

Automatic Differentiation of Ultrasonic Images of Cystic and Solid Breast Lesions

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Abstract : In most cases, typical cysts are easily recognized at ultrasonography. The specificity of this method for typical cysts reaches 98%, and it is usually considered as gold standard for typical cyst diagnosis. However, it is necessary to have all the following features to conclude the typical cyst: clear margin, the absence of internal echoes and dorsal acoustic enhancement. At the same time, not every breast cyst is typical. It is especially characteristic for protein-contained cysts that may have significant internal echoes. On the other hand, some solid lesions (predominantly malignant) may have cystic appearance and may be falsely accepted as cysts. Therefore we tried to develop the automatic method of cystic and solid breast lesions differentiation. Materials and methods. The input data were the ultrasonography digital images with the 256-gradations of gray color (Medison SA8000SE, Siemens X150, Esaote MyLab C). Identification of the lesion on these images was performed in two steps. On the first one, the region of interest (or contour of lesion) was searched and selected. Selection of such region is carried out using the sigmoid filter where the threshold is calculated according to the empirical distribution function of the image brightness and, if necessary, it was corrected according to the average brightness of the image points which have the highest gradient of brightness. At the second step, the identification of the selected region to one of lesion groups by its statistical characteristics of brightness distribution was made. The following characteristics were used: entropy, coefficients of the linear and polynomial regression, quantiles of different orders, an average gradient of brightness, etc. For determination of decisive criterion of belonging to one of lesion groups (cystic or solid) the training set of these characteristics of brightness distribution separately for benign and malignant lesions were received. To test our approach we used a set of 217 ultrasonic images of 107 cystic (including 53 atypical, difficult for bare eye differentiation) and 110 solid lesions. All lesions were cytologically and/or histologically confirmed. Visual identification was performed by trained specialist in breast ultrasonography. Results. Our system correctly distinguished all (107, 100%) typical cysts, 107 of 110 (97.3%) solid lesions and 50 of 53 (94.3%) atypical cysts. On the contrary, with the bare eye it was possible to identify correctly all (107, 100%) typical cysts, 96 of 110 (87.3%) solid lesions and 32 of 53 (60.4%) atypical cysts. Conclusion. Automatic approach significantly surpasses the visual assessment performed by trained specialist. The difference is especially large for atypical cysts and hypoechoic solid lesions with the clear margin. This data may have a clinical significance.

Keywords : breast cyst, breast solid lesion, differentiation, ultrasonography

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