Breast Boundary Detection in Mammogram Using Entropy

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Abstract: ***In this paper we present the novel technique for detection of breast boundary (also known as Breast contour, breast edge, skin-air interface or also called skin-line). Breast boundary extraction is an important preprocessing step in Computer Assisted Diagnosis (CAD) systems. The Breast boundary region detection is a tough task because low contrast region near skin line(boundary). The proposed method is noise resistant and uses the concept of entropy estimation for breast boundary detection. The proposed algorithm was tested on 103 mammographic images taken from CityU Image Database of different profiles and visual results were evaluated by the expert.***

Keywords: *Breast Boundary Detection, Mammogram, Entropy, skin-line estimation*

1. Introduction

The breast cancer is most common form of cancer in women and mammogram is only available tool for early detections of cancer. The early detection of cancer successfully treated. The sensitivity of mammography can be improved between 15% – 30% by an independent second reading of mammograms [1]. Mammogram can detect only 80% to 90% of breast cancer in women without symptoms [2].

Mammogram is a summation of images i.e all breast tissues overlapped in each view[2]. Breast boundary detection is considered as an initial and essential pre processing step for CAD systems. Breast boundary has informations which is used in restricting the region where the segmentation algorithms are applied, for density correction of peripheral breast tissues [4], and limiting the area to be processed into a specific region in an image. The failure in accuracy detection of breast boundary leads to miss the lesion located near the breast boundary [5].

There are many methods proposed for breast boundary detection. Silva [3] used stroma edges for detection of breast boundary and the breast contour is obtained from the candidate points using a dynamic programming algorithm. Mendez [6] utilizes a gradient based method to detect the breast contour by splitting the image in regions and scanning it in different directions according to its location. Lou [7] assumes that the intensity values from the breast region near the skin-air interface are a monotonic decreasing function; he exploits this observation to extract an initial boundary point that is refined until final border point obtained. These points are then linked to obtain the breast contour. Ferrari [8] obtained an initial contour by thresholding an image enhanced with the logarithm operator, whose noise was reduced with morphological opening. This was then refined by the adaptive active deformable model. Sun [9] used an adaptive thresholding to obtain an initial contour which was refined by a curve extrapolation method. This consisted in using the Euclidean distance as constraint that was propagated to the upper and lower breast regions to obtain the complete skin-line estimate. Thiruvenkadan [10] obtained an initial contour using a fuzzy segmentation which was refined by a region-based active contour segmentation method.

The paper is organized as : Section2 describe the proposed method, Section3 present simulation results, Section4 present conclusion and Section5 references are given

2. Proposed Method

Figure1 shows the flowchart of proposed method used for detection of breast boundary in mammogram images. The mammogram images are first loaded whose boundary is to be detected. In second step Images are converted into double data type. Double returns the double-precision value. Then logarithmic transform is applied on the mammogram images. The log transformation is used to increase the dynamic range of dark regions of image. The general form of logarithmic transform is given as:

$$I_o = c \ln[1 + (e^{\sigma} - 1) I_{in}(i, j)] \quad \text{...........(1)}$$

Where $\mathbf{I_o}$ is output image, **c** is constant, $\mathbf{I_{in}}$ is input image and **σ** is the scaling factor that controls the input range to the logarithmic function

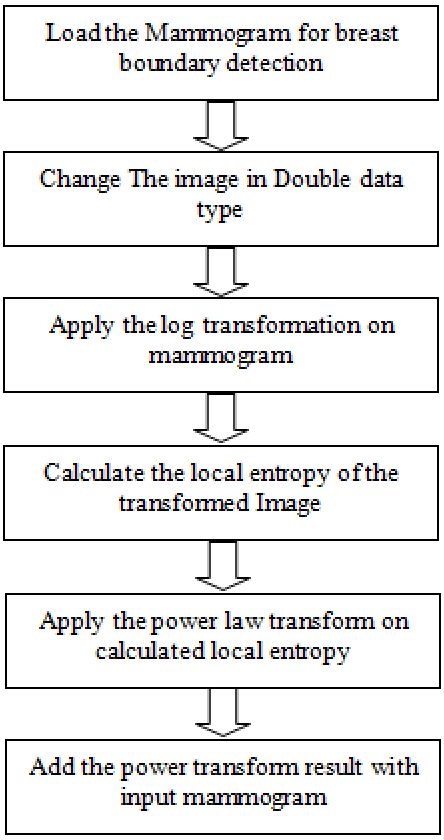

Figure 1 - flowchart of steps used for breast boundary detection

Figure 2 shows the graph of the logarithmic function used for transformation. The logarithmic transform increases the intensity of the breast boundary region

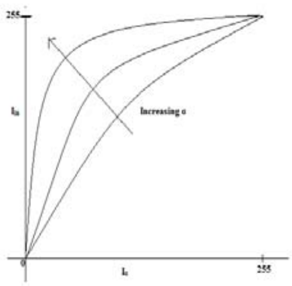

Figure 2 - Logarithmic Transform

The low contrast of the region near skin line is corrected using log transform. The next step is to calculate the entropy of the log transformed mammogram. The entropy changes when the probability of information content of pixels changes. So, the entropy will change drastically near breast boundary. It is a concept of information theory & is used to measure the amount of information [12]. Entropy is defined as terms of the probabilistic behavior of a source of information. According to this definition, any random event A that occurs with probability P (A) is said to contain

$$I(A) = \log[1/P(A)] = -\log[P(A)] \quad \text{-----(2)}$$

units of information. The amount I(A) is called the self-information of event A . The amount of self information of the event is inversely proportional to its probability. The basic concept of entropy in information theory has to do with how much randomness is available in a signal or in a random event. In another way this is to talk about how much information is carried by the signal. The entropy near the boundary is very high, so in order to sharpen the entropy values we use Exponential transform or power law transform on the calculated local entropy measurements.

The power transform or exponential transform is the mapping function defined as follows:

$$I_o(i,j) = e^{I_{in}(i,j)} \quad \text{...........(3)}$$

This transform enhance the details in high value regions whilst the decreasing the range of low value region as shown in figure 3

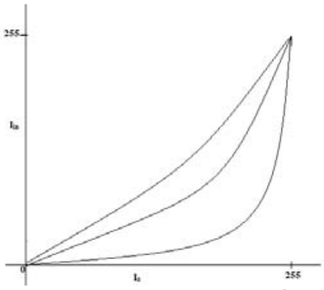

Figure 3 - Power Law or exponential transform

3. Results

The proposed algorithm was operated on103 mammogram images, 8-bit grayscale images with size of 1024×1024 pixels belonging to the.**CityU Image Database [13].** After the breast boundary detection the images were tested by expert. The parameters for log transforms were c= 5, σ=2.The method was implemented using the MATLAB and tested in a HP dv2000 notebook 2.00GHz pressor and 3GB RAM. Figure 3 shows the images obtained during the process fig.4 (a) shows the original mammogram image fig.4(b) is the log transform of the original mammogram image as shown in fig. 4(a), the fig.4(c) is local entropy estimation of the log transformed image, fig.4(d) is showing the resultant image.

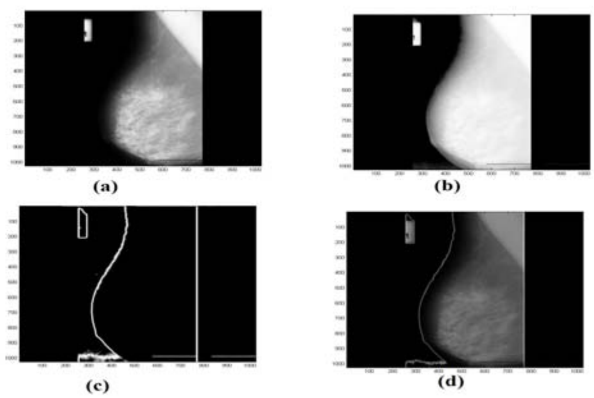

Figure 4 - Results -- a) Original Image b) Log transform c) The entropy of log transformed image d) The Breast boundary detected

4. Conclusion

The proposed method works efficiently for the detection of narrow regions of breast boundary from mammogram images. But still there is need of segmentation algorithm which can perform more accurately for different images.

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