Terahertz Tomography Technique for the Assessment of Breast Cancer Tumor Margins

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When traces of cancerous cells are found within 10mm of the excises breast tissue, it is termed as *positive margins*. This case indicates high chance of cancer recurrence unless more breast tissue is removed. Pathological analysis of the excised tissue can take several days. Terahertz waves have been recently proposed for the assessment of breast tumor margins due to their sub-millimeter resolution. Over the last few years, preliminary clinical studies have demonstrated the potential of using terahertz waves to image and assess the margins of excised tumor tissue. The terahertz images obtained in these clinical studies were generated using direct reflection and/or transmission from tissue samples which could suffer blurring due to complications such as multiple reflections or diffraction.

In this work, terahertz tomography algorithms, that have potential of imaging and assessing the margins of breast cancer tumors, are investigated. We hypothesize that these inverse scattering algorithms will achieve at least one order of magnitude improvement in the resolution of the terahertz images obtained using the direct reflection and/or transmission. The anticipated improvement in resolution, termed Super-Resolution, has been previously demonstrated in different applications as reported by F. Chen and W. Chew, Applied Phys. Lett., 72, 3080-82, 1998. The terahertz higher resolution is hypothesized to increase the accuracy in tumor tissue images especially for invasive cancer tumors where healthy and cancerous tissue can be highly intermingled.

Examples of tomography algorithms to be developed are the Born and Rytov approximations. Synthetic terahertz data of the electric fields scattered from heterogeneous regions will be calculated using the DDSCAT (open source package) which implements the Discrete Dipole Approximation. DDSCAT has the capability of simulating targets discretized into dipoles of different materials. This poses the DDSCAT as flexible technique for modeling highly heterogeneous media such as invasive tumor tissue. The dielectric properties of healthy and cancerous dipoles will be simulated according to the reported terahertz spectroscopy study of breast tissue by P. Ashworth, E. Pickwell-MacPherson, E. Provenzano, S. Pinder, A. Purushotham, M. Pepper, and V. Wallace, Opt. Express., 17, 12444-54, 2009. Variety of numerical results will be presented in the conference to demonstrate the potential of tomography algorithms for tumor margin assessment.