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Optimization of Time-Intensive Electromagnetic Structures Using Adjoint Sensitivities

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The tradition approaches for optimizing high frequency electromagnetic structures may be time-intensive. Global optimization techniques require an extensive number of simulations. The robust sensitivity-based techniques require first- and second- order derivative information. This information is classically obtained using repeated simulations of the structure with perturbed parameters. For a structure with *n* parameters, at least *n* extra electromagnetic simulations are needed to estimate the gradient. Estimating second-order derivatives requires $O(n^2)$ simulation. This computational cost can be prohibitive for structures with intensive simulation time or with large number of parameters.

Adjoint sensitivities offer an efficient approach for evaluating the required first- and second-order sensitivities. Using at most one extra simulation, the sensitivities of the desired objective function or response are estimated relative to all parameters regardless of their number. The cost of estimating the first-order derivatives is reduced from n to 1. In some cases, the cost is reduced from n to 0. The cost of estimating the second-order Hessian information is reduced from $O(n^2)$ to only n.

In this presentation, we give an overview of recent developments in adjoint sensitivity analysis of time-intensive electromagnetic solvers. We discuss their applications in the optimization and modeling of microwave, mm-wave, terahertz, infrared, and photonic structures. We review their applications in microwave imaging and cloaking of objects.