A Comparative Performance Analysis of Ultrawideband and Narrowband Microwave Imaging Sensor Arrays for Early Detection of Breast Cancer

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About 250,000 cases of breast cancer were reported in 2014 in the United States alone. Such alarming statistics necessitate serious efforts for early detection of breast cancer. The existing breast cancer screening methods like mammography, ultrasound and magnetic resonance imaging have a wide range of drawbacks from causing patient discomfort to emitting ionizing radiations. Overcoming these limitations of the current techniques paved way for the development and application of microwave imaging techniques to such health-related issues.

Simulation studies of microwave incidence on healthy and malignant tumors affecting the breast tissue show the distinct variation of tissue properties with increase in frequency, hence motivating the high bandwidth requirement. The discernable differences in the electrical properties of malignant and benign tumors, non-ionizing properties, deeper depth of penetration and low-cost makes imaging at microwave frequency ranges an attractive, viable alternative for early detection of breast cancer. Earlier studies [S. K. Davis, E. J. Bond, S. C. Hagness & B. D. Van Veen, *Journal of Electromagnetic Waves and Applications*, vol. 17, no. 2, pp. 357-381, 2003] have shown that suitable frequency domain beamforming techniques at can detect tumor cells of the order of millimeters.

The main purpose of the investigations reported here is to examine the impact of sensor bandwidth on processing algorithms for early detection of breast tumors. Of particular interest, is a comparative performance analysis of 3 x 3 microstrip array that can be realized with UWB, and relatively narrowband, patch elements utilizing the same post-processing algorithm. The information gleaned from such performance studies is expected to impact the design and implementation of the post processing algorithms with the least hardware complexity. This, in turn, is expected to impact the overall cost of prototyping of such sensor arrays. To that end, the relevant computer simulations were carried out using the commercially available EM software FEKO. Results for the performance comparison of the various post-processing or beamforming algorithms such as delay-and-sum (DAS), microwave imaging via space-time (MIST), multi-static adaptive microwave imaging (MAMI), etc., on both types of sensor arrays will be presented.