# Early Breast Cancer Detection via Novel Radiomics Techniques and Ultrasonography

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## Abstract

A developing field in bioinformatics and medical science is radiomics, the study of data generated by radiological imaging. The field is novel, and scientists have begun to pioneer studies that will further the scope of preventive medicine. Different imaging modalities have been used in radiomics studies, with ultrasound appearing to be the most promising. Vast amounts of data are being generated each day with different methodologies and statistical tools consistently progressing the scope of analysis and image interpretation. This review focuses on radiomics applied to ultrasound data, analysis tools, and breast cancer – a disease where radiomics research looks most promising.

## Introduction

The data-driven 21st century has prompted interdisciplinary research, interfacing the clinical and computer sciences. A byproduct of the Big Data Revolution is radiomics (also known as radiogenomics, or computer-aided diagnostics) which uses radiological images and scans, converts them to higher dimensional data, and extracts information to make diagnostic conclusions (1,2).

High throughput computing allows a tremendous amount of information to be extracted from CT, PET and MRI data, reflecting underlying pathophysiology of the patient (3). Benefiting greatly from these operations is precision medicine, which focuses on developing and administering timely patient-specific treatments (3). While radiomics technologies would not be used as stand-alone diagnostic tools, they would provide extraordinary decision support, helping diagnose and treat conditions early.

Radiomics is implemented in many different radiological modalities, but ultrasound (also known as sonoelastography, tomosynthesis, or ultrasound elastography) has been overlooked. In a 2014 study by Parker et al., it was found that ultrasound scans could be used in conjunction with CT without compromising patient outcomes (4). In that particular study, patients saved more than 450 dollars per individual scan, and also prevented potential excess exposure to radiation (4). Since then, new ultrasound transducers have been developed, with some, such as the Clarius, handheld and controlled by a mobile app.

This review aims to discuss how radiomics has been implemented to ultrasound images, in the breast, analyze the prospective directions of the technology, and predict the future of patient outcomes.

## Materials and Methods

### Early Radiomics Research

As early as 2000, mammographic parenchymal patterns were analyzed using computer programs (5). However, only in the last few years has it been possible to improve the accuracy and precision of these systems (2). Using tomosynthesis and recent advances in medical imaging resolution, it is possible to pinpoint with over 90 percent accuracy the presence of cancerous tissues in the breast without exposing women to excess radiation via repeated mammograms (2).

### "New-Age" Radiomics Studies

Recent radiomics studies affirm that the discipline will soon be a fixture in medical diagnoses. A 2017 paper by Guo et al. extracted information from sonoelastography data and differentiated between malignant and benign breast ductal carcinomas with statistically significant accuracy (6). The group partitioned and assessed tumor boundaries, and in cases where the program could not perform automatically, seasoned radiologists were called to manually refine the boundary regions (6). With machine-learning and artificial intelligence driving the study, it is possible to envision a future where sonoelastography systems have autonomy in reading medical scans.

The shapes, margins, boundaries, and patterns were collected from 215 patients of Asian heritage over a period of two years (6). However, with human populations, it is important to consider the variability between people of different evolutionary origins (7). Several of the most recent radiomics studies are conducted by groups in China (6,8,9,10). Despite their overall success, the systems cannot be translated to populations of European or African ancestry without accounting for differences in histology (2).

### But Why Breast Cancer?

Imaging the breast is often ideal for radiological data collection and has been the basis for early radiomic experimentation. Breast tissue is ideal for post-hoc studies, because patients often self-diagnose the presence of tumors via palpation. This makes them likely to seek help early, crafting a robust dataset of early images. As a result, computer-aided diagnostics are afforded training datasets that are unique to breast cancers and can be used to diagnose the beginning stages of the disease (9). Preventative imaging in combination with histological data, may even allow women to identify breast cancer well before identifying tumors independently (6).

**East vs. West and its Effect on a Dataset**

Radiomics studies in Western countries are markedly lagging. This may be due to stringent medical protocols surrounding mammograms, particularly in the United States (2). When breast density is high, the sensitivity of mammograms reduces, leaving cancer undetected, and often putting these women at high risk (2). Medical protocol often keeps the records of these women sealed, and clinical research becomes nearly impossible with regulations surrounding medical informatics due to HIPAA (11). While ethical research standards must not be compromised, patients should be made aware of the overall benefits of providing anonymous data points for training models to detect breast cancer early.

The increased power of these tests lies in the recent ability of computers to handle large datasets. Studies, such as the one conducted by Zhang et al., truly capitalize on the allowances of Big Data – having a high throughput dataset consisting of over 364 features analyzed over 117 patients who had 45 malignant and 75 benign breast tumors (10). Other studies, especially in countries like Italy and the United States, do not analyze nearly as many features or patients, with Tagliafico et al. only analyzing tomosynthesis images from 45 women (2). Interestingly, Guo et al., another Chinese research group, conducted a post-hoc analysis on ultrasound imaging from N=215 women (6).

**<u>Discussion</u>**

Using ultrasound modalities to diagnose cancer proves beneficial to both patients and physicians alike. Low doses of radiation, reduced imaging costs, and out-patient evaluation make it one of the most promising radiological modalities (4). Additionally, the big-data revolution makes it incredibly easy to evaluate images and obtain thorough information from available datasets (3).

Radiomics has just begun to take a stronghold in next-generation medical care. Although many groups are consistently creating evaluation models that accurately diagnose cancers more than 90 percent of the time, it is important to recognize that these results are not translatable across human populations, or cancers (2). Likely, other research groups will be creating decision support models for a range of diseases, not just cancer, across different populations, age groups, and genders, among other factors.

As the sciences become more interdisciplinary, it is critical that physicians and scientists work together to create medical diagnostics that employ the newest innovations of their respective fields. Although cancer remains a scary word, the allowances of the 21st century provide hope that with good tools, models, and diagnostic criteria it can be diagnosed early – perhaps just by looking at a picture.