Breast MRI Lesion Classification: Comparison between Human Readers and Backpropagation Neural Network (BNN)

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Introduction: Breast cancer is the second leading cause of cancer deaths in women today. Currently, mammography is the primary method of early detection. However, research has shown that many cases (10-30%) missed by mammography[1] can be detected using breast MRI (BMRI). BMRI is more difficult to interpret than mammography because it generates significantly more data. Also, there are fewer people qualified to use it for diagnosis because it is not the standard breast imaging modality.

Methods: Our goal is to develop and test a computer-aided diagnostic (CAD) system to aid and improve the performance of radiologists with different levels of experience in reading breast MR images. Part of the CAD system is an image loader and viewer capable of displaying multiple sequences simultaneously, with standard region of interest and high-level analysis tools for segmentation and classification. We propose a semi-automatic segmentation method that identifies significant lesions. Then, 42 shape, texture, and enhancement kinetics based features were computed. The top 13 best features were selected and used as inputs to a backpropagation neural network (BNN). BNN was trained and tested with leave-one-out method on a set of 75 BMRI datasets contained 80 lesions (37 benign, 43 malignant) using pathology results as the gold standard. Five human readers (a BMRI expert, two mammographers, and two body imaging fellows) manually classified the 80 lesions, both with and without CAD system assistance. The performance of the computer classifier and human readers were compared using ROC curves, and the human readers' performance was also evaluated using multi-reader multi-case (MRMC) analysis[2].

Results: Human readers significantly improved when aided by the CAD system ($p < 0.05$). The MRMC analysis showed that the human reader performance with and without CAD system assistance can be generalized to the population of cases ($F(1,79) = 13.83$, $p = 0.0004 < 0.001$). Specificity at sensitivity of 0.9 = 0.505 for interpretation without CAD assistance, and was raised to 0.807 for interpretation with CAD assistance. The difference was also statistically significant ($F(1,79) = 5.60$, $p = 0.0205 < 0.05$).

Conclusion: These results show significant advantages to using CAD system in classifying BMRI lesions.

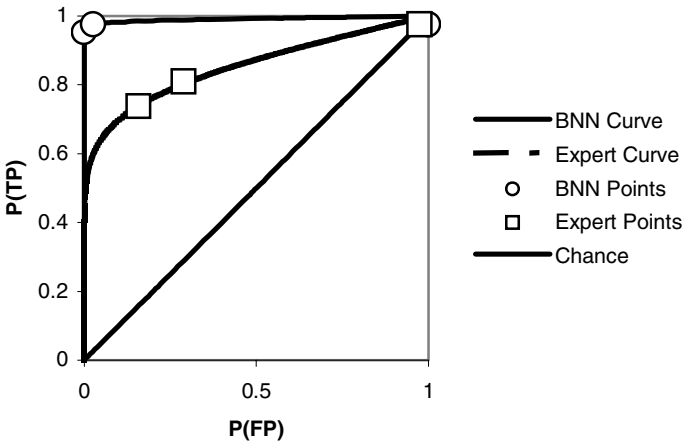

FIGURE 1: CAD system classification results, ROC curve for breast MRI expert without CAD assistance.

Observer	Az w/o CAD	Az w/ CAD
Expert	0.854	0.965
Mammographer 1	0.825	0.923
Mammographer 2	0.824	0.930
MRI fellow 1	0.741	0.925
MRI fellow 1	0.716	0.830
(0.792 vs. 0.915, $F(1,79) = 13.83$, $p = 0.0004$)		

TABLE I: Az for the five readers with and without CAD assistance

Observer	Az w/o CAD	Az w/ CAD
Expert	0.436	0.878
Mammographer 1	0.638	0.831
Mammographer 2	0.592	0.838
MRI fellow 1	0.433	0.837
MRI fellow 1	0.426	0.652
(0.505 vs. 0.807, $F(1,79) = 5.60$, $p = 0.0205$)		

TABLE II: Specificity for the readers with and without CAD assistance for a sensitivity of 90%

1- J. E. Martin, "Breast cancer missed by mammography," American Roentgen Ray Society, vol. 132, pp. 737–739, May 1979.
2- D. D. Dorfman, *et al.*, "Receiver operating characteristic rating analysis: Generalization to the population of readers and patients with the jackknife method," Investigative Radiology, vol. 27, no. 9, pp. 723–731, Sept. 1992.