Average Dielectric Properties of the Human Breast from Ultra Wide Band Transmission Measurements

Jeremie Bourqui, Elise C. Fear
University of Calgary, Calgary, AB, Canada

Microwave imaging systems are being developed for breast cancer screening, treatment follow-up and breast health monitoring. Several different methods are being investigated. Microwave tomography (1) uses an array of antennas to collect transmission data through the breast; a forward model and iterative algorithm are used to reconstruct a dielectric property map of the breast interior (Meaney et al., Breast Cancer Research, 2013). Radar based techniques (2) rely on reflections from breast tissues to reconstruct a scattering intensity map where high scatter indicates potential tumors (Fear et al., IEEE Trans. Microw. Theory Techn., 2013). In this contribution, we report on a time domain spectroscopy technique using microwave transmission data between two antenna arrays. The resulting information is an average permittivity value of the breast over the interrogation frequencies, which is useful for both radar and tomography.

The measurement system consists of two arrays containing 5 ultra-wideband (UWB) sensors each (Bourqui et al., IEEE Antennas Wireless Propag. Lett., 2012). The breast is placed between the arrays while separation distance is adaptable in order to ensure proper contact with the breast skin. Transmissions are efficiently measured between 1.5 to 10 GHz for all possible combinations of sensor pairs between the two arrays, totalling 25 independent transmission coefficients. The frequency domain information is then transformed in the time domain from which the transmission delay is extracted. The time value is then used along with the separation distance to produce a relative permittivity value for each sensor pair. The corresponding permittivity values are mapped onto a 2D surface based on the signal path. Finally the average property is computed based on the computed 2D permittivity distribution. The system is currently used on healthy volunteers and breast cancer patients, and initial results provide insight into the capabilities of this approach.

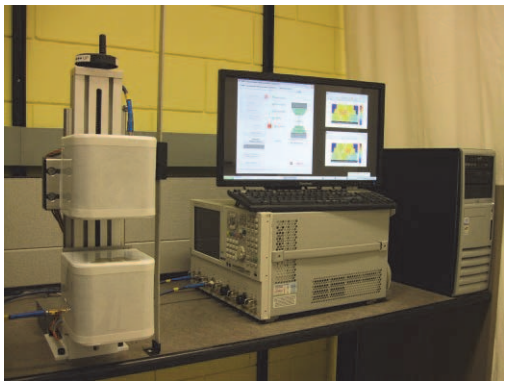

Figure. 1. View of the transmission system and its user interface