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Classification of contrast-enhanced spectral mammography (CESM) images

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Abstract

Purpose: Contrast-enhanced spectral mammography (CESM) is a recently developed breast imaging technique. CESM relies on dual-energy acquisition following contrast agent injection to improve mammography sensitivity. CESM is comparable to contrast-enhanced MRI in terms of sensitivity, at a fraction of the cost. However, since lesion variability is large, even with the improved visibility provided by CESM, differentiation between benign and malignant enhancement is not accurate and a biopsy is usually performed for final assessment. Breast biopsies can be stressful to the patient and are expensive to healthcare systems. Moreover, as the biopsies results are most of the time benign, a specificity improvement in the radiologist diagnosis is required. This work presents a deep learning-based decision support system, which aims at improving the specificity of breast cancer diagnosis by CESM without affecting sensitivity.

Methods: We compare two analysis approaches, fine-tuning a pretrained network and fully training a convolutional neural network, for classification of CESM breast mass as benign or malignant. Breast Imaging Reporting and Data Systems (BIRADS) is a radiological lexicon, used with breast images, to categorize lesions. We improve each classification network by incorporating BIRADS textual features as an additional input to the network. We evaluate two ways of BIRADS fusion as network input: feature fusion and decision fusion. This leads to multimodal network architectures. At classification, we also exploit information from apparently normal breast tissue in the CESM of the considered patient, leading to a patient-specific classification.

Results: We evaluate performance using fivefold cross-validation, on 129 randomly selected breast lesions annotated by an experienced radiologist. Each annotation includes a contour of the mass in the image, biopsy-proven label of benign or malignant lesion and BIRADS descriptors. At 100% sensitivity, specificity of 66% was achieved using a multimodal network, which combines inputs at feature level and patient-specific classification.

Conclusions: The presented multimodal network may significantly reduce benign biopsies, without compromising sensitivity.

Keywords: Breast cancer; Computer vision; Contrast-enhanced spectral mammography (CESM); Deep learning; Multimodal neural networks.

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