MoRePaS 2015

Adaptive Preconditioning of Fast Frequency Sweeps by ROMs

O. Floch[1], A. Sommer[1], D. Klis[1], and R. Dyczij-Edlinger[1]

[1]Chair for Electromagnetic Theory, Saarland University, Saarbrücken, Germany

Adaptive multi-point methods of model-order reduction (MOR) provide a highly efficient way of computing the broadband frequency response of electromagnetic structures by the finite-element (FE) method. When the considered model is many wavelengths in size, however, the dimension of the FE system is typically so large that it must be solved by iterative methods. Since the number of expansion points for the reduced order model (ROM) tends to grow as well, generating the ROM becomes computationally expensive.

To alleviate this problem, the present paper proposes to employ the ROM already available at a given adaptive step for constructing an efficient two-level preconditioner [1]. As the preconditioner is built in an adaptive manner, we use a domain-decomposition (DD) method [2] as a one-level preconditioner. To demonstrate the benefits of the suggested approach, we consider a linear array of 50 Vivaldi antennas in the frequency band $f \in [1, 4]$ GHz. The geometry of a single radiator is shown in Figure 1. FE discretization results in a linear system of dimension $8 \cdot 10^6$. It is solved by the restarted GMRES(30) iterative method [3], with stopping criterion $\delta = 10^{-6}$. As shown in Figure 2, the ROM-based two-level approach proposed in this paper reduces iteration count up to a factor of 20, compared to a standard DD preconditioner.

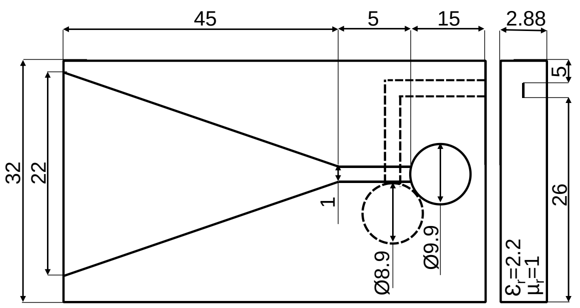

Figure 1: Antenna geometry of a single radiator. All dimensions are in mm.

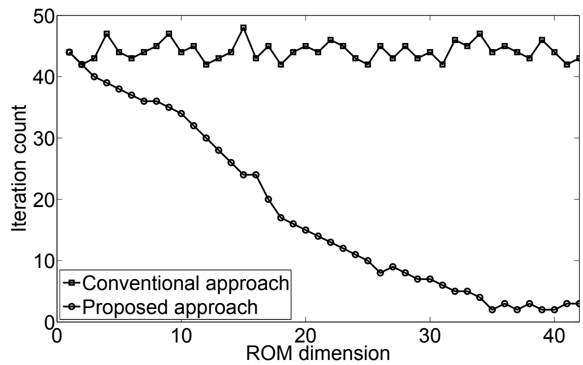

Figure 2: Iteration count versus ROM dimension for the standard one-level and the proposed two-level preconditioners.

References

[1] Y. A. Erlangga and R. Nabben. Deflation and balancing preconditioners for krylov subspace methods applied to nonsymmetric matrices. *SIAM Journal on Matrix Analysis and Applications*, 30(2):684–699, 2008.

[2] V. Rawat and J. Lee. Nonoverlapping domain decomposition with second order transmission condition for the time-harmonic maxwell's equations. *SIAM Journal on Scientific Computing*, 32(6):3584–3603, 2010.

[3] Y. Saad and M. Schultz. Gmres: A generalized minimal residual algorithm for solving nonsymmetric linear systems. *SIAM Journal on Scientific and Statistical Computing*, 7(3):856–869, 1986.