Abstract

Breast cancer is the leading cause of cancer-related death among women. Masses and architectural distortion are important yet challenging signs of breast cancer visible in mammograms. This thesis proposes novel methods for automatic detection of mammographic masses and architectural distortion.

The pectoral muscle and the nipple are two important landmarks of the breast that appear in mammograms. Novel methods are developed in the present work for the detection of the pectoral muscle and the nipple. The pectoral muscle detection algorithm first approximates the muscle boundary as a straight line using weighted average gradient-, position-, and shape information of the pectoral muscle. The straight line is then converted into a smooth curve using local gradient searching. For automatic detection of the nipple, a method based on the oriented patterns of the breast tissues in mammograms is proposed, using Gabor filters and the Radon transform.

Screening mammograms obtained prior to the detection of cancer may contain subtle signs of early stages of breast cancer, specifically, architectural distortion. The presence of architectural distortion changes the orientation of breast tissue patterns in a mammographic image. In this study, two new methods are developed for the detection of architectural distortion in prior mammograms of interval-cancer cases. First, based on the orientation field of a given mammographic image, two new angle cooccurrence matrices (ACMs) are derived to estimate the joint occurrence of the angles of oriented structures. Statistical features are then computed from each of the ACMs to discriminate sites of architectural distortion from the false-positive regions obtained by the application of Gabor filters and phase portrait analysis. The best result obtained with the method in terms of the area under the receiver operating characteristic (ROC) curve with the leave-one-patient-out method is 0.76. The method obtains a sensitivity of 80% at 4.2 false positives per patient. In the second approach, using a divergence measure, the angular deviation of the oriented structures in a mammogram as compared to the expected orientation is analyzed to detect potential sites of architectural distortion. The second method shows improved performance over the existing literature on the detection of potential sites of architectural distortion in prior mammograms of interval-cancer cases.

Based on the hypothesis that masses generally appear as high-intensity focal regions enclosed by regions with gradually diminishing intensity values, an iterative method of multilevel high-to-low intensity thresholding followed by region growing is proposed for the localization of masses in mammograms. For the reduction of false positives, several texture- and shape-based features that characterize the masses are then analyzed. With a dataset of good size of direct radiography mammograms and scanned-film mammograms, the sensitivity achieved by the proposed method is greater than 90% with less than 1.5 FP/image.

Keywords: Angle cooccurrence matrix; architectural distortion; breast cancer; classification; computer-aided detection; divergence; expected orientation; feature extraction; Gabor filter; landmark detection; mammography; mass; multilevel thresholding; nipple; orientation field; pectoral muscle; prior mammogram; radial region growing; Radon transform; stepwise logistic regression; weighted average gradient.