

## Chapter 40

# Fuzzy Image Segmentation for Mass Detection in Digital Mammography: Recent Advances and Techniques

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### ABSTRACT

*In the last decade, many computer-aided diagnosis (CAD) systems that utilize a broad range of diagnostic techniques have been proposed. Due to both the inherently complex structure of the breast tissues and the low intensity contrast found in most mammographic images, CAD systems that are based on conventional techniques have been shown to have missed malignant masses in mammographic images that would otherwise be treatable. On the other hand, systems based on fuzzy image processing techniques have been found to be able to detect masses in cases where conventional techniques would have failed. In the current chapter, recent advances in fuzzy image segmentation techniques as applied to mass detection in digital mammography are reviewed. Image segmentation is an important step in CAD systems since the quality of its outcome will significantly affect the processing downstream that can involve both detection and classification of benign versus malignant masses.*

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## INTRODUCTION

Breast cancer is one of the most common causes of death in women worldwide, and its occurrence is still on the rise. Early detection of breast cancer has shown to be effective in improving the chance of full recovery. Mammography is a widely used breast imaging technology for the detection of masses which can develop further into breast cancer. However, a double reading of mammography images (i.e. independent readings by two radiologists) is not only costly but will also incur a significant increase of workload. In order to enhance the sensitivity of detection, thereby improving the detection rate of breast cancer, CAD systems have been utilized as a second opinion in the interpretation of mammography images.

Digital mammography is now accepted as an essential technique in early detection of breast cancer. However, due to the difficulty posed in interpreting mammography images by visual inspection even for trained radiologists, medical-imaging techniques for accurately segmenting potential cancerous masses from normal tissues have continued to be an active area of research since the turn of the century. In particular, applications of fuzzy-logic techniques have been proven very efficient in the analysis of mammography images in the past decade. Since masses appearing in mammography images often possess uncertain boundaries and low-intensity contrast, fuzzy-logic approaches for breast-cancer detection have demonstrated to be far more robust than systems that were built following a rigid approach. A major contribution of this book chapter will be an up-to-date review of current techniques for segmenting masses for cancer detection in mammographic images by applying a fuzzy logic approach. Although several review articles on topics related to the computer-aided detection and diagnosis of breast cancer have been published in the past few years, most were fairly broad in their coverage (Sampat, Markey, & Bovik, 2005; Tang, Rangayyan, Xu, El Naqa, & Yang, 2009). The current book chapter

distinguishes itself from other reviews in that it has a clear focus, and that is on fuzzy image segmentation techniques for mass detection. This chapter aims to contribute a useful reference for researchers and students who would like to gain an understanding of recent advances in fuzzy logic approaches for image segmentation as applied to digital mammographic imaging.

The rest of this chapter is organized as follows. In the next section, we will review the background of cancer detection, particularly as it relates to breast cancer. We will explain what digital mammography is, followed by a general description of CAD system and its main processing stages. Next, we will introduce medical imaging in digital mammography by discussing the role of image pre-processing and mass detection and classification, before detailing how image segmentation is being performed by conventional approaches. After this, we will focus on fuzzy image segmentation for mass detection. Here, we cover fuzzy image processing, fuzzy concept for mammography images, and recent advances and techniques in this area. We will also mention performance and metrics towards the end. Finally, the last section gives the conclusions.

## BACKGROUND

According to the Oxford Dictionary, *cancer* is a disease that is caused by an uncontrolled division of abnormal cells in a certain part of the body (Oxford Dictionary, n.d.). The result of this unusual growth is normally in the form of a mass or tumor. Most types of cancer are named according to the part of the body in which the cancer first arises. Breast cancer can thus be considered an uncontrolled growth of cells in the breast tissue. A human female's breast (illustrated in Figure 1) consists of lobules and ducts, which are surrounded by fatty and connective tissues. Lobules are glands that produce milk, while ducts connect lobules and carry milk to the nipple.

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