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Parallel FDTD/GA for Microwave Image Reconstruction

In the past few years microwave imaging has received significant interest due to its potential to detect breast tumors at an early stage. Microwave imaging is the process by which radiofrequency electromagnetic waves are used to generate an image of a body to enable physicians to diagnose disease. To create images from microwave measurements, it is necessary to construct an electromagnetic field, which is able to transmit microwaves and measure the scattered waves at one or more sampling points. "Tomography" is one of the methods used in microwave imaging. In this method, to solve an inverse problem, a forward solver and an optimization tool are needed. The numerical Finite Difference Time Domain (FDTD) method is a powerful tool used as forward solver for solving Maxwell's equations to compute the scattered electric field at the observation points. The Genetic Algorithm (GA) is a popular evolutionary global optimization method that performs very well for problems with a high number of parameters and high degrees of non-linearity.

This talk presents an effective method of microwave imaging using FDTD as forward solver and GA for optimization. Since both FDTD and GA are computationally intensive parallel computations of the GA and FDTD codes are proposed. Using Message-Passing Interface (MPI) libraries, we are able to reach high-quality images with a reasonable run-time. The parallelization for the GA is based on master/slave protocol and for FDTD based on the distributed heartbeat algorithm. To the best of our knowledge, this implementation of hybrid method of parallel GA and FDTD represent a novelty in the framework of the finding early stage breast cancer application.

With contributions from Prof. Sima Noghanian and Prof. Stephen Pistorius (both University of Manitoba).