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Comparison of deep learning and classical breast mass classification methods in ultrasound

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Michal Byra
- Dept. of Ultrasound, Inst. of Fundamental Technol. Res., Polish Acad. of Sci., Warsaw, Poland

Michael Galperin
- Almen Labs., Inc., Vista, CA

Haydee Ojeda-Fournier Linda Olson Mary O'Boyle
- Radiology, Univ. of California, San Diego, San Diego, CA

Christopher Comstock
- Breast Imaging, Memorial Sloan-Kettering Cancer Ctr., New York, NY

Michael P. Andre
- Dept. of Radiology, Univ. of California, San Diego, and the San Diego VA Healthcare System, 9500 Gilman Dr., La Jolla, CA 92093, mandre@ucsd.edu

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ABSTRACT

We developed breast mass classification methods based on deep convolutional neural networks (CNNs) and morphological features (MF), then compared those to assessment of four experienced radiologists employing BI-RADS protocol. The classification models were developed based on 882 clinical ultrasound B-mode images of masses with confirmed findings and regions of interest indicating mass areas. Various transfer learning techniques, including fine-tuning of a pre-trained CNN, were investigated to develop deep learning models. A matching layer technique was applied to convert gray-scale images to red, green, blue to efficiently utilize discrimination of the pre-trained model. For the classical approach, we calculated MF related to breast mass shape (e.g., height-width ratio, circularity) and then trained binary classifiers. We additionally evaluated both approaches using two publicly available US datasets. Several statistical measures (area under the receiver operating curve [AUC], sensitivity and specificity) were used to assess the classification performance on a test set of 150 cases. The matching layer significantly increased AUC from 0.895 to 0.936 while radiologists' AUCs ranged from 0.806 to 0.882. This study shows both deep learning and classical models achieve high performance. When developed as a clinical tool, the methods examined in this study have potential to aid radiologists accurate breast mass classification with ultrasound.

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