Neural Networks as Statistical Indicator of Breast Cancer Using Scattered Electromagnetic Data

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In this work we will present the application of neural networks as a preprocessor in breast cancer imaging. In our previous work on imaging breast cancer using microwave modality, we observed that the reconstruction of shape and location of three-dimensional tumor required several CPU hours on a Hewlett-Packard Alpha Server DS25. We are proposing to avoid the high computational expenses of these algorithms by initially processing the data using neural networks, which have been used recently in predicting breast cancer based on mammography or magnetic resonance imaging data. In these applications, the neural network was used to replace radiologists or physicians interpretations. The major advantage of using neural networks lies in its real time results. We are proposing to train neural networks on data based on scattered electromagnetic fields from the breast with and without a tumor. The basic idea is to train the neural network on synthetic data and then test it on different data with added noise. The neural network will statistically indicate the presence or absence of a tumor. In case of a suspicious abnormality in the breast, our three-dimensional imaging algorithm will be used to reconstruct the tumor.

Our preliminary results show that when neural networks were trained with a reasonable amount of noise, they successfully predicted the cancer. In determining the utility of a neural network, the systematic approach espoused by Goodman was taken. First, a logistic regression model was constructed. After determining the linear weights for one set of synthetic data (fifty samples without a tumor, ten with), the model was tested on a second similar, but independent, set. Based upon the performance of the model on the new data, a non-linear model was indicated. The choice for a non-linear model was a single-hidden-layer neural network with full interconnections between layers. Experiments showed that the network's hidden layer could be composed of as few as two nodes and still achieve perfect prediction on the independent set. Moreover, training the network on the second set and testing on the original achieved the same result. Finally, an inferential analysis of a network trained on the combined data sets will be performed to yield the most important linear and non-linear aspects of the imaging data.