Computerized Classification of Benign and Malignant Breast Lesions on DCE-MRI Utilizing Novel Shape Descriptors

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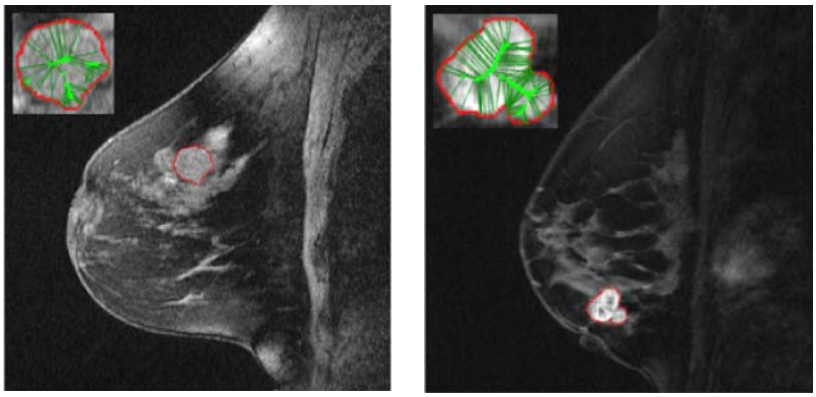
Introduction: Dynamic contrast enhanced (DCE)-MRI has recently emerged as an adjunct screening tool to conventional x-ray mammography due to its high detection rate of malignant lesions. However, DCE-MRI is associated with high interobserver variability, with κ ranging from 0.21 to 0.40 [1]. For the specific task of describing lesion morphology (smooth versus spiculated), there is high interobserver (κ=0.29) and intraobserver (κ=0.22) variability [2]. The development of a computerized decision support tool capable of quantifying differences in lesions morphology may aid in reducing observer variability and accurate breast lesion diagnosis on DCE MRI. In this work, we present a computerized classification system to distinguish benign from malignant breast lesions using shape descriptors on DCE MRI. Our classification utilizes a novel Explicit Shape Descriptors (ESDs) to describe differences between the appearance of lesions on DCE-MRI.



(a) (b)

Figure 1. DCE-MRI postcontrast images with insets of lesions delineated (red) and medial axis (green) for (a) benign and (b) malignant lesions.

Methods: DCE-MRIs of 41 suspicious breast lesions were collected under IRB approval. An attending radiologist selected the 2D slice that was most representative of the lesion, and the radiologist manually delineated the boundary of the lesion. Each lesion was diagnosed as benign or malignant by the attending radiologist and confirmed via histological evaluation. ESDs were determined for each lesion by: (a) modeling lesion shape (via the medial axis transform seen in Figure 1), (b) pairwise comparison between shape models, and (c) dimensionality reduction to obtain ESDs. Three feature sets were compared against: (i) 6 implicit morphologic features modeled on the BIRADs descriptors [4]; (ii) Fourier Descriptors (FDs), an alternative shape model approach [5]; (iii) 13 Haralick co-occurrence texture features [4]. Feature sets were evaluated on their ability to distinguish benign from malignant lesions using a SVM classifier with 3-fold cross validation over 5 trials.

Feature	Texture	Implicit	FDs	ESDs
Accuracy	75.2±6.4	72.9±3.2	71.8± 2.6	**83.0±4.5**

Table 1. SVM Classifier accuracy for feature sets using randomized 3-fold cross validation over 5.

Results: ESDs have a higher accuracy than comparative state-of-the-art features in distinguishing benign from malignant lesions. Note that, even texture features, which outperform more traditional shape descriptors, are less effective in distinguishing benign from malignant lesions on DCE-MRI [4].

Concluding Remarks: In this paper, we have developed a computerized system which can distinguish between benign and malignant breast lesion with high accuracy utilizing ESD features. ESDs outperform two other morphologic features sets, and texture feature set. Our computerized system represent a reliable and accurate method to quantify subtle morphologic differences between benign and malignant lesions using appearance on DCE-MRI.

Acknowledgements:

References

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