Automated Detection of Tumor Using Wavelet Based Histogram and Adaptive Windowing Technique

Nisha Nagose, Rajshree Mundewarikar

Abstract— The most effective method for detection of early breast cancer is mammography, which is the most reliable method for the detection of early breast cancer, Mammography is the compulsory and only option for the premature detection of breast cancer in women, of all diagnostic methods currently available for this purpose this is more reliable method. This paper present a wavelet and window method to detect breast tumours using wavelet thresholding. The compressed image is decomposed at level 4 using daubechies 6 wavelet and histograms for all components (approximation, horizontal, vertical & diagonal) is evaluated for first two level and only approximation components are calculated for remaining two level. Further the histogram of horizontal, vertical and diagonal components are decomposed at level 5 and the thresholds corresponding to minima of the histogram is found. Transferring those thresholds at components horizontal, vertical and diagonal are thresholded. Further a global threshold is found to segment reconstructed image, fine segmentation is done using window based operation & using a wavelet approach for final threshold. Depending upon the threshold values, the suspicious areas have been segmented. The works effection in an over segmented image. The related work was implemented using image processing tools, and using the MATLAB.

Index Terms— Wavelet based Thresholding, breast cancer, mammograms, window based Thresholding, segmentation.

1 Introduction

Breast cancer is a major health problem not only in all over the world but also in India. Breast cancer is a leading cause of death among the women [1]. According to National Cancer Registry program, the survey conducted in few cities in 2000, by this survey the number of breast cancer patient increases in every year. Also according to the International Agency for Research on Cancer which is the world health Organization, there were approximately 80000 women affected by breast diseases in India in 2001 and 90000 women in 2002. Detection and Diagnosis of breast cancer in its early stage increases the successful treatment and complete recovery of the patient. Mammography image uses a low-dose x-ray system for examination of breasts. In mammography system x-ray film is replaced by solid-state detectors which are used to convert x-rays into electrical signals. The detectors are same as image found in digital camera. By using electrical signal breast images are produce that can be seen on a computer screen and printed on special film similar to conventional mammograms.

Computer-aided diagnosis systems digitized mammographic image that can be obtained from either a conventional film mammogram [2]. Presence of cancer indicates abnormal areas of density, mass, or calcification . The system highlights areas on the images, alerting the radiologist to the need for further analysis.

Early diagnoses of breast cancer are of great importance in modern medicine. Many breast cancers cannot be accurately detected on the basis of tumors by visual examination. This is partly due to the fact the tumors are poor quality images with low-contrast resulting from the small differences in X-ray attenuation between breast tissues. The sensitivity of the human eye indicate large numbers of images decreases with increasing number of cases, when only a small number of images show abnormalities. Therefore, it is useful to the development of fully automated techniques with high sensitivity and specificity faces several difficulties stemming from the nature of radiographic images to aid early diagnosis of breast cancer with mammography [4].

There are two types of breast cancer, Masses and Micro-calcification. Calcifications are tiny mineral deposits within the breast tissue that appear as small white spots on the films. There are 2 types of calcifications: Macro calcifications are larger calcium deposits that represent degenerative changes in the breasts. Micro-calcifications are defined as small bright spot in mammograms [3]. Masses are occur with or without calcifications, are another important change seen on a mammogram [5]. Masses are defined as shape and boundary properties.

2 Literature Survey

Majority of the research in medical image segmentation pertains to its use for mammograms images, particularly in breast imaging because mammograms imaging having high resolution and gives detailed imaging. There are numerous techniques used for detection of tumors in digital mammograms some of them are as follows.

Chen Gang design a method of detection of micro-calcification in mammograms using wavelet and adaptive

thresholds, here the regions of interest is selected from the whole breast area by using wavelet and adaptive thresholds according to each mammogram. To reduce the false positive rate, region of interest is further analyzed. After filtering process, each pixel is classified as calcification by comparing the filtered pixel value with threshold T [6]. Zhang and Desai develop segmentation of bright targets using wavelets and adaptive thresholding. The bright target is a connected, cohesive object which has an average intensity distribution above that of the rest of the image. Here an analytic model for the segmentation of targets, which uses a multiresolution analysis in concert with a Bayes classifier to identify the possible target areas. The threshold value is choosing to segment targets from background by using a multi scale analysis of the image probability density function. A Gaussian distribution model is performance analysis based and it is used to show that the obtained adaptive threshold is often close to the Bayes threshold [7]. Barba and Gil present a parametric fitting algorithm for segmentation of cervical and breast cell images from cytology smears. The objects are convex and a shape model can be used for segmentation. The parameters are adjusted to fit the cell shapes while minimizing a cost function. The iterative shrink-wrap operation is used to obtain the accurate shape of the segmented nucleus. The result is based on a tissue image with only two cell nuclei. The composition of the algorithm is also very complicated when overlapped structure is present in the image [8]. Brzakovic proposed a global thresholding is one of the common techniques for segmentation of image. The technique is based on the global information like histogram. The masses are usually having greater intensity than the surrounding tissue and used for finding global threshold value. The regions with an abnormality impose extra peaks while a healthy region has only a single peak on the histogram. Segmentation is done on abnormal region after finding a threshold value. The technique is not good to identify region of interest because masses are often superimposed on the tissue of the same intensity level [9] Umesh Adiga design high throughput analysis of multispectral images of breast cancer tissue. A region-growing technique discussed by Umesh Adiga which is constrained by shape and size similarities of cell nuclei. He requires an automatic initial seed selection and becomes slow due to the requirement of continuous updating of similarity measures [10]. Anna Rejani develops breast cancer detection using multilevel thresholding. Method combines several image processing techniques like inversion of image, threshold value and segmentation of threshold image for detection of tumor in mammograms. An algorithm that acts as a preprocessor for marking out the suspicious tumor regions in the mammogram for increasing segmentation accuracy, fractal analysis.The result shows that Adaptive Thresholding and Fast Segmentation Algorithm are efficient and successful [11]. Maitra, Nag proposed a detection of abnormal masses using divide and conquer algorithm in digital mammogram extracting the region within the breast is done by demarcation of the breast contour and pectoral muscle. This limits the search for by eliminating the background of the mammogram abnormal regions only within the breast region. The method is fully automated process for detection of abnormal masses by using anatomical segmentation of Breast Region of Interest [12]. A new homogeneity enhancement algorithm namely divide and conquer homogeneity enhancement algorithm (DCHEA), followed by an innovative approach for edge detection (EDA). To obtain breast ROI, use Anatomical Segmentation of Breast ROI (ASB) algorithm to differentiate various regions within the breast. The algorithms are fully autonomous, and are able to isolate different types of abnormalities. An algorithm has shown significant improvement in binary homogeneity enhancement algorithm.

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3 Proposed Method

In this proposed method, the first step is pre-processing. The contrast stretching is applied for pre processing an image which is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task. Then 6- point wavelet transform is applied to a pre-processed image. Proper scaling channel is chosen using prior information of appropriate size of the target. Next step is finding histogram of a wavelet transformed image. Then perform 5 scale 1-D db-6 wavelet transform. Calculate the local minima of the 1-D wavelet transformed pdf at the selected scale. The threshold value is selected by using that local minima value. Then segmentation is done by using threshold value to obtain the segmented areas.

3.1 Pre-processing

Image pre-processing techniques are necessary, in order to remove the noise, to enhance the quality of the image and to extract the breast region [13]. Before any image-processing algorithm can be applied on mammogram, pre-processing steps are very important in order to limit the search for abnormalities without undue influence from background of the Mammogram. Digital mammograms are medical images that are difficult to be interpreted, thus a preparation phase is needed in order to improve the image quality and make the segmentation results more accurate. The main objective of this process is to improve the quality of the image to make it ready to further processing by removing the unrelated and surplus parts in the back ground of the mammogram. Breast border extraction is also a part of pre-processing. The types of noise observed in mammogram are high intensity rectangular label, low intensity label, tape artifacts etc [14]. The pre-processing is used in mammogram orientation, label and artifact removal, mammogram enhancement and mammogram segmentation.

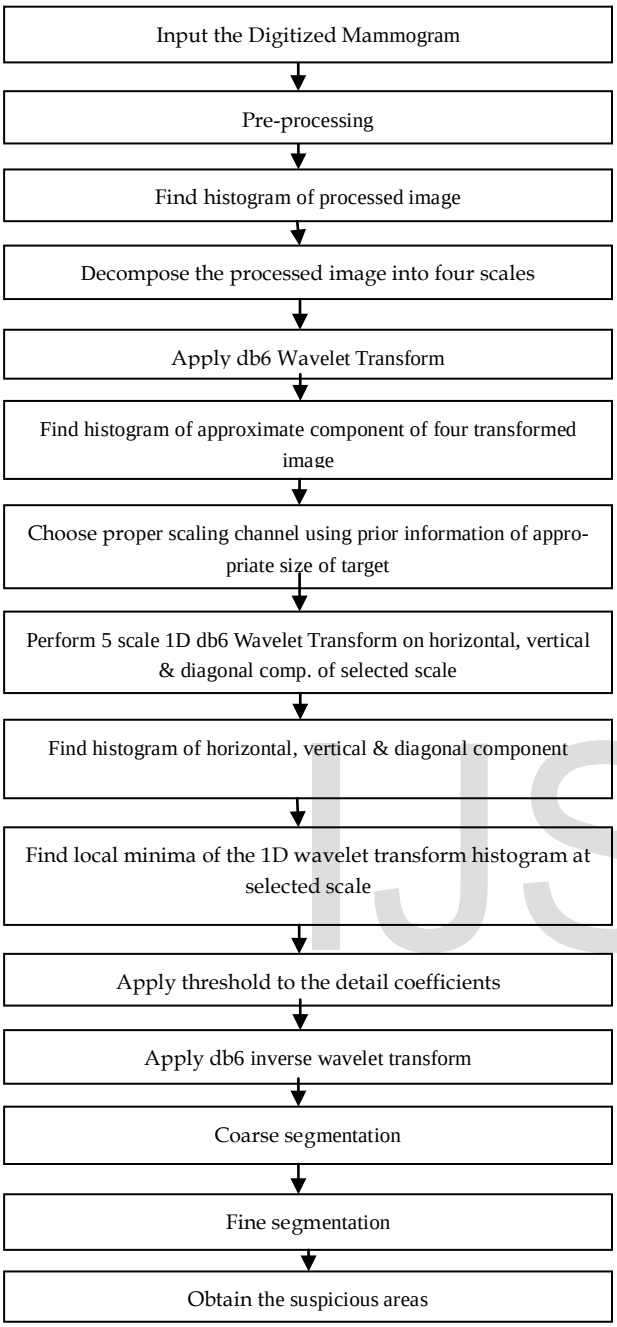


Fig -1 Flow chart of the wavelet based adaptive windowing method of segmentation

3.2 Discrete Wavelet Transform

In DWT, signals are analyzed in discrete steps through a series of filters. This method is realizable in a computer and has the advantage of extracting non-overlapping information about the signal. In the DWT, an image signal can be analyzed by passing it through an analysis filter bank followed by a decimation operation. This analysis filter bank, which consists of a low pass and a high pass filter at each decomposition stage, is commonly used in image compression. When a signal passes through these filters, it is split into two bands. The low pass filter, which corresponds to an averaging operation, extracts the coarse information of the signal. The high pass filter, which corresponds to a differencing operation, extracts the detail information of the signal. The output of the filtering operations is then decimated by two.

Wavelets decompose an image into orthogonal sub bands with low-low (LL1), low-high (LH1 high-low (HL1), and high-high (HH1) components. The LL1 sub band is further decomposed into another four sub bands, and the Low Low 2 (LL2) from this second decomposition sub band is decomposed once again and so on, as seen in Figure 2 (a)-(b). Because of the nature of mammogram few levels of decompositions are necessary to analyze them. In this application two-level decomposition was used. There are several types of wavelet transforms that can be chosen depending on the application.

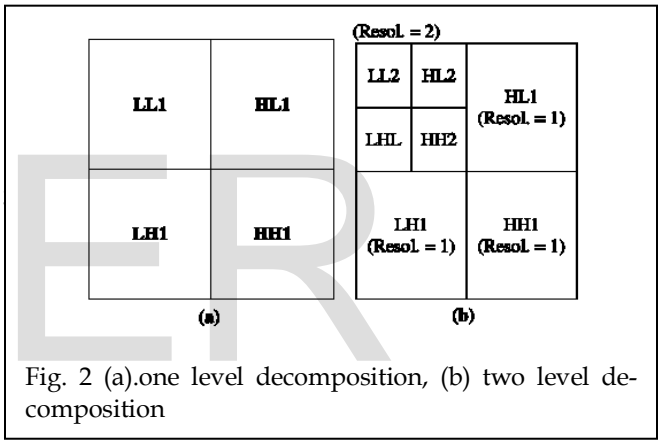


Fig. 2 (a).one level decomposition, (b) two level decomposition

In this paper a feature vectors is extracted from mammograms based on multilevel wavelets decomposition. These vectors are can be use for segmentation of mammograms. The Discrete Wavelet Transform (DWT) is applied to each dimension separately. This yield a multi resolution decomposition of the signal into four sub bands called the approximation (low frequency component) and details (high frequency component). The approximation (a) indicates a low resolution of the original image .The detail coefficients are horizontal (h), vertical(v) and diagonal (d).

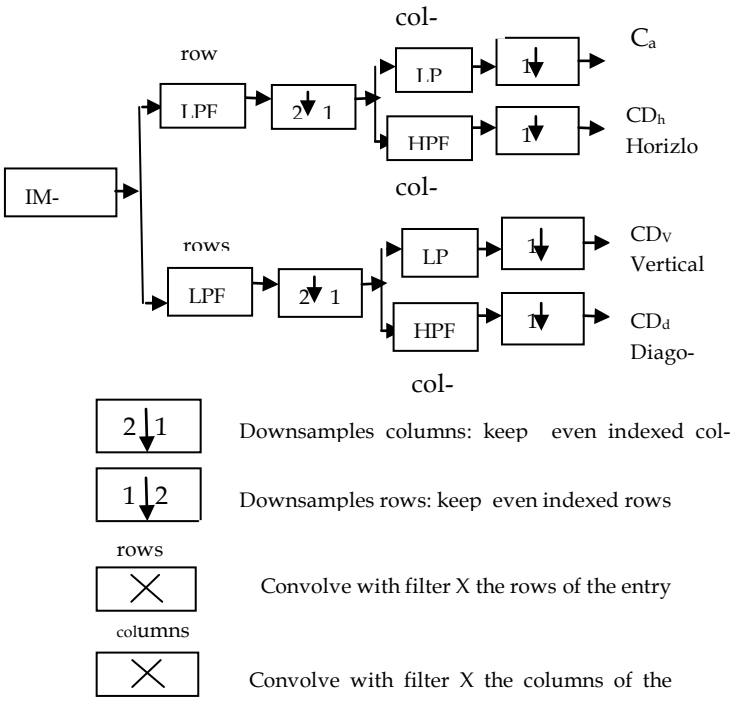


Fig. 3. Two Dimensional DWT decomposition

In this paper, the concepts of Daubechies wavelet transform are discussed. The Daubechies wavelets are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. With each wavelet type of this class, there is a scaling function which generates an orthogonal multi resolution analysis. Daubechies wavelets are widely used in solving a broad range of problems, e.g. self similarity properties of a signal or fractal problems, signal discontinuities, etc.

3.3 Segmentation

Segmentation involves separating an image into regions (or their contours) corresponding to objects. We usually try to segment regions by identifying common properties. Or, similarly, we identify contours by identifying differences between regions (edges). The simplest property that pixels in a region can share is intensity. So, a natural way to segment such regions is through thresholding, the separation of light and dark regions.Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one. What you want to do with pixels at the threshold doesn't matter, as long as you're consistent. If g(x, y) is a thresholded version of f(x, y) at some global threshold T,

$$g(x,y) = \begin{cases} 0 & f(x,y) < T \\ 1 & f(x,y) \geq T \end{cases}$$

Thresholding is a simple, efficient segmentation technique which exhibit following point

- Usually refer to Intensity Thresholding
- Classify pixels into two categories.
- Create a binary image (binarisation)

3.4 Global Thresholding

Fixed or Global threshold: the threshold value is held constant throughout the image. A variation which uses two thresholds to define a range of intensity values:

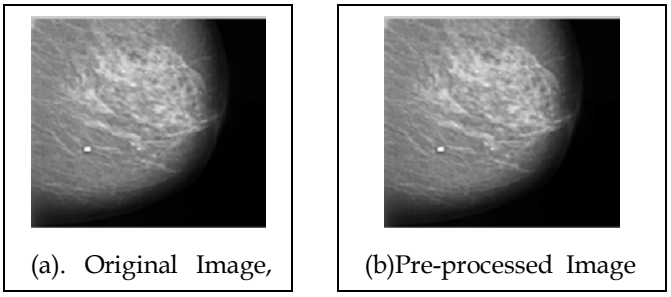
$$g(x,y) = \begin{cases} 0 & f(x,y) < T_1 \\ 1 & T_1 \leq f(x,y) \leq T_2 \\ 0 & f(x,y) \geq T_2 \end{cases}$$

The success of thresholding depends critically on the selection of an appropriate threshold single threshold or double threshold.

We use two types of segmentation coarse segmentation and fine segmentation. . In this paper, the rough segmentation is done by using wavelet based histogram thresholding where, the thereshold value is chosen by performing 1-D wavelet based analysis of PDFs of wavelet transformed images at different channels. The first step in fine segmentation is to resize , pad the image, choose proper window size.

4 Result and Discussion

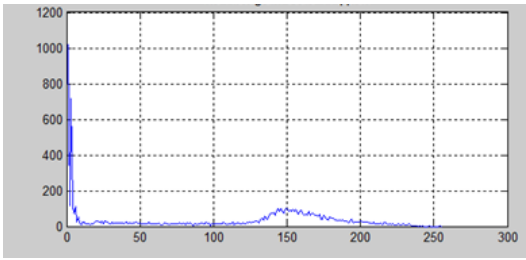
The proposed method is tested by using the mini-MIAS database of mammograms. The algorithm was implemented in a MATLAB environment. The original image is shown as Fig.4 (a). The preprocessing is done by linear contrast stretching which is shown in Fig.4 (b). Daubechies 6-point wavelet is selected to process the image.



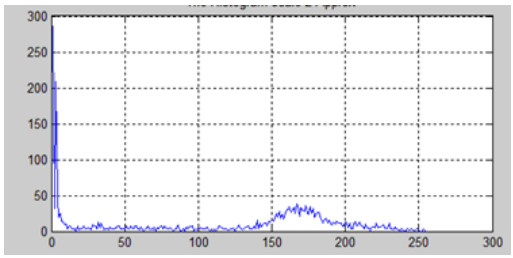
(a). Original Image, (b)Pre-processed Image

Fig. 4 Original image and pre-processed image

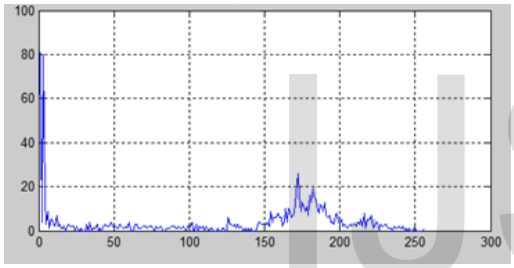
Fig 5 (a) - (d) shows histogram (PDFs) of the four transformed images respectively. The images in the scale 2 issued for segmentation since it can effectively detect the tumours present in the digital mammograms. Next 5-scale wavelet transforms for the histogram of the images in scale-2 is taken.



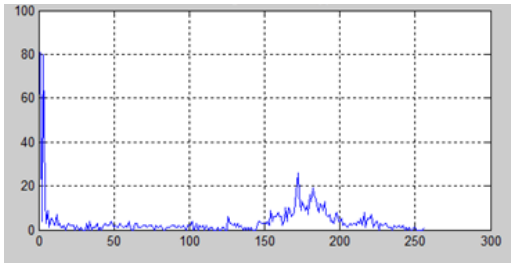
(a) Histogram of first scaling channel



(b) Histogram of Second scaling channel



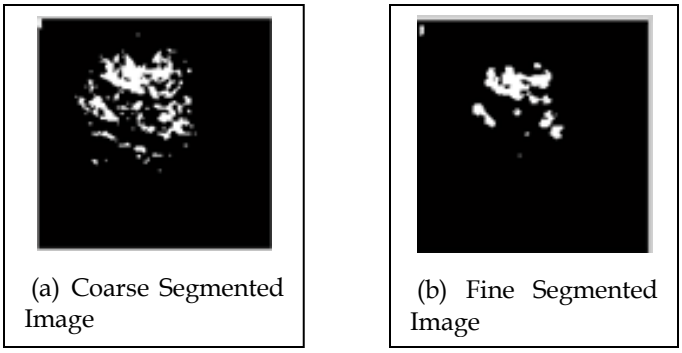
(c) Histogram of Third scaling channel



(d) Histogram of Fourth scaling channel

Fig. 5 Histograms (PDFs) of four transformed images

By taking the local minima of the curve at the adaptive scaled four local minima are obtained. Using the largest local minima as the adaptive threshold, the coarse segmented area is obtained. After doing fine segmentation suspicious region Fig. 6(a)- (d) shows the images of coarse segmented Fine segmented image.



(a) Coarse Segmented Image

(b) Fine Segmented Image

Fig. 6 Coarse Segmented Image and fine Segmented Image

5 Conclusion

The proposed work will explore breast tumor detection and segmentation using wavelet and window thresholding algorithm is done using MATLAB. A new general method is presented for the segmentation of bright targets in an image. Wavelet transforms are used in the new method for the segmentation problem. An approach for choosing the threshold adaptively by looking for the global local minima of the PDFs of wavelet transformed images is proposed. The examples show that the new method is effective to segment the tumors in mammograms and it can also be used in other segmentation applications. To select an appropriate scale of image is an important step of this method. To show the superiority of the proposed method it is also compared with Global thresholding method. Global threshold methods suffer from drawback as threshold value is fixed manually. Some of them can be segmented accurately and part the tumour does not be detected correctly. The segmentation results for the window based adaptive thresholding method in which other than tumour area is also be segmented along with the suspicious area and it cannot detect the entire tumour areas. Simulation results show that the proposed algorithms yield significantly superior image quality when it is compared to the Global thresholding method and window based adaptive thresholding method.

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