Mammographic Risk Assessment Based on Anatomical Linear Structures

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Abstract. Mammographic risk assessment is concerned with the probability of a woman developing breast cancer. Recently, it has been suggested that the density of linear structures is related to risk. For 321 images from the MIAS database, a measure of line strength was obtained for each pixel using the Line Operator method. The proportion of pixels with line strength above a threshold level was calculated for each image and the results categorised by Tabar pattern, Boyd SCC class and BIRADS class. The results indicated a significant difference between Boyd classes 1–3 (low risk) and classes 4–6 (high risk), and between most Tabar patterns and BIRADS classes.

1 Background

Mammographic risk assessment is concerned with estimating the probability of women developing breast cancer. Risk assessment is a rapidly developing area of research and aims to improve the likelihood of the early detection of breast cancer. Breast density is an important indicator of mammographic risk [1] and the best predictor of mammographic sensitivity [2]. However, more recently, it has been suggested that the distribution of linear structures is also correlated with mammographic risk [3, 4, 5]. So far it is not entirely clear if it is just the density of linear structures (either by percentage area or volume) or if the distribution of the linear structures plays a role as well.

Tabar et al. have proposed a mammographic risk assessment model based on four structural components, where the relative proportions of each component is linked to the risk of developing breast cancer [3, 4, 5]. One of the four structural components is linear density. The main purpose of this work is to investigate if automatic methods can be used to correlate the density of linear structures to mammographic risk classification metrics.

Three classification models are used: Tabar patterns [5], Boyd SCC classes [6] and Breast Imaging Reporting and Data System (BIRADS) classes [7]. Tabar's classification consists of five *patterns*, where patterns I–III represent a low risk of developing breast cancer, and patterns IV–V indicate a higher risk. Screening tests have shown that cancer prevalence in women with patterns IV-V is approximately twice that in women with patterns I-III [5]. The Boyd SCC model

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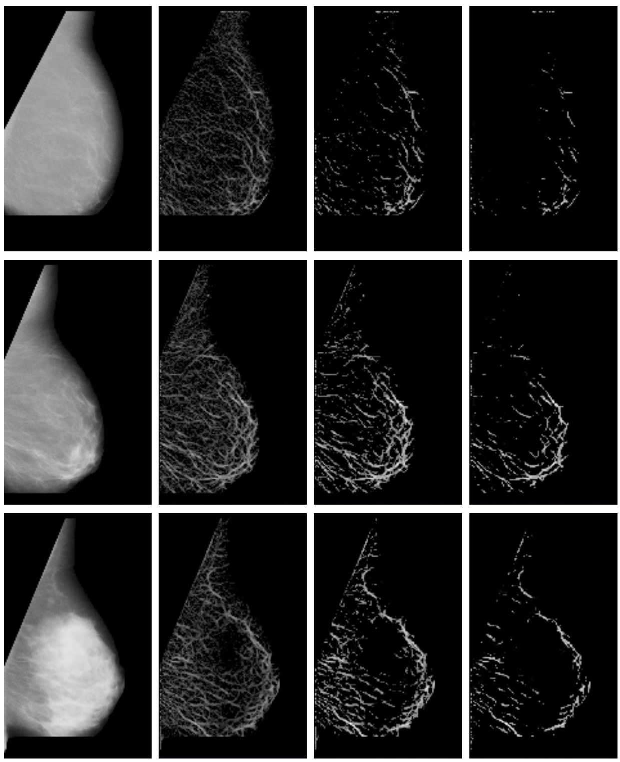
consists of a scale of six classes where class 1 indicates the lowest risk and class 6 indicates the highest risk. Finally, the BIRADS classification uses a scale of four classes, where class 1 represents a low risk and class 4 represents a high risk.

2 Method

Three hundred and twenty-one mammographic images from the Mammographic Image Analysis Society (MIAS) database were classified according to Tabar patterns [5], Boyd SCC [6] and BIRADS classes [7] by an expert radiologist. Example images of low, moderate and high risk mammograms are shown in Fig. 1 (a).



(a) (b) (c) (d)

Fig. 1. The top row shows a mammogram of Boyd SCC class 1/Tabar pattern II/BIRADS class 1 (low risk), the middle row shows a mammogram of Boyd SCC class 3/Tabar pattern III/BIRADS class 2 (moderate risk) and the bottom row shows a mammogram of Boyd SCC class 6/Tabar pattern IV/BIRADS class 3 (high risk). The images in column (a) show the original mammograms, column (b) shows the results after processing with the line operator, and columns (c) and (d) show the results after thresholding at 4/204 and 6/204 respectively. The lines in (b), (c) and (d) have been enhanced for viewing.