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MULTIPARAMETRIC SHELL EIGENVALUE PROBLEMS

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Real-life engineering problems are often subject to significant parameter uncertainties due to e.g. manufacturing imperfections or uncertain material properties. Including such uncertainties in the underlying mathematical model results in a multiparametric problem, in which the stochastic dimension of the system is approximated by using a finite, but possibly large, number of parameters.

In this talk we consider multiparametric shell eigenvalue problems that arise from introducing random material properties to the shell model. A notable feature of such problems is that, whereas the smallest eigenmode of a second order elliptic problem is always simple, for a shell eigenvalue problem this need not be the case. In fact we demonstrate that the eigenmodes of shells of revolution appear to be clustered due to periodic nature of the angular components and in special cases also due to physical properties of the problem.

Sparse stochastic collocation [2] and spectral inverse iteration algorithms [1] have recently been proposed for resolving simple eigenmodes of multiparametric eigenvalue problems. If the material properties of the shell are constant in the angular direction, then eigenmodes may be computed by applying these algorithms to a reduced one-dimensional problem. In order to resolve the eigenmodes of the full two-dimensional problem, however, we extend the aforementioned algorithms in a way that subspaces associated to clustered eigenvalues may also be computed.

Numerical experiments suggest that the proposed subspace algorithms are able to resolve the eigenclusters effectively. The observed convergence rates for the stochastic collocation and spectral inverse iteration algorithms agree well with the theoretical estimates known for elliptic second order problems. Moreover, the asymptotic behaviour of the smallest eigenvalue, as the shell thickness tends to zero, is analogous to the deterministic case.

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