# Quantitative Analysis of Breast Density from Ultrasound Tomographic Images


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## Abstract

*Early identification of breast cancer is the most important factor determining survival. Three guiding concepts for breast cancer screening are that: 1) early detection and treatment improves outcome; 2) procedures must not harm healthy women; and 3) procedures must be practical and cost-effective. Ultimately, this project aims to improve early detection of breast cancer in patients with dense breasts using automated volume breast ultrasound scanning. To acquire images, we use a specially developed breast ultrasound machine that makes a series of scans of each breast. The patients will lay on their stomach with their breast extending through an opening on the scanning table into water. After their breast is properly positioned, a series of scans will be made while they lie still. Using the collected data, we seek to write an algorithm that extract distinctive features of dense or glandular tissue and allows one to distinguish between fibroglandular and fatty breast tissues.*


## 1. Introduction

Emerging evidence has shown that women with high mammographic breast density are at four to five-fold increased risk of developing breast cancer [1]. Breast density is consistently associated with breast cancer risk, more strongly than most other risk factors for this disease, and extensive breast density may account for a substantial fraction of breast cancer [4-5]. Thus, a measurement of density carries information about the difficulty of detecting cancer in a mammogram. In many literatures, the initial methods for assessing mammographic density were entirely subjective and qualitative; however, in the past few years methods have been developed to provide more objective and quantitative density measurements. Research is now proceeding to produce and validate techniques for volumetric measurement of density [3]. In his article, Martin J. Yaffe, discusses alternative imaging modalities to measure breast density, such as ultrasound and MRI. Unlike the conventional imaging techniques, they do not require the use of ionizing radiation and may be more appropriate for use in young women or where it is desirable to perform measurements more frequently. In his article, Yaffe further reviews the techniques for measurement of density and illustrates their strengths and limitations.

Most of the work on breast density measurement has been done with mammography, but other medical breast imaging modalities also provide information about tissue composition. These alternative imaging techniques have advantages of providing three-dimensional images and do not require exposure of the breast to ionizing radiation. For the case of this project, we focus on ultrasound as means to quantitatively analyze the composition of breast tissues. Although the images primarily are sensitive to acoustic reflections at tissue boundaries, the signals are also dependent on the speed of sound and its attenuation, and all three of these factors are, in turn, dependent on tissue composition [3]. Over the course of this project, we aim to produce an automated volume ultrasound system that would be reproducible and produce reliable quantitative results.

### 1.1. Data Acquisition

To acquire images, we use a specially developed breast ultrasound machine that makes a series of scans of each breast. The patients will lay on their stomach with their breast extending through an opening on the scanning table into water. After their breast is properly positioned, a

Figure 1: Illustrates the setting for image acquisition

series of scans will be made while they lie still, as displayed in figure 1.

**VBUS Data Acquisition:** Approximately 270 scans will be acquired at 20 /second over 360 in 18 seconds for reflection, sound speed, attenuation measurements.

**Reflection Imaging:** B-mode images are summed over all acquisition angles with a high-performance GPU at 0.100 second/slice followed by unsharp masking to improve resolution.

**Sound Speed Imaging:** Sound speed data will be measured using the time delay (spatial shift) from a back wall reflector. The delay represents the relative change in sound speed from baseline as sound propagates through different breast tissues.

### 1.2. Standard vs. advance volume breast US

Unlike the standard diagnostic ultrasound machine, our specially developed ultrasound provides images with better quality since we use so many images as explained above. Also, our images do not suffer from the speckle artifact, so they are more amenable to computer aided diagnosis.

### 1.3. Fatty vs. glandular

Regions of fat appear darker on the ultrasound images while regions of brightness associated with fibroglandular tissue. In other word, the fibroglandular tissues are more reflective (i.e. has more interfaces that reflect sound back). This is illustrated in figure 2.

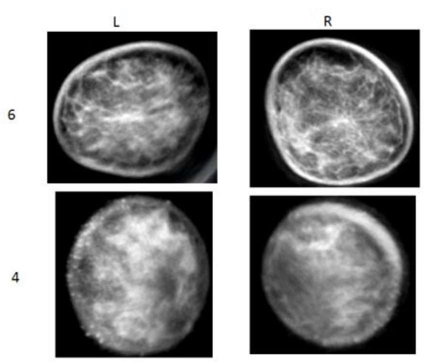


Figure 2. Images acquired from two different patients.

## 2. Algorithm

A methodology will be introduced for the automated assessment of structural changes of breast tissue in ultrasound images. It employs a generic machine learning framework and provides objective breast density measures quantifying the specific biological effects of interest.

## 3. Qualifications

Here are the list of related courses that I took at UCSD: ECE 153, ECE 175A, ECE 187, ECE 251A, ECE 253A. And am taking BENG 280B this quarter.

## 4. Milestones

Milestone 1: finish gathering datasets or training data by the end of week 3.

Milestone 2: Start implementing my own algorithm by the end of week 5.

Milestone 3: Debug and improve the algorithm by the end of week 10

## 5. Lists of Questions

Are there ways to improve the current image qualities?

Besides speed of sound, what are the defining factors for measuring breast density?

What are the main physiological features that help one to identify a fibroglandular tissue?

How can we employ sound speed tomogram to assess breast density?

Is sound speed tomogram a useful tool in clinical response of breast cancer patients?

How does women menstrual cycle affects the images?

## References


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