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MAMMOGRAM IMAGE SEGMENTATION USING WATERSHED

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The use of Image Processing techniques in the field of bio-medical imaging is well known. This paper is an attempt to use image processing algorithms for the enhancing and highlighting suspicious areas in mammogram images for breast cancer detection. An image segmentation method based on morphological watershed transform has been developed. It is based on extraction of watershed lines from a topographic representation of the input image. As mammograms are complex images, some kind of pre-processing is required that aids in highlighting suspicious areas. A slight modification to the existing method has been done that help in reducing the number of regions obtained after segmentation. The proposed method has been tested on standard digital mammograms obtained from standard database. The results obtained are quite good and also approved by the radiologists.

Keywords: Image Processing, Mammograms, Topography, Morphology, Watershed Segmentation.

1. Introduction

Breast cancer is the leading cause of cancer deaths among women in many countries. According to studies breast cancer incidence and death rates generally increase with age. During 2000-2004, 95% of new cases and 97% of breast cancer deaths occurred in women aged 40 and older [1]. Also, early detection is the best defense against developing cancer. Many imaging techniques for breast cancer detection are available, but mammography is considered most effective screening method. It can detect a tumour up to two years before a lump can be felt. Mammography generally detects to varying degrees the following signs of breast cancer: clustered micro calcifications, circumscribed masses, architectural distortions and speculated lesions. In digital mammography X-ray images are recorded in computer code. The images are displayed on a computer monitor. These could be enhanced before printing on film thereby providing more flexibility.

It has been found that interpretation of mammograms by radiologists, many a times give high rates of false positive cases. So, efforts have been made in past also by many researchers to develop effective diagnostic methods based on the use of image processing algorithms. This could better assist radiologist in accurate interpretation of mammograms. The rest of the paper is organized as follow: section 2 gives a brief review of related work. Section 3 presents an introduction to the basic segmentation technique used. The proposed system is described in section 4. Results and conclusion are given in section 5 and 6 respectively.

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2. Review of Related Work

Many studies have been carried out that deal with mammogram image analysis [2], [3], [4]. Different techniques are presented in their papers. In this paper we are using the algorithm given in [2] as the basis of our work so as to carry out the proposed modification.

3. The Watershed Algorithm

Watersheds are one of the classics in the field of topography and have long been admitted as a useful tool in image segmentation. It is based on morphological concepts and was originally proposed by Digabel and Lantuejoul. However, many modifications and improvements have been carried out in the past over the original algorithm. For the time being, the development of efficient watershed algorithm still attracts attention. In image processing, especially mathematical morphology, grey scale images are considered as topographic relieves. In topographic representation, we visualize the image in 3-dimensions such that at each point the grey value represents the height or altitude at that point.

The idea of watershed is straightforward and could be explained by reference from geography. As we are now dealing with the topographic representation of the image, it is considered as a landscape. If we take this landscape and immerse it in water, the regions in the image will start filling up with water. This immersion process starts from the points of minimum grey value. Eventually a time will come when water level in two or more adjacent basins will start merging as it has risen above the maximum height. At this point we have to prevent this merging. To do this we create barriers or more commonly dams at the points (or lines) where water coming from different regions would meet. When the water level has reached the highest peak in the landscape, all the regions are separated by dams. These regions are referred to as catchment basins and the dams or lines are called the watershed lines dividing the given input image into a set of regions.

After this division, it is up to our interpretation to decide which regions represents the areas of interest. As for the present application we are interested in a division of the image where a region represents a suspicious area so that it could be analyzed further for presence of cancer.

4. PROPOSED ALGORITHM

The proposed method is explained here as a series of steps. As mammograms are complex images and offer low contrast, these must be pre –processed. In our present system pre-processing is carried out so as to suppress unwanted detail present in mammogram image corresponding to the complex network of curves formed by blood vessels, milk ducts and other fibrous tissue in the breast regio n. The proposed segmentation method is illustrated in figure below.

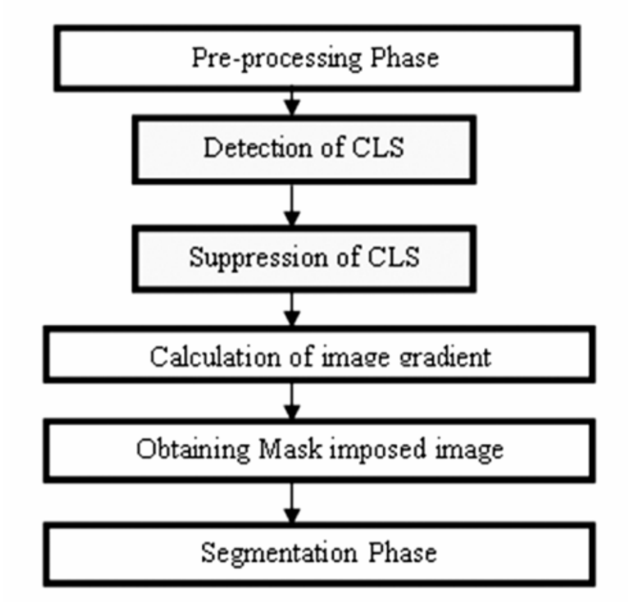

Fig.1: Steps of Process

A good pre-processing scheme that aims to suppress normal breast tissue and also helps in enhancing the sign of abnormalitie is crucial for good segmentation. To isolate the region of interest with much accuracy the mammogram is first filtered so that CLS get suppressed. This pre-processing consists of two sub-phases as explained below.

4.1 Detection of Curvilinear Structures

To detect CLS, a filter is first applied on the input image to obtain a binary representation of the CLS present. As sobel filter gives the maximum gradient of the image, we have used a vertical sobel filter mask of size 11x11 for performing convolutions with the input image at 12 different torientations. Each such convolution produces a set of more or less parallel lines of variable intensity representing the CLS matter at that orientation. Now, to obtain the complete image consisting of all the CLS we combine the results of these 12 masks using binary addition. Next, we apply a suitable threshold on the binary image obtained above to keep the best defined area only. We have selected the threshold value for each image on the basis of visual analysis.

4.1.1 Suppression of Curvilinear Structures

After obtaining the CLS image, we need to suppress their appearance in the image. For this averaging is performed with the help of an 11x11 pixel window centred on the corresponding pixel (i.e. the pixel belonging to CLS) on the original image.

4.2 Calculation of Image Gradient

Calculation of gradient is required because if watershed segentation is directly applied on the input image it generally results in over segmentation. In this work, we have used Canny's edge detection for calculation of gradient. Canny edge detection is the most robust method that produces closed contours. It is based on the concepts of non-maximal suppression and hysteresis thresholding.

4.3 Obtaining Mask Imposed Image

After calculation of gradient the next step proposed is to find regional minima points in the gradient image. Watershed segmentation using standard Vincent-Soille approach is carried out. The watershed lines thus obtained are ORed with the minima image obtained earlier to form a mask image. This mask is then imposed on the gradient image. The use of this mask image is in reducing the number of basins obtained in the segmentation result.

4.4 Segmentation Phase

After this, watershed segmentation is carried out on mask-imposed image using the immersion analogy. This segmentation is based on catchment basins technique. In this the topographic representation of image is immersed in water such that the water starts rising through the minima points in the image. In topographic representation the grey level of pixels acts as the height at that point. This flooding ends when the water reaches the highest level. At this point virtual barriers are built to prevent the merging of water. These dams represent the watershed lines that give the complete division of the input image into a set of regions. Each region corresponds to a region of interest.

5. RESULTS AND DISCUSSION

The proposed method of segmentation has been applied to a series of mammogram images obtained from standard online databases. The results of segmentation are satisfactory and also approved by expert. The results of various phases are shown below.

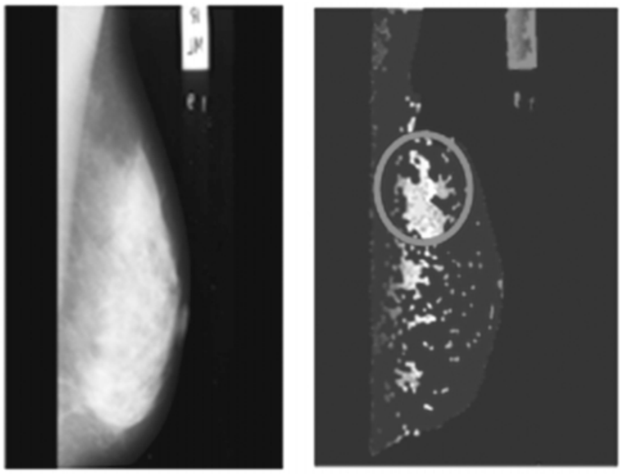

Fig. 2: (a) Original (b) Segmented Results

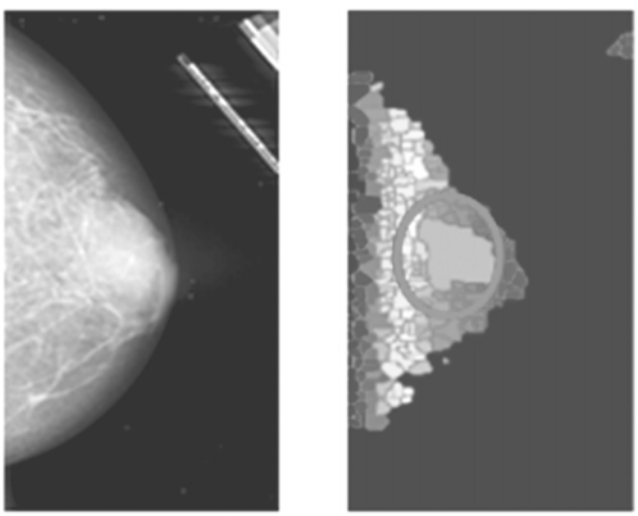

Fig. 3: (a) Original (b) Segmented Results

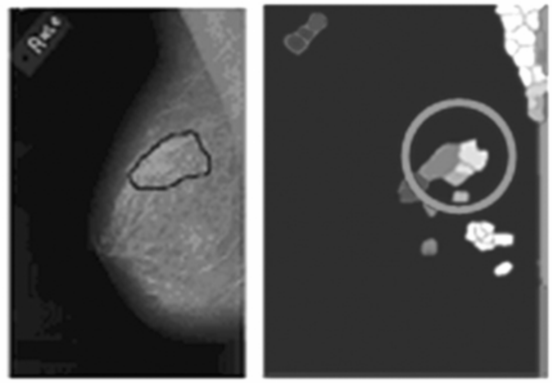

Fig. 4: (a) Original (b) Segmented Results

6. CONCLUSION AND FUTURE WORK

In this paper a method for segmentation of cancerous areas in a mammogram has been developed. The suspicious areas in the image are highlighted that could be analyzed further to check if the masses detected are cancerous or not. Although satisfactory results are obtained by the application of the proposed method further improvements must be carried out in the code to make it more robust.

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