Thresholding



b) Thinning Filter Figure 3.1 Lower Contour Detection

Figure 3.1 shows lower contour detection, where Figure a shows normal thresholded image and Figure b denotes the thinning filter image which shows the lower contour or edge. Figure 3.2 shows the upper contour or edge. Figure 3.3shows the overlapped image before segmentation, it also shows the connection between the pixels of the lower and upper contour by vertical lines. Figure 3.4 shows the segmented breast image, Figure a shows the cropped left breast and Figure b shows the cropped right image.

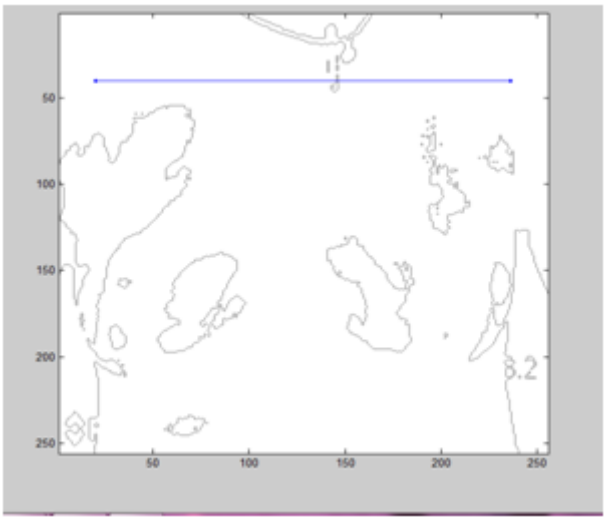


Figure 3.2: Upper Contour Detection

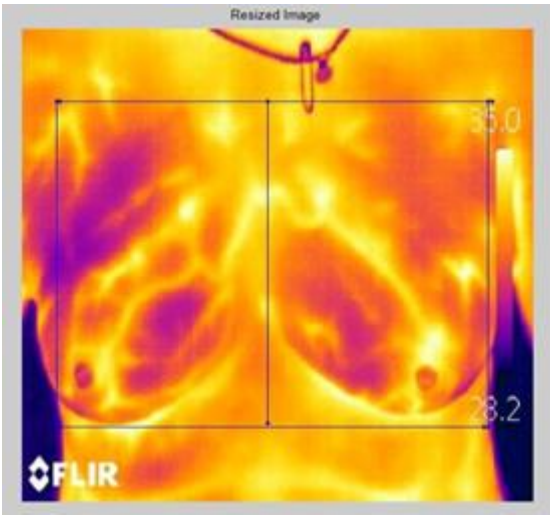
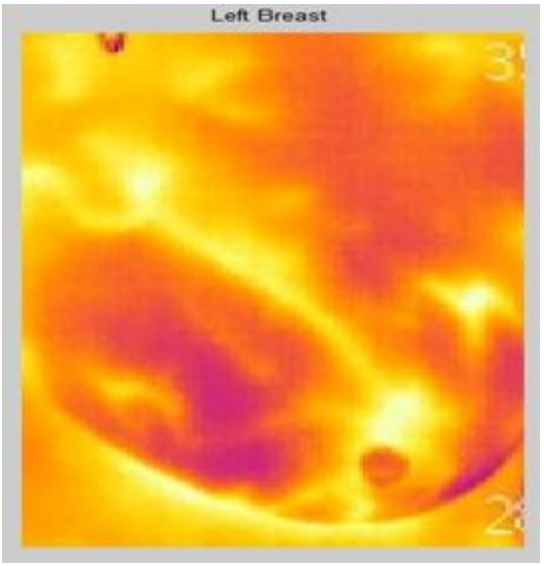
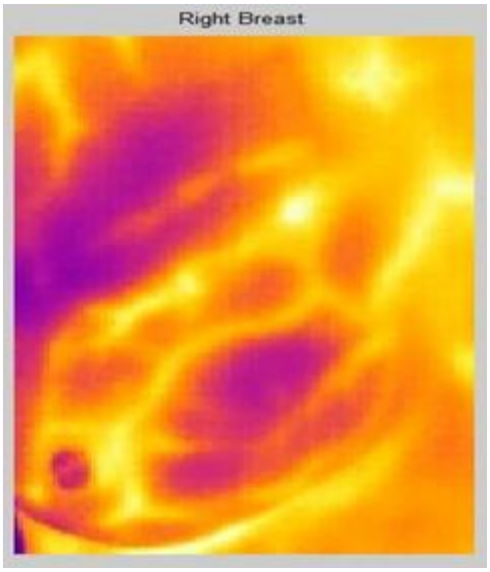


Figure 3.3: Overlapped Image



a) Cropped LeftBreast



b) Cropped Right Breast

Figure 3.4: Segmented Breasts after Cropping

4. Discussions

The usual approach followed by various authors like Rodrigo Carvalho Serrano, et al in the paper "About the feasibility of Hurst Coefficient in Thermal Images for Early Diagnosis of Breast Disease" (2008) [7] and Otton T. da Silveria. F, et al in the paper "On using Lacunarity for Diagnosis of Breast Diseases Considering Thermal Images" [8] (2009) had just cropped the breasts into left and right directly without performing any pre - processing steps as their center focus was towards the asymmetrical analysis. The pre - processing steps are very essential, because in direct cropping the exact central coordinate was not used for separation, so the size and the area of interest varies both in width and length, the left and right cropped breast image will not be similar to each other. In proposed approach it overcomes this dissimilarity as the pre - processing steps are done, so exact segmentation is been achieved, irrespective of the anatomical structure of the breast. Author Leonardo Motta, et al in the paper "Using a New Method in Thermal Images to Diagnose Early Breast Diseases" [9] (2002) has followed some pre - processing steps by using neighbourhood operations, temperature distribution and pixel connectivity to segment the breasts which seems to be a complicated approach. Similarly another author Pragati Kapoor, et al in the paper "Real Time Intelligent Thermal Analysis Approach for Early Diagnosis of Breast Cancer" (2010) [1], segmented the breasts by performing edge detection and Hough transform to find out the feature curves which is a very tedious approach. Author Auro Conci in the paper "Automatic Segmentation on The rmograms in Order to Aid Diagnosis and 2D Modelling" [10] (2010), has segmented the breast using some mathematical formulas which involves series of steps which is difficult to perform, whereas in this proposed approach of semi - automatically segmenting the breast into left and right is very simple, quick and efficient approach analysis.

5. Conclusion & Future work

This proposed method is aimed to segment the breasts, semi - automatically using only upper and lower contour detection. This is a very efficient, quick and simple method and produces accurate result irrespective of anatomical structure of the breast. In future, these segmented breasts can be used for various asymmetrical analyses [22], [23], [24], [25] to detect cancer and then classify into various stages according to the severity.

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