

AN ITERATIVE SEGMENTATION METHOD FOR REGION OF INTEREST EXTRACTION

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Abstract: *In this paper, a method is presented for applications which include mammographic image segmentation and region of interest extraction. Segmentation is a very critical and difficult stage to accomplish in computer aided detection systems. Although the presented segmentation method is developed for mammographic images, it can be used for any medical image which resembles the same statistical characteristics with mammograms. Fundamentally, the method contains iterative automatic thresholding and masking operations which is applied to the original or enhanced mammograms. Also the effect of image enhancement to the segmentation process was observed. A version of histogram equalization was applied to the images for enhancement. Finally, the results show that enhanced version of the proposed segmentation method is preferable because of its better success rate.*

Keywords: *Digital Image Processing, Mammography, Image Segmentation, Image Enhancement*

1. INTRODUCTION

Mammography is the best available examination for the detection of breast cancer [1]. However, a considerable number of lesions that are visible on mammograms in retrospect are missed by radiologists [2]. A computer aided detection (CAD) system can provide a second opinion to a radiologist [3]. In Turkey, cancer, which goes up to the second row below the cardiovascular diseases, was fourth in 1970s amongst the known causes of deaths [4].

Most common types of cancer are pulmonary cancer and breast cancer amongst man and woman respectively [5]. This fact makes medical image processing a popular research area and researchers have developed many CAD systems for the last decade which can be helpful for radiologists. In general, most of the CAD systems are developed in four stages. The first step contains certain image processing algorithms to make images

prepared for the further stages of the CAD system. After preprocessing stage, region of interests (ROI) are extracted from image which is called segmentation and features of these ROIs are used as input data for the classifier which decides the case of the ROI. In this paper we focused on to the segmentation stage of the CAD systems and explain an iterative algorithm for segmentation.

2. MATERIALS AND METHODS

In this work, mini MIAS database was used for the evaluation of the proposed algorithm. Also a computer program was written with C# programming language. Image enhancement techniques were used to observe their effects to the segmentation process.

2.1. Image Enhancement

Histograms of mammograms were normalized by applying histogram equalization (HE). But global histogram equalization (GHE) did not bring about the desired results because of the very unbalanced histogram distribution of mammographic images. This imbalance occurs when an image has light areas broadly rather than dark areas or vice versa. Therefore GHE is not convenient for normalization in applications which use biomedical images like mammograms. A more convenient way to enhance mammographic images is using only the necessary data for equalization. Since the big dark areas which are seen outside the breast region are redundant and aggravating, we can throw these parts of the image and use the information of the rest for HE. Thereby we get a better enhanced image with respect to GHE.

2.2. Image Segmentation

The purpose of the segmentation in CAD systems is extracting regions from images in order to search only the areas which are suspected to have abnormalities instead of searching all parts of images. Thresholding is a very effective method for segmentation. In this work the automatic thresholding method of Otsu [6] was used to threshold images. Thresholding a mammographic image gives us the entire breast region. There is no requisite to get breast region other than a single automatic thresholding algorithm because of the statistical properties of the mammographic images. By taking advantage of this situation breast region can be acquired by masking

original image with its threshold result. After that automatic thresholding and masking process is applied once again to the segmented and enhanced breast region. In practice, the result of the second threshold is not always seen as small ROIs inside the breast region. Second threshold gives the breast region again as a result for some of the images. Second threshold result differs from the first by the extracted breast region's size and border properties which are slightly smaller. Masking the result of the second thresholding process with the result of partial HE gives us a new image. When we threshold this new image for the third time we have the desired ROIs eventually. Thresholding the image and masking the threshold result with original image iteratively gives ROIs. An example of this iterative segmentation is shown in Figure 1. In this example, the image is thresholded and masked three times. The pectoral muscle and label information seen on the image can easily be eliminated by means of their quite distinctive properties.

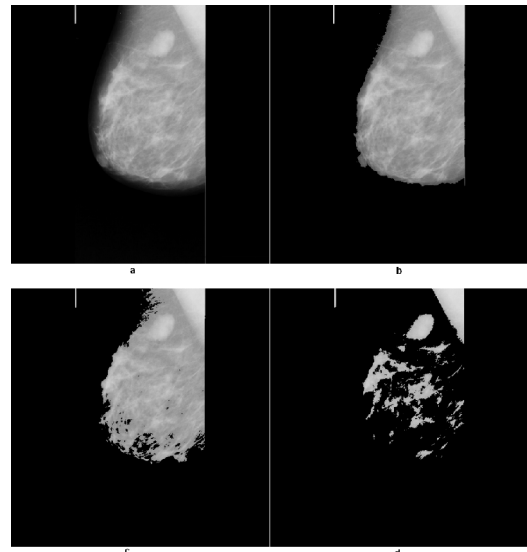


Figure 1 Results of the steps of the segmentation algorithm (a) original image, the results of (b) first, second (c) and (d) third thresholding and masking operations.

Effects of image enhancement to the segmentation are observed by applying HE for every iterations of the thresholding and masking operations. HE algorithm do not use all of the information gathered from every place of the image but uses only the

information from the places which are obtained by the masking process. In Figure 2 a comparison of the enhanced and not enhanced versions of the algorithm is shown. It may be seen there is not any differences between two images at first glance. But it is obvious that the edges of the ROIs in the enhanced version are more roughened.

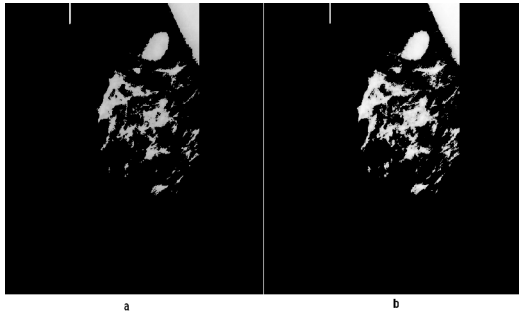


Figure 2 A comparison of the enhanced and not enhanced versions of the algorithm. (a) not enhanced version and (b) enhanced version

3. RESULTS

Randomly selected 25 images from mini MIAS database were used to test the segmentation method in the way of extracting ROIs which include mass. In Table 1 the results for two versions of the method are both shown. Column A states the version which does not include any image enhancement process and Column B states the version which HE is included. It is seen obviously that HE improves the success of segmentation. Nevertheless, applying HE impedes the correct segmentation for some of the test images. In the last column the results are shown for the situation which comprises from both of the methods. In this work only the images which include masses were selected for the evaluation of the segmentation method. Table 1 shows whether the mass in the image is segmented as a ROI or not.

Table 1 Segmentation results

| Image No | A | B | Total |
|----------|---|---|-------|
| 1 | 0 | 1 | 1 |
| 5 | 0 | 0 | 0 |
| 10 | 1 | 1 | 1 |
| 15 | 1 | 1 | 1 |
| 17 | 0 | 0 | 0 |

| Image No | A | B | Total |
|-------------------|-----------|-----------|-----------|
| 19 | 0 | 1 | 1 |
| 21 | 1 | 0 | 1 |
| 25 | 1 | 1 | 1 |
| 28 | 1 | 1 | 1 |
| 30 | 0 | 0 | 0 |
| 32 | 0 | 1 | 1 |
| 63 | 0 | 1 | 1 |
| 69 | 1 | 1 | 1 |
| 80 | 0 | 0 | 0 |
| 91 | 1 | 1 | 1 |
| 134 | 0 | 1 | 1 |
| 141 | 0 | 1 | 1 |
| 184 | 1 | 1 | 1 |
| 198 | 0 | 0 | 0 |
| 199 | 0 | 0 | 0 |
| 202 | 1 | 1 | 1 |
| 206 | 0 | 0 | 0 |
| 207 | 0 | 0 | 0 |
| 270 | 0 | 1 | 1 |
| 315 | 0 | 0 | 0 |
| Toplam (%) | 36 | 60 | 84 |

4. CONCLUSION

In conclusion, thresholding the image and masking the threshold result with original image recursively, gives us ROIs. The problem is the number of the repetition of the process. Repeated threshold and mask processes must be applied between two and four times according to the statistical properties of the histograms of images. These histogram properties depends on pixel values and pixel values which stand out themselves as light or dark areas on images according to their intensity levels depends on the tissue of the breast. Therefore the number of iterations of consecutive thresholding and masking operations either can be determined manually by the user of the CAD system application according to the type of the breast tissue or all the results obtained from all iterations can be taken into consideration.

5. REFERENCES

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