A Probabilistic Approach for Breast Boundary Extraction in Mammograms

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The extraction of the breast boundary is crucial to perform further analysis of mammogram. Methods to extract the breast boundary can be classified into two categories: methods based on image processing techniques and those based on models. The former use image transformation techniques such as thresholding, morphological operations, and region growing. In the second category, the boundary is extracted using more advanced techniques, such as the active contour model. The problem with thresholding methods is that it is hard to automatically find the optimal threshold value by using histogram information. On the other hand, active contour models require defining a starting point close to the actual boundary to be able to successfully extract the boundary. In this paper, we propose a probabilistic approach to address the aforementioned problems. In our approach we use local binary patterns to describe the texture around each pixel. In addition, the smoothness of the boundary is handled by using a new probability model. Experimental results show that the proposed method reaches 38% and 50% improvement with respect to the results obtained by the active contour model and threshold-based methods respectively, and it increases the stability of the boundary extraction process up to 86%.

1. Introduction

Breasts are soft parts of the body which are normally composed of fatty tissues as well as specialized tissues that produce milk. Breast cancer is a very serious disease. The early detection of the disease increases the success of treatment. However, its early detection is difficult since there are no symptoms during the first stages of breast cancer development. Fortunately, X-ray mammography can reveal small changes in breast tissue [1]. Mammograms can be used to detect characteristic masses and microcalcifications.

We distinguish two kinds of mammographies, namely, cranio-caudal (CC) where the breast is compressed horizontally and an X-ray image is taken in the direction from head to toe and mediolateral oblique (MLO) where the breast is vertically compressed and an X-ray image is taken from the side. Although our method is suitable for both approaches, in this paper, we only concentrate on MLO mammographies since the database (mini-MIAS) that is used in this study only provides this type of mammograms.

To take mammograms, radiographers help patients to position their breast between two small plates where X-rays pass through the tissues of the breast. The plates then compress the breast for a moment to take an X-ray image. Each breast is compressed to a thickness of approximately 6 cm, and an X-ray image is taken perpendicular to the plane of compression [1]. The diverse densities of the breast tissues attenuate the X-rays differently and translate into different degrees of brightness in the final image.

The breast is connected to the pectoral muscle, fatty tissues are located below the skin, and lobules and ducts are located at the center of the breast. There is a phenomenon, known as ductal carcinoma in situ (DCIS), that affects the cells lining the breast ducts. The breast cancer cells are only inside the ducts and lead to the generation of dense areas at the center of the breast (in some women, DCIS may spread into the surrounding breast tissues after some years to become an invasive ductal breast cancer [2]).

As we stated before, during a mammography process, X-rays enter from one side of the breast and exit from the other side. Inside the breast, each tissue attenuates the X-rays
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