Specific Absorption Rate (SAR) Computation Using the D-H Unconditionally Stable ADI-FDTD Method

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As more and more applications of wireless devices in the personal space are emerging, the interaction of electromagnetic energy and biological objects has become increasingly important to researchers and the public. Due to the fear and awareness that health damage may be caused by the use of wireless equipment, it is important to minimize the electromagnetic interaction of wireless designs with the human body. Repetitive prototyping and measurements for specific absorption rate (SAR) minimization often can be too expensive and time consuming; hence, efficient and fast numerical methods are a very attractive alternative.

Electromagnetic problems, involving inhomogeneous dispersive media, are easily solved using the finite-difference time-domain (FDTD) method. For explicit FDTD methods, the fine geometric detail given in anatomical models, which is often far smaller than the wavelength under investigation, would dictate rather small time steps due to the CFL stability bound. This would lead to a large number of necessary computations and lengthy simulations. In contrast, an unconditionally stable FDTD method can alleviate the time step constraint and lead to an efficient method for bioelectromagnetic problems.

Our objective is to apply an unconditionally stable alternating direction implicit (ADI) method to the simulation of bioelectromagnetic problems and the computation of the SAR. To this end, a material independent D-H field formulation of the perfectly matched layer (PML) absorbing boundary condition is used. This choice leads to an efficient and simple implementation, which allows the truncation of dispersive material models. Furthermore, this formulation is easily extended to n^{th} order dispersive materials. The D-H ADI FDTD method is tested on spherical geometries where the SAR distribution is computed. Results are compared to the explicit FDTD method and previously published experimental results.