A new Mammography segmentation technique based on Watershed, Wavelet and Curvelet transform

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Abstract—With the repaid advancements of computing technology, any use of the computer-based technologies. Increase in different scientific fields. The segmentation’s image is an important problem in different fields of computer vision and image processing. This paper presents a new approach for computer aided detection of microcalcifications clusters in digital mammograms. The proposed microcalcification detection method is done With MATLAB. New result of watershed segmentation entirely relay on the image contrast. Image contrast may be degraded during image acquisition. So watershed algorithm can generate under or over segmentation on badly contrast images. In order to reduce these deficiencies of watershed algorithm a preprocessing step using Curvelet or Wavelet transform is performed on input images. The proposed approach is applied to a database of some dense mammographic images, originating from the MIAS database. Results shows that the proposed approach gives a satisfactory detection performance

Keywords—Image processing, Curvelet transform, segmentation, watershed.

I. INTRODUCTION
Breast cancer is one of the frequent and leading causes of mortality among woman, in developed countries. The age is one of the risk factor of breast cancer and women within the age between 40-69 have more risk of the breast cancer. In west about 53%-92% of the population has this disease. In a study a mammogram was done to 151,198 women. Though early detection of breast cancer can increase the survival rate. The current diagnostic method for early detection of breast cancer is the mammography, so mammographie is low dose X-ray projections of the breast, and it’s the best method for detecting cancer at the early stage. Microcalcifications are tiny bits of the calcium, and may be show in patterns or in clusters and they are associated with extra cell activities in breast. Usually an extra cell growth isn’t cancerous, yet sometimes tight clusters of microcalcifications can indicate early breast cancer. Macrocalcifications are usually a sign of benign breast cancer. 82% of the microcalcification is benign. microcalcifications in the breast show up as white speckles on breast X-rays image. The calcifications are usually small; varying from 100 micrometer to 300 micrometer, Therefore it’s very difficult to detect the microcalcifications as such, when more than 10 microcalcifications are clustered together, it becomes possible to diagnose malignant disease. So the survival depends on how early the cancer is detected. But any calcification formation should be detected at the benign stage. Hence, the Computer Aided Diagnosis system is used to detect calcification clusters. Many algorithms have been proposed for automatic detection of breast cancer in mammographies. Features extracted from mammograms can be used for detection of cancers.

The method for preprocessing on the images is Curvelet or Wavelet transform is a multiscale directional transform which allows an almost optimal non adaptive sparse representation of objects with edges. It has generated increasing interest in the community of applied mathematics and signal processing over the past years. It is an approach used to enhance the image contrast when image is degraded.

II. THE CURVELET TRANSFORM
The Curvelet transform is a multiscale directional transform and a higher dimensional of the Wavelet transform which allows an optimal non adaptive representation of edges
designed to represent images at different scales and different angles. [1][2] Curvelet has two mathematical properties [3] [4]: Please submit your manuscript electronically for review as e-mail attachments.

a- The curved singularities should be approximated with some coefficients and in a non-adaptive representation named «curvelet.»

b- The curvelets remain coherent waveforms under the action of the wave equation in a smooth medium. A curvelet frame [15] \{\psi_\gamma\} is a wave packet frame on L2 R2 based on second dyadic decomposition:

\[ f(\alpha) = \sum_\gamma C_\gamma \psi_\gamma(\alpha) \quad C_\gamma = \int f(\alpha) \psi_\gamma(\alpha) \, d\alpha \]

Then the Frequency shells is 2k<|\xi|<2 (k+1); and the Angular Sectors is \((\omega, \xi) \leq 2 (-k/2)\) finally the approximation rate is optimal:

a- We choose n largest coefficients )

b- And no frame can do better for jumps along C2curves. C2 in f = \sum_\gamma C_\gamma \psi_\gamma and \|f - f_n\|_2^2 \leq n^{-1} \log(n)^2

c- The wavelet expansion : \|f - f_n\|_2^2 \leq n^{-1}

III. THE WAVELET TRANSFORM

The wavelet transform is a mathematical tool that can be used to describe images in multiple resolutions. The wavelet decomposition is a complete representation, since it allows a perfect reconstruction of the original image. Also, since a low-pass filter is involved, noise suppression is inherent to this transform. According to Mallat's pyramid algorithm the input image is convolved with low-pass and high-pass filters associated with a mother wavelet, and downsampled afterwards. Four images (each one with half the size of the original image) are produced, corresponding to high frequencies in the horizontal direction and low frequencies in the vertical direction (HL), low frequencies in the horizontal direction and high frequencies in the vertical direction (LH), high frequencies in both directions (HH) and low frequencies in both directions (LL). This last image is a low-pass version of the original image, and will be called the approximation image. This procedure is repeated for the approximation image at each resolution 2j (please note that dyadic scales are used). The four images HL, LH, HH and LL are denoted, respectively, by , and A2j. If the wavelet transform is applied up to the scale 2J, the original image can be reconstructed using images A2J and . In this paper, the Haar wavelet was chosen because of its orthogonality and, more important, its small support. Also, it requires small computational complexity (linear with respect to the size of the input image) to compute the wavelet decomposition with the Haar wavelet. The expressions for the low-pass h[n] and high-pass g[n] filters for the Haar wavelets are provided in this equation

\[ h[n] = \left[ \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right], \quad g[n] = \left[ \frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}} \right] \]

IV. THE WATERSHED TRANSFORM

The watershed transform [6] is a morphological based tool for image segmentation. In grey scale the mathematical morphology watershed transform for segmentation is originally proposed by Digabel and Lantuejoul in 1977 and later improved by Li et al in 2003. The watershed transform can be classified as a region-based segmentation approach.

![Fig. 1 Illustration of immersion process of watershed transforms. (CB: Catchment basins)](image)

The idea [5] of watershed can be view as a landscape immersed in a lake; catchment basins will be filled up with water starting at each local minimum. Dams must be built where the water coming from different catchment basins may be meeting in order to avoid the merging of catchment basins. The water shed lines are defined by the catchment basins divided by the dam at the highest level where the water can reach in the landscape [7]. As a result, watershed lines can separate individual catchment basins in the landscape. The idea is described in Figure 1 which describes the flooding or rain falling process of watershed algorithm. The process of rain falling is described in Figure 2.

![Fig. 2 Illustrations of flooding (process of watershed transform)](image)

V. PROPOSED TECHNIQUE

The proposed Mammography segmentation algorithm here is able to segment the mammograms with minimum drawbacks of under segmentation and over segmentation. The steps of the proposed system are shown in Figure 3.
VI. RESULTS

The results of the proposed techniques are described in this section, we used MIAS database for mammograms:

Fig. 3 Proposed process for image segmentation
VII. CONCLUSION

The goal of Mammography segmentation process is to identify the segments of the image according to the image characteristic e.g. Cancer shape. The simplified working of the image segmentation system is stated here. The most important step is the mammography acquisition. Any lack during mammography acquisition can cause many problems in the result. The image used in this process is taken from MIAS database. The input images are of low contrast. This segmentation process deals with the problem caused by these low contrast images by applying a preprocessing step using Curvelet or Wavelet transform. This step enhances the contrast of the input image so that the gradient of the image is strong enough to properly segment the image by using the watershed. After preprocessing step the gradient of the image is finding by converting the input image to grey scale. And this gradient of image is used as the input the image. The results show the improvement in the segmentation results using Curvelet or Wavelet transform. The system will inspected only one mammography at a time. This system can be very helpful for the segmentation of the mammography which are used in different computer’s diagnosis. And the mammography analysis process can be enabled by this system. The research content of this system was segmentation and image enhancement.

REFERENCES