Term Project/Semesterarbeit

(Mathematics/Computational Science & Engineering)

Supervisor: Prof. Dr. R. Hiptmair (SAM, D-MATH)

Reduced Order Modelling for Complex Eigenvalue Problems

Field. Finite elements, eigenvalue problems, wave propagation, perfectly matched layers, *software development*

Problem. We consider the complex eigenvalue problem

$$-\operatorname{div}(\alpha(\mathbf{x})\,\mathbf{grad}\,u) = \omega^2 u \quad \text{in } \Omega\,,$$

with *absorbing boundary conditions* imposed on $\partial\Omega$. The problem is discretized by means of linear finite elements on a regular grid and numerical approximate absorbing boundary conditions are realized by so-called PML (perfectly matched layers).

The computation of eigenvalues and eigenfunctions is made difficult by the poorly structured complex sub-matrices of the entire stiffness matrix introduced by the PML.

Idea. Instead of PML we enforce Neumann boundary conditions first and compute several of the lowest (real) eigenmodes. Then we use these eigenmodes as basis functions in a Galerkin scheme together with standard finite elements in the PML layer. This approach is called reduced order modelling.

Task. Implementation of the method for one-dimensional and two-dimensional model problems in MATLAB. Investigation of accuracy as a functions of the number of eigenmodes.

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