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ULTRASOUND IMAGE SEGMENTATION OF SOLID BREAST TUMORS

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BONAFIDE CERTIFICATE

Certified that this project report entitled "**ULTRASOUND IMAGE SEGMENTATION OF SOLID BREAST TUMORS**" is the bonafide work of **BALASUBRAMANIAM.D** [Reg. no. 1020106002] who carried out the mini project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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Head of the Department

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The candidate with university Register no. 1020106002 is examined by us in the mini project viva-voce examination held on ....23.5.2011..

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ABSTRACT

Medical ultrasound scanning is widely implemented in breast diagnoses. Breast lesion investigations help to determine different types of abnormalities including cancer. In most cases it is recommended to use ultrasound scan rather than mammography for young females. The physics of ultrasound wave propagation and interaction with different human body structures, results in scattered echoes in form of speckle noise, which reduces the resolution of the scanned object. This noise is remarkably influencing the soft tissue such as breast, in which lesion detection and boundary characterization is a major part of ultrasound screening and diagnosing. The anisotropic diffusion filter has been implemented to reduce the noise and enhance the contrast. Finally tumor region is segmented. The image processing was performed in MATLAB environment.

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CHAPTER 1

INTRODUCTION

For the past twenty years, new medical imaging techniques have been under development that image the solid mechanical properties of tissues using pre-existing imaging modalities. An imaging technique involves exposing the object to a form of energy and creating an image from how the object interacts with the input energy. The most popular underlying imaging modality used is ultrasound. Ultrasound is a useful diagnostic tool to distinguish benign from malignant masses of the breast. It is a very convenient and safe diagnostic method.

1.1. PROJECT GOAL

The purpose of this project is to segment a breast tumor from the surrounding tissue in an ultrasonic image. The segmentation can be used to validate the effectiveness of imaging in locating and distinguishing benign and malignant breast tumors. Once the tumor region and background region are defined, quantitative measures such as contrast or area can be calculated.

1.2 OVERVIEW

The sequence of the proposed algorithm consists of filtering processes, segmentation, morphology operations and tumor detection. Due to the noise and speckles in the ultrasonic images, the anisotropic diffusion filter are used to reduce the noise and enhance the edge information. Automatic thresholding method is used to create binary image. Morphology operation is used to detect the tumor region in the given ultrasonic image.

1.3 SOFTWARE USED

- Matlab 7.8

1.4 ORGANIZATION OF THE REPORT

- **Chapter 2** discusses about the proposed algorithm.
- **Chapter 3** discusses about the anisotropic diffusion filtering.
- **Chapter 4** discusses the thresholding method.
- **Chapter 5** discusses the morphological operations.
- **Chapter 6** discusses the results of the image at each stage of the algorithm.
- **Chapter 7** shows the conclusion of the project.

CHAPTER 2
PROPOSED ALGORITHM

Step 1: Get the input ultrasonic image.

Step 2: Remove the noise using anisotropic diffusion filtering.

Step 3: Apply thresholding, to produce binary image.

Step 4: Create the negative of the image.

Step 5: Remove the holes and non tumor regions after identifying the tumor.

Step 6: Apply the boundary of the detected tumor region to the input image. This image is the final segmentad image.

CHAPTER 3

ANISOTROPIC DIFFUSION FILTERING

In image processing and computer vision, anisotropic diffusion, also called Perona–Malik diffusion, is a technique aiming at reducing image noise without removing significant parts of the image content, typically edges, lines or other details that are important for the interpretation of the image. Anisotropic diffusion resembles the process that creates a scale-space, where an image generates a parameterized family of successively more and more blurred images based on a diffusion process. Each of the resulting images in this family are given as a convolution between the image and a 2D isotropic Gaussian filter, where the width of the filter increases with the parameter. This diffusion process is a linear and space-invariant transformation of the original image. Anisotropic diffusion is a generalization of this diffusion process: it produces a family of parameterized images, but each resulting image is a combination between the original image and a filter that depends on the local content of the original image. As a consequence, anisotropic diffusion is a non-linear and space-variant transformation of the original image.

In its original formulation, presented by Perona and Malik in 1987, the space-variant filter is in fact isotropic but depends on the image content such that it approximates an impulse function close to edges and other structures that should be preserved in the image over the different levels of the resulting scale-space. This formulation was referred to as anisotropic diffusion by Perona and Malik even though the locally adapted filter is isotropic, but it has also been referred to as inhomogeneous and nonlinear diffusion, or Perona-Malik diffusion. A more general formulation allows the locally adapted filter to be truly anisotropic close to linear structures such as edges or lines: it has an orientation given by the structure such that it is elongated along the structure and narrow across. As a consequence, the resulting images preserve linear structures while at the same time smoothing is made along these structures. Both these cases can be described by a generalization of the usual diffusion equation where the diffusion coefficient, instead of being a constant scalar, is a function of image position and assumes a matrix (or tensor) value.

Although the resulting family of images can be described as a combination between the original image and space-variant filters, the locally adapted filter and its combination with the image do not have to be realized in practice. Anisotropic diffusion is normally implemented by means of an approximation of the generalized diffusion equation: each new image in the family is computed by applying this equation to the previous image. Consequently, anisotropic diffusion is an iterative process where a relatively simple set of computation are used to compute each successive image in the family and this process is continued until a sufficient degree of smoothing is obtained.

3.1 ANISOTROPIC DIFFUSION FILTER

There are several fundamental requirements of the noise filtering methods for medical images. First, it should not to lose the important information for object boundaries and detailed structures, second, it should efficiently remove the noise in the homogeneous regions, and third, it should enhance morphological definition by sharpening discontinuities. The anisotropic diffusion filter can get rid of the major drawback of the conventional spatial filters and improve the image quality significantly while preserve the important boundary information. The power of the anisotropic smoothing scheme lies in its dealing with local estimates of the image structures. Smoothing is formulated as a diffusive process, suppressed or stopped at boundaries by selecting locally adaptive diffusion strengths. Hence, in this filter, the smoothing operation could be prevented from across edges, the discontinuities can be preserved, and a weak slope remains nearly unchanged if the slope falls within the monotonically increasing part of the gradient values.

CHAPTER 4
THRESHOLDING METHOD

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images . During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of "1" while a background pixel is given a value of "0." Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label's.

The key parameter in the thresholding process is the choice of the threshold value. In an ultrasonic image, the region of the tumor appears to be darker and the background is brighter. After the image processed through the anisotropic diffusion filter the thresholding scheme is used to turn an ultrasound gray level image into a binary one to separate the tumor from its background. The automatic threshold-determination method, proposed by N. Otsu which can choose the threshold to minimize the intraclass variance of the black and white pixels automatically

CHAPTER 5
MORPHOLOGICAL OPERATIONS

Segmentation is done by the labeling, morphology operations and lesion boundary detection. The regions other than the tumor has been removed by the binary erosion function. The erosion was implemented to reduce the cost function of labeling technique. The manipulation of the binary labeling function has two objectives. Firstly, to trace any connected pixels attached to the border of the segmented image, because in most cases boarder objects present ultrasound image artifact. Secondly, to extract the major lesion by measuring the length of existed objects in the region, the largest lesion will be selected as the lesion of interest. The edge detection of the lesion is computed by approximating the skeletons of the objects, The morphological dilation is performed to smooth the sharp edges . The dilatation is implemented using structuring element of disk shape and four neighborhoods.

CHAPTER 6

RESULTS AND DISCUSSION

A program is written and implemented in matlab for the ultrasound for this project.

MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

Key Features

- High-level language for technical computing
- Development environment for managing code, files, and data
- Interactive tools for iterative exploration, design, and problem solving
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration
- 2-D and 3-D graphics functions for visualizing data

The resulting images at various stages of the algorithm for the given input image are shown and attached here.

6.1 INPUT ULTRASONIC IMAGE

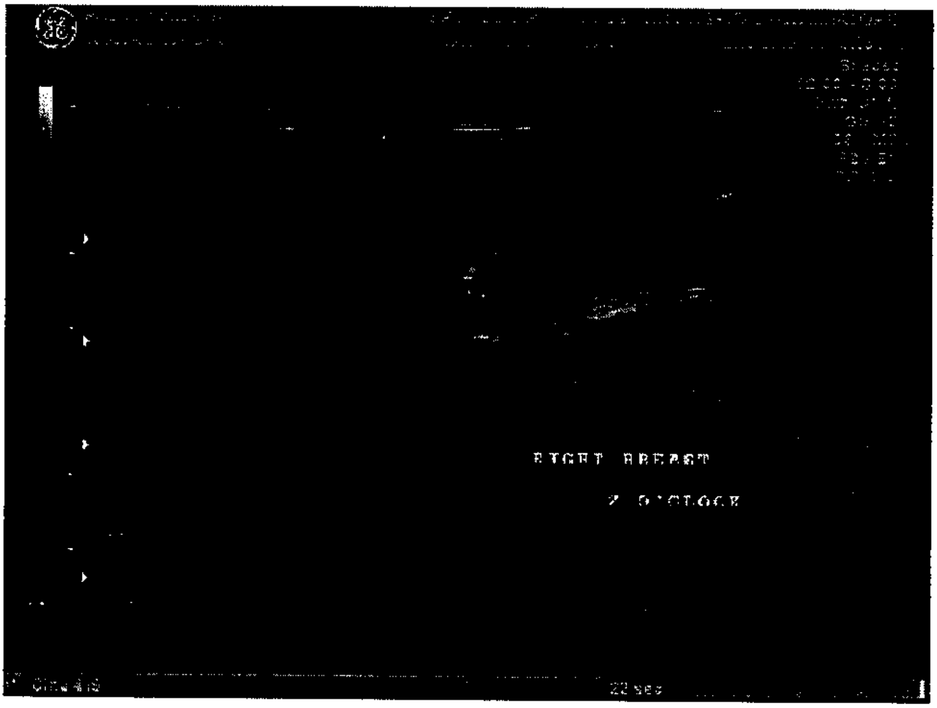

Figure 6.1 The given input ultrasonic image.

6.2 ANISOTROPIC DIFFUSION FILTERING

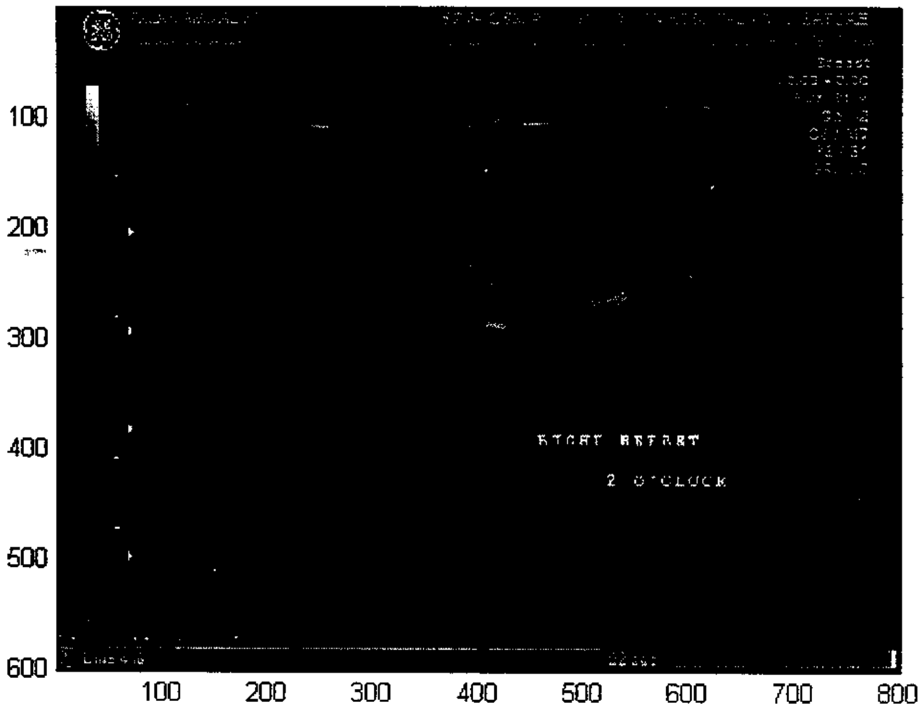

Figure 6.2 The filtered image.

6.3 AUTOMATIC THRESHOLDING METHOD

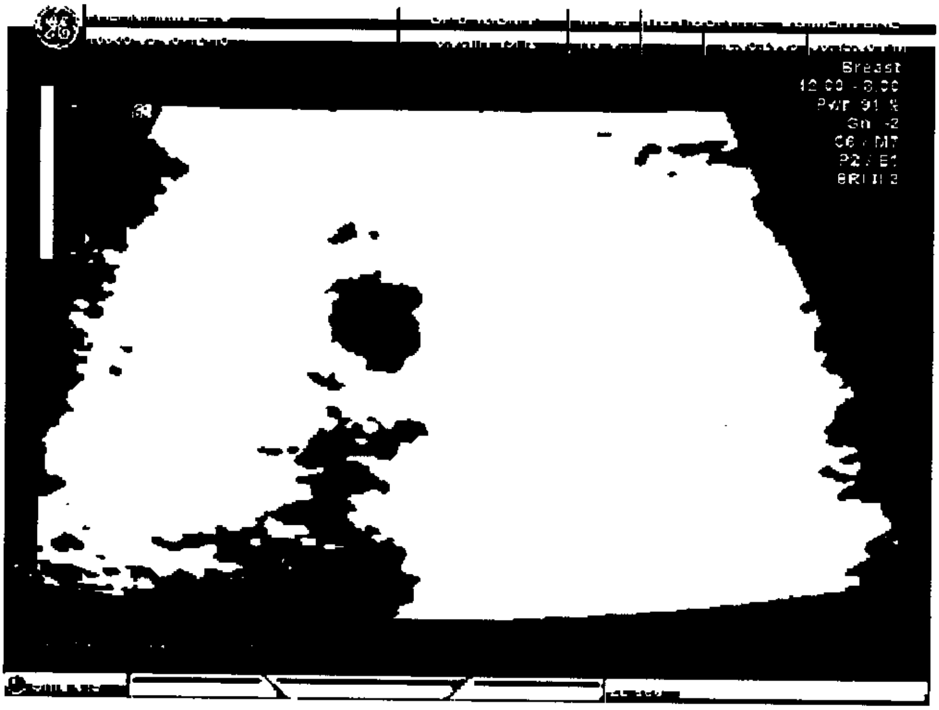

Figure 6.3 The binary image.

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6.4 NEGATIVE IMAGE

Figure 6.4 Negative of the image.

6.5 TUMOR REGION

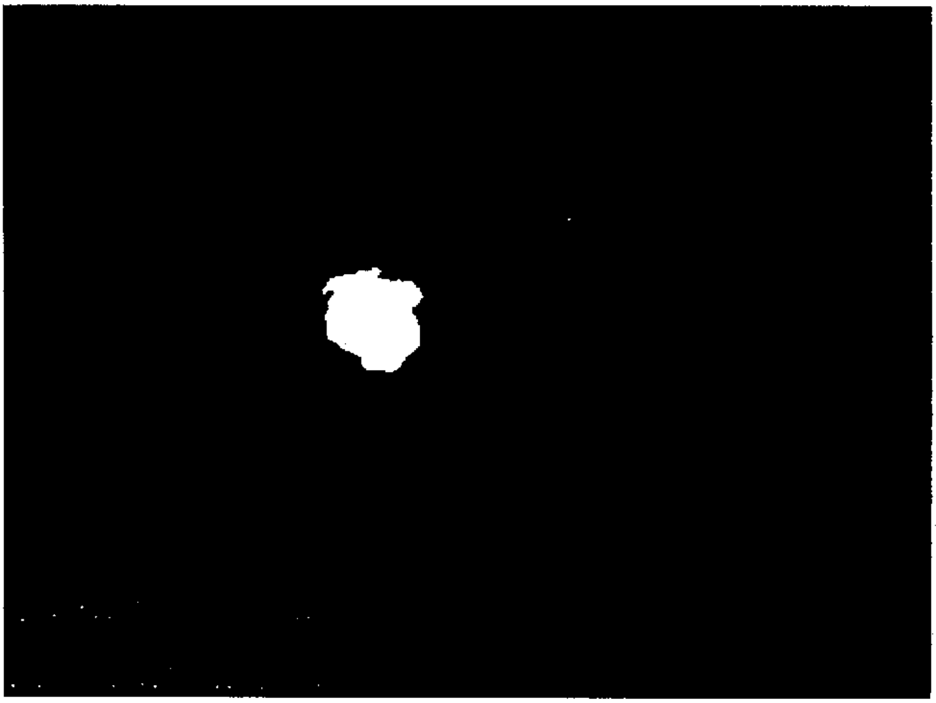

Figure 6.5 The identified tumor region.

6.6 SEGMENTED TUMOR REGION

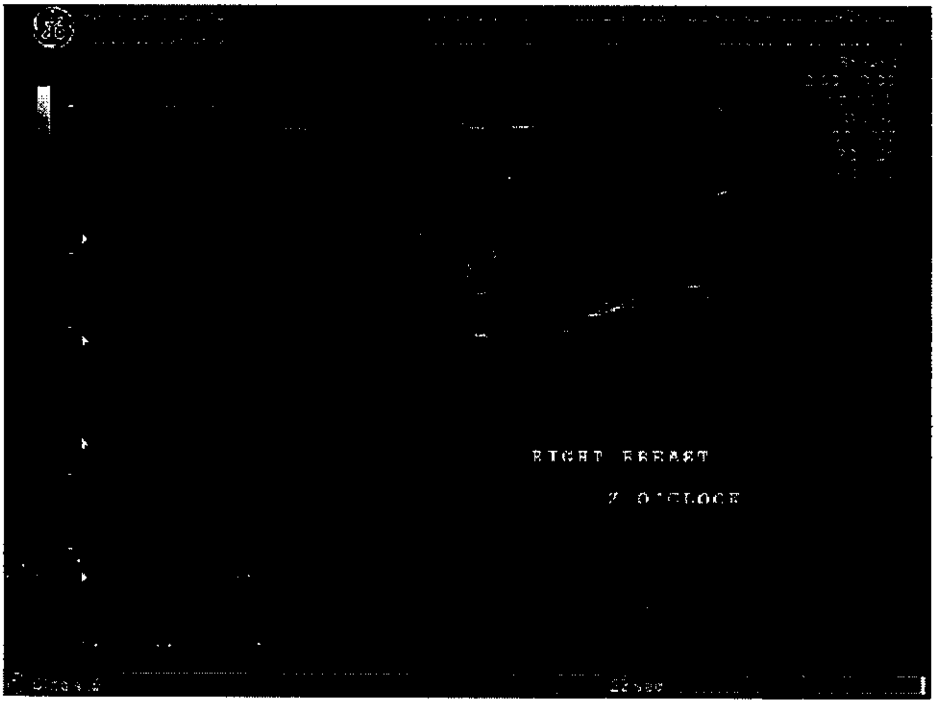

Figure 6.6 The segmented tumor region with boundary highlighted

CHAPTER 7
CONCLUSION AND FUTURE SCOPE

This project presents a segmentation method for the ultrasonic images of the breast tumor images. The noise which affects the image quality is removed by filtering

A finite number of iterations are required to implement the diffusion filter. The anisotropic diffusion filter is used to avoid the blurry problem of conventional low-pass filter. Thresholding with the mean of the image is used. The tumor region is identified by labelling the connected components and its boundary is imposed on the input image.

FUTURE SCOPE

Future scope of this project is to classify the tumors into benign or malignant based on their shape informations using support vector machines.

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