Chapter 2
Automatic Mammographic Parenchyma Classification According to BIRADDS Dictionary

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ABSTRACT
Internal density of the breast is a parameter that clearly affects the performance of segmentation and classification algorithms to define abnormality regions. Recent studies have shown that their sensitivity is significantly decreased as the density of the breast is increased. In this chapter, enhancement and segmentation process is applied to increase the computation and focus on mammographic parenchyma. This parenchyma is analyzed to discriminate tissue density according to BIRADS using Local Binary Pattern (LBP), Gray Level Co-Occurrence Matrix (GLCM), Fractal Dimension (FD), and feature fusion technique is applied to maximize and enhance the performance of the classifier rate. The different methods for computing tissue density parameter are reviewed, and the authors also present and exhaustively evaluate algorithms using computer vision techniques. The experimental results based on confusion matrix and kappa coefficient show a higher accuracy is obtained by automatic agreement classification.

1. INTRODUCTION
Medical image analysis becomes more and more popular in recent years due to the advances of the imaging techniques, including Magnetic Resonance Imaging (MRI), Computer Tomography (CT), Mammography, Positron emission tomography (PET), X-ray, and Ultrasound or Doppler Ultrasound. It is widely accepted in the medical community that breast tissue density is an important risk factor for the development of breast cancer. Thus, the development of reliable
Automatic methods for classification of breast tissue is justified and necessary. Every effort has been directed to improving the early detection of breast cancer. Therefore, many computer vision techniques applied to analysis of digital mammograms have been proposed. Most of them require an initial processing step that splits the image into interesting areas, such as the breast region, background and patient markings (El-henawy et.al, 2009). For example, it is well known that information derived from mammographic parenchyma patterns provides one of the most robust indications of risk of developing breast cancer. Moreover, the segmentation method should be robust enough to handle a wide range of mammographic images obtained from different image acquisition systems.

A recent trend in digital mammography is CAD systems, which are computerized tools designed to help radiologists. Most of these systems are used for the automatic detection of abnormalities. However, recent studies have shown that their sensitivity is significantly decreased as the density of the breast is increased. The internal density of the breast is a parameter that clearly affects the performance of segmentation algorithms to define abnormality regions. Surprisingly, most of these segmentation algorithms do not take this information into account leading to many false positive regions, when system identifies abnormality regions.

The computer-aided interpretation systems of mammographic images have two different approaches: 1) a computer-aided detection platform, which processes the mammograms looking for abnormalities 2) a featured computer-aided diagnosis (CAD), which works as a content-based image retrieval (CBIR) (Birdwell et.al, 2001).

CAD systems are being developed to assist radiologists in the evaluation of mammographic images (Freer et.al, 2001). However, recent studies have shown that the sensitivity of these systems is significantly decreased as the density of the breast increases while the specificity of the systems remains relatively constant (Jain et.al, 1998). From a medical point of view, these studies are disappointing, because it is well-known that there is a strong positive correlation between breast parenchyma density in mammograms and the breast cancer risk (Wolfe, 1976). Therefore, automatic classification of breast tissue will be beneficial for estimating the density of the breast.

As Taylor (Taylor et.al, 1994) suggested, the development of automatic methods for classification of breast tissue are justified by two factors: 1) to permit better use of the time and skills of expert radiologists by allowing the difficult mammograms to be examined by the most experienced readers. 2) to increase the scope for computer-aided detection of abnormalities.

The origin of breast density classification is the work of Wolfe (Wolfe, 1976) and Muhimmah (Muhimmah et.al, 2006), which showed the relationship between mammographic parenchyma patterns and the risk of developing breast cancer, classifying the parenchyma patterns to four categories. Since the discovery of this relationship, automated parenchyma pattern classification has been investigated, as is explained in the next section. However, the American College of Radiology (ACR) Breast Imaging Reporting and Data System (BIRADS) is becoming a standard for the assessment of mammographic images (ACR, 1998). In this standard, breasts are classified into four categories according to their density.

- **BIRADS I**: The breast is almost entirely fatty
- **BIRADS II**: There is some fibro glandular tissue
- **BIRADS III**: The breast is heterogeneously dense
- **BIRADS IV**: The breast is extremely dense.

Automatic tissue classification methods try to imitate radiologist visual judgment. There are a number of different dictionaries for breast tissue