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An Approach for Detecting Breast Cancer using Wavelet Transforms

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Abstract

Background/Objectives: The goal of screening exams for breast cancer is to find cancer before they start to cause symptoms. The objective of this paper is to propose a diagnosis tool to detect breast cancer at the earlier stage. **Methods/Statistical Analysis**: The proposed diagnosis tool for detecting breast cancer involves the various processes which includes wavelets. The diagnosis tool is proposed to execute multiscalar contrast enhancement at different wavelet scales. The process is continued with segmentation techniques which combine information of the core image structure and the boundaries. The approach confirms the use of a single algorithm for image processing and detects both microclassification and masses in the breast image. **Findings:** An algorithm has been proposed for the enhancement and denoising of an image with the help of processing through wavelets. Moreover, in case of microcalcification, a general method is described. The function is to execute multiscalar contrast enhancement at different wavelets scales. On the other hand mass detection means a segmentation of image where mathematical morphology is mixed with dyadic wavelet information. Segmentation technique is divided in two different groups: 1. Discrete contour model and 2. Region growing. The proposed system was able to identify the masses and micro classification without any biopsy and other process. In this paper we have proposed a technique that introduces segmentation combining efficiently both the information of the core of image structure and the boundaries. This approach confirms the use of a single algorithm for image processing and detects both microcalcification and masses. **Application/Improvements:** The proposed diagnosis tool is also used for enhancing tiny features which can be still accurate in cancer detection. Further the algorithm can be used to classify the breast image as malignant or benign.

Keywords: Enhancement, Masses, Matlab, Microclasification, Morphology, Region Growing, Wavelet

1. Introduction

In women the major cause of death is cancer. The root of breast cancer is still unknown so it is difficult to prevent it from happening from the start, still this is not the end, and if we diagnose the early stages of this killing breast cancer it can still be cured[1]. Around 25% of death occurs within the age range of 41 to 50 in women due to the breast cancer.

For the purpose of diagnosing and screening of the breast cancer the radiologists now a day use the most frequent technique known as the X-ray mammography. Imaging that is used to examine the breast using a low dose X-ray system is known as mammography[2]. A mammogram is an examination object of mammography which is useful for the diagnosis and the early detection of the breast cancer in women.

A false negation rate of 8.59% was acknowledged when 870 people were checked with breast cancer from associated clinic which was carried out at general hospital in Birmingham. The number of cancers has steadily been falling per year. This abatement has been more persistent with the new and the improved techniques of radiotherapy.

Some doctors say that the death rate from breast cancer in women can be decreased by mammography, while some

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doctors oppose it. When we use X-ray mammography for the purpose of screening and diagnosing, an approx of 10 to 30% of the lesions are not found in the duration of routine screening of the mammographic image. Lesions are damaged or unwanted tissues in a human body. They can be found in any part of the body.

The main acclamations of this disease are:

- Masses.
- Microcalcifications.

It is difficult to detect microcalcification because it is difficult detecting noisy images and low contrast and mammograms are low contrastand noisy images[3]. The space taking damaged tissues which occur in a group are called as masses. These are deposits of calcium in a particular place. They are detected by their shape and the boundary properties that they inherit. When a cell in abreast grows abnormally in size, changes its size and divides destructively. Calcifications are small flake of calcium. They can be seen on mammograms, which appear on the soft tissue of the breast. These calcium bits are not the cancers.

These microcalcifications are not sign of breast cancer, they symbolise the pre cancer conditions. Microcalcifications appear as white dots on the mammogram.

Wavelet processing is desired while considering multiscale. The details which are arise at various different scales while enhancing them at resolution levels. A mathematical expression, known as wavelet, which can be used in digital signal processing and image compression. Wavelets can be usedfor this purpose but the existence of wavelet is old. This paper is read as follows:

The Module 1 shows the process of denoising of a mammographic image using Gaussian filter. Module 2 describes microcalcification, and module 3 the process of mass detection. Module 4 comprises of the methodology followed involving the steps such as- acquiring an image, image negation, darkening an image, thresholding, grey level slicing, bit plane slicing. Module 5 gives the results, and Module 6 the conclusion of the study.

2. Denoising the Image

Most of the times, some noise is present in any real signal. To smoothen the flow of image enhancement operation it is very necessary to apply denoising operation. The common wavelet denoising process is as given: 1. Appling wavelet transformation to the signals which are noisy, thus producing coefficients of wavelet noise till the level where occurrence of PD can be rightly distinguished. 2. Selection of suitable limit of threshold at individual level and selection of threshold function (remove noises through hard and soft thresholding). 3. Obtains a denoised signal by inversing the wavelets transformation of the threshold coefficient of wavelets[4]. A tool known as wavelet denoise plug-in tool is used to reduce noise in each channel of an image separately from one another. Suitable denoising method should be developing to achieve the appropriate SNR (Signal-to-Noise Ratio) value to allow perception of lesions. Correct diagnosis is given negative effect by noises in digital image and low contrast regions[5]. For digital mammography system, noise can result from flat-fielding, detector gain variations, electronic noise of the detectors and the analog to digital conversion system. Image preprocessing is an important procedure to reduce the noise level of the image preserving the mammography structures and to improve the detection of mammography features.

2.1 Low Pass Gaussian Filter

A number of types of noises can be removed with the help of Gaussian filter. Gaussian filter is in 2 dimensions, the multiplication of the two Gaussians, one in every direction.

$$G(x,y) = (1/2\pi\sigma^2)e^{-x^2+y^2/2}\sigma^2$$

Here the distance from the (0,0) in horizontal axis is x, and from (0,0) in vertical axis is y, and standard deviation σ of the Gaussian distribution. The value of standard deviation of the white Gaussian noise was set to 0.6. The estimated parameter of $\sigma = 0.6$ is then applied to the real mammographic images and the simulated image.

Convolution exists in the filtering method. In two dimensional data the formula for its convolution matrix is precomputed and convolved. Gaussian blur i.e. one kind of image blur is affected by this kind of filter. The elements present in matrix individually represent a pixel attribute such as brightness or colour intensity present in image preprocessing techniques.

3. Microcalcification

Microcalcifications are very tiny speck of mineral deposits (calcium). These are generally scattered throughout the mammary gland. They can sometimes occur in clusters as well. If their presence is detected on a mammogram then it's the radiologists concern to decide whether those specks are of concern or not. Most of the times the presence of these tiny gentle depositions cysts is indicated, and can give a sign of the presence of early breast cancer. Therefore, as recommended by your health service, it is important to attend regular screening sessions. Unlike cancerous tumors which are solid in nature, these cysts are fluid-filled masses in the mammogram. These generally occur in women whose age is over 50, and hence we can say that aging is the most common cause of breast cancer.

The future course of action to be undertaken in case of presence of these patterns is determined by the analysis of these patterns. Depending on this analysis it is decided whether further investigation is to be done or there is requirement of more regular screening. The microcalcifications that are scattered are usually sign of gentle breast tissues. In this paper we will give an algorithm for detection of microcalcification from mammographic images. The following diagram shows the presence of microcalcification on a mammogram.

4. Mass Detection

When compared to a non-affected tissue, a mass is not similarly spread with the fat cells in the same proportion. These masses which are found in the mammography process are analysed depending upon their shape, density i.e., amount of fat cells present and density of suspicious cells and its margins.

Presence of masses signifies detection of cancer at a later stage. These appears camouflaged i.e. similar to the surroundings, because of the low contrast. This is caused because of the variation in the density of parenchymal structure of tissue. Therefore both the visual detection and

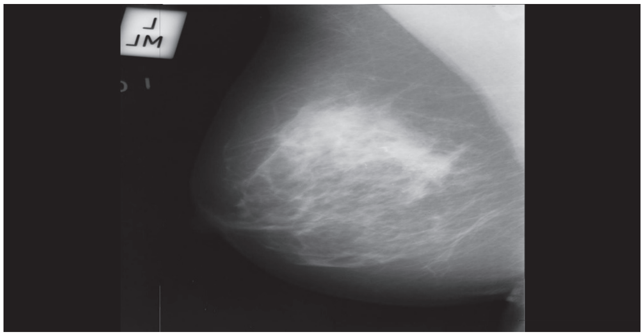

Figure 1. Microclassification image.

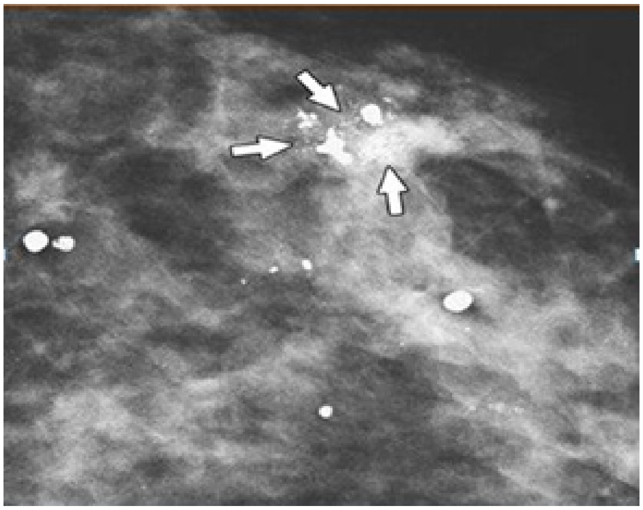

Figure 2. Presence of tumor in the mammogram.

distinguishing their presence on a mammogram proves to be difficult in the wavelet domain. Thus segmentation of image is required for the operation of a selective enhancement of various features.

4.1 Segmentation

In terms of computer, the process of partitioning a digitized image into a number of segments i.e. set of pixels or super pixels. The main objective of the segmentation process is easing and changing the representation of an image into one which can prove to be more meaningful and also which can be simpler for the analysis process. The most common use of image segmentation is to locate the objects and the boundary in images i.e., line, curve, etc. More exactly, segmentation of image refers to the process where a label is assigned to each pixel of an image so that certain same characteristic of sight is shared by pixels within common label. In the other hand, image segmentation is to separate the suspicious regions that may contain masses from the background parenchyma, i.e., to separate the mammogram into several non-overlapping regions, then extract Regions of Interests (ROIs), and locate the suspicious mass candidates from ROIs[6]. The suspicious area is an area that is brighter than its surroundings, has almost uniform density, has a regular shape with varying size, and has fuzzy boundaries[7].

The segmentation of an image is a technique that can be divided in two important groups, depending on the used algorithm approach: 1. Discrete contour model and 2. Region growing. Discrete contour is used as a technique of detecting edges. Each object in edge-point is displayed by the edge-image. These edge-points are to be linked to get boundaries that are closely connected. These are required for the segmentation of image, but this result is not always exactly correct. The starting of region growing segmentation is with a group of seed points[8]. The region grows by adding the neighbouring pixels having same characteristics as the seed correspondingly to every seed.

As the growing standard rule various ranges of the grey levels have been used. The very first step of process is to determine the region of seeds. When talking about mammograms, it is already proved that the tumor region pixel have the maximum allowed digital value i.e., 255 in unit 8 images. Depending on this information, the technique of thresholding is of use for the detection of present clusters containing mass. The features of images are extracted for the removal of these clusters belonging to back ground the natural tissues at once.

4.2 Enhancement

Now we have acquired the segmentation of a mammographic image. The resultant binary image is used as a kind of map for operation of an appropriate enhancement process in wavelet domain.

5. Methodology

For the summarizing process of the algorithm for both microcalcification and mass detection processing we use an algorithm which first reads an image, then finds the negation of that image. After negation the image is darkened and thresholding function is applied. Gray level slicing is performed with background and without background. The Bit plane slicing is performed.

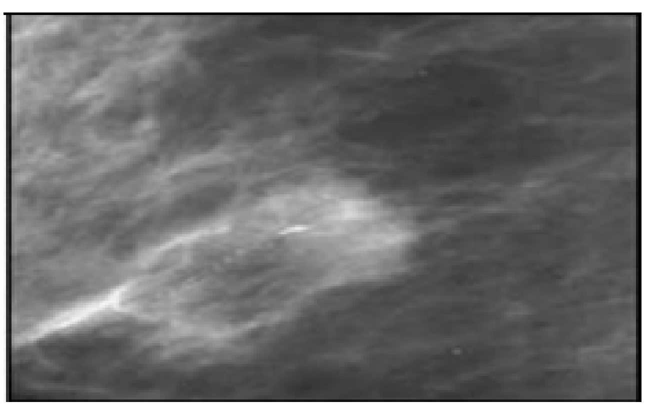

Figure 3. Segmenting the image.

5.1 Acquiring an Image

The acquirement if an image is done with the help of a tool known as Image Acquisition Toolbox. Videos from various camera can also be grabbed in matlab through this toolbox.

A = imread(filename,fmt);

The above formula is used to read a grey or colour image from the specified path browsed containing file of specified filename. In case file is not present in the specified folder, the whole path is used to browse the image for its acquirement.

5.2 Image Negative

The negation of a mammographic image with gray level between 0 and l-1 is gained with the help of negation of image as described by the figure given below and is denoted by the formula, $S = l - 1 - r$

The Figure 4 shows the negative of a mammographic image. The above formula leads to the image's reverse of gray levels intensity. Which then produces a image which is similar to negative. The mapping of the result of the module is done into gray scale lookup table, having value within the range 0 and l–1.

5.3 Darkening of an Image

The number from each pixel from the top layer is multiplied to the corresponding number of pixel of the bottom layer with the help of multiply blend mode. The highest value that we can get is 65025 i.e., 255 * 255, by simple multiplication of 8 bits/channels. This value is much higher than the maximum allowed value i.e., 255. The resultant is then divided by 255, thus giving a darker image then before.

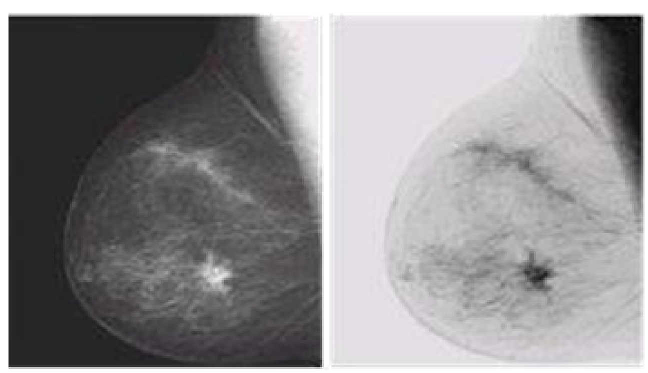

Figure 4. Negative of a mammographic image.

Formula:

Result Color = (Top Color) * (Bottom Color)/255

5.4 Thresholding

The simplest method of image segmentation is thresholding. From a gray scale image, thresholding can be used to create binary images. If the value of pixels in an image is greater than some threshold value, using the thresholding process, those pixels are marked as 'object' pixels (assuming background to be darker than the object) and as 'background' pixels otherwise. This assembling is known as threshold above. Discrepancy includes threshold below, which is opposite to threshold above; threshold inside, where if pixels value is between two thresholds it is labeled as 'object'; and opposite of threshold inside is the threshold outside. Typically, a value of '1' is given to an object pixel, while a value of "0" is given to background pixel. At last, each pixel is colored white or black and a binary image is created, depending on a pixel's labels. The choice of the threshold value is the key parameter in the thresholding process.

5.5 Gray Level Slicing

Two common methods are used for highlighting a specified range of gray levels present in an image. These methods are as follows:

- Gray level slicing without background:- The grey levels of a specific range are given a higher value. The remaining grey levels are provided with a lower value.
- Gray level slicing with background:-The grey levels of a specific range are given higher value. As well the background is preserved in the image. In both the procedures, the required range is initialized to be constant when intensity is considered. In the method 1. All the grey levels are turned into a lower constant. On the other hand in method 2. The values of grey levels are kept with the use of a linear function.

5.6 Bit Plane Slicing

Highlighting the contribution made to total image appearance by specific bits might be desired, instead of highlighting gray level ranges. Suppose that each pixel in an image is represented by 8 bits. Assume that the image is composed of 8. One bit planes, ranging from LSB (Least Significant Bit) zero till the bit plane seven as the MSB (Most Significant Bit). When mentioning 8 bits in each byte, the zero plane consists of the bytes containing bits having lower order[8]. They also consist of the pixels in an image. Plane seven consists of the bits having higher order. Keep into track that the higher order bits (4 top most) in the Figure 6 here consists of the maximum MSB. The remaining bit planes result in greater attenuate characteristics of an image. In this process a digitised image is partitioned into various bit planes that are used in the estimation of approximate role played by individual bits of an image. It helps in determination of required number of bits that are used in the quantization of each and every pixel. This process is as well used in the process of compression of an image. In the bit plane extraction of 8 bit image, the difficulty lies in showing the image in form of bit plane seven. This can be gained by image processing along with a threshold grey level transformation function which (1) maps every level from zero to 127 of an image into 1 level. (2) maps every level lying in range 129 to 255 to one another.

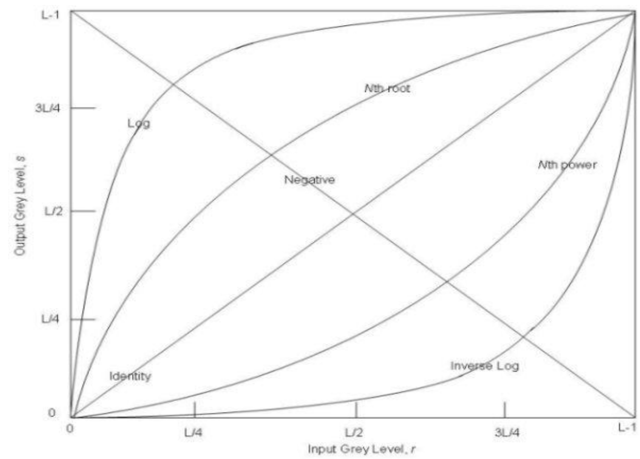

Figure 5. Log transformation

6. Result and Discussion

The method described in this paper has been tested on many mammographic images. It helps in easing the process of computer aided diagnosis. This allows the radiologist to detect the masses andmicrocalcification present on the mammogram in a better way than the standard enhancement algorithms.

The following Figure 7 and 8 shows the identification of microcalcification.

The following Figure 9 and 10 shows the **massdetection.**

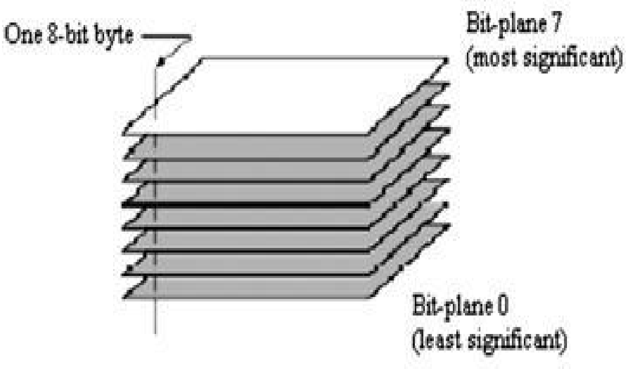

Figure 6. Bit plane slicing.

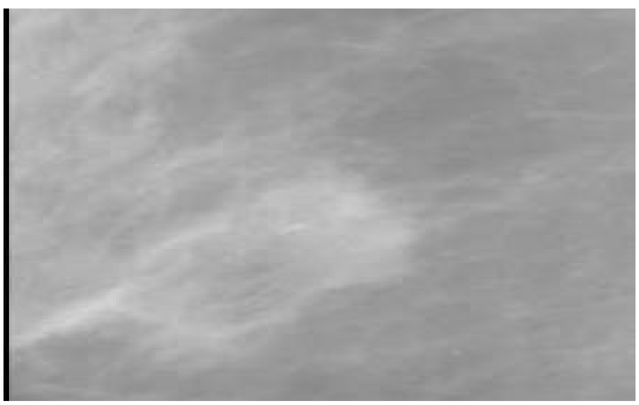

Figure 7. Original image 'a'.

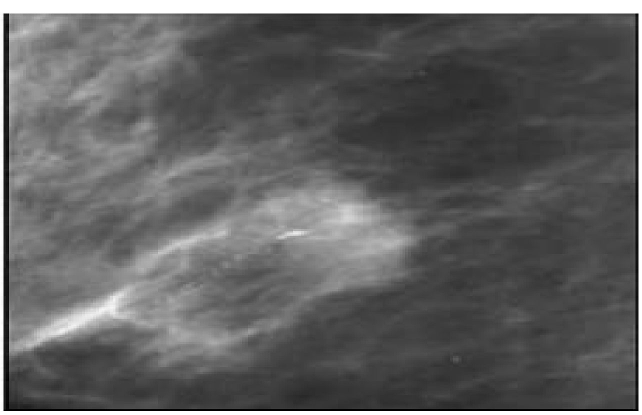

Figure 8. Enhanced image of 'a'.

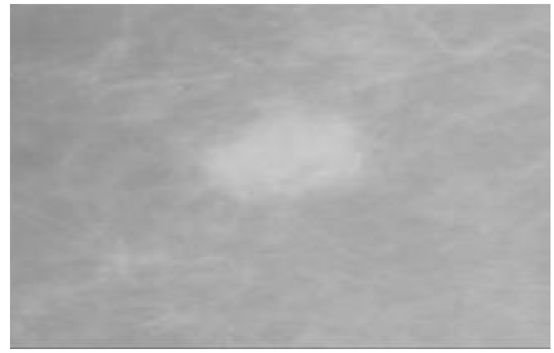

Figure 9. Original image 'b'.

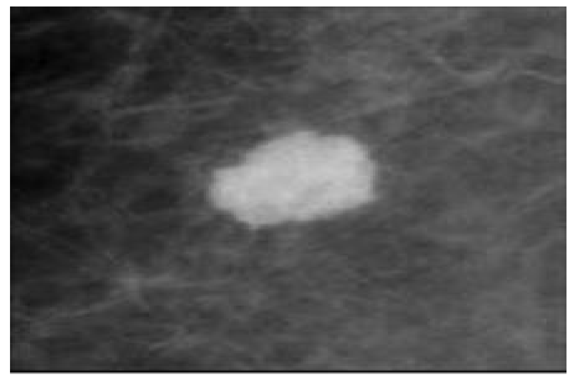

Figure 10. Enhanced image of 'b'.

7. Conclusion

In the given paper the focus has been on the problem of denoising and enhancement of mammographic images. An algorithm has been proposed to detect the masses and the microcalcification through that single core algorithm. It has been proposed as it has been proved successful for various diagnostic reports. This approach has been useful for enhancing both the tiny features such as microcalcifications, and masses which are the low contrast features of an image. This can help to a great extent in detection of breast cancer at an early stage.

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