Solving Large-scale Inverse Electromagnetic Scattering Problems: A Parallel AD-based Approach

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Abstract: The inverse scattering problem considered in this presentation aims at the reconstruction of material properties of a 3D object based on the spatial and temporal analysis of intersecting radar waves. For our industrial application, a sensor receives scattered emissions from a sender at the surface of the material block. For a suitable reconstruction of the domain, this material block is discretized in 3D with up to 1000^3 grid elements each of which impacts on the signal at the receiver. For a given permittivity field this signal can be approximated with the FDTD (finite differences in time domain) method for a given permitivity. To determine the actual permittivity of the object, we formulate an inverse problem, i.e. adjust the permittivity values to minimize the difference between simulated and received signals. The resulting optimization problem is solved with a quasi-Newton-algorithm which requires the gradient of the objective function. The gradient is provided by Algorithmic Differentiation. The numerical complexity of this problem and the memory requirements result in a parallel calculation of the objective function and the gradient. We will present preliminary numerical results of a parallelization using MPI.

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