Eigenvalue Reduced Basis Approximation for Complex Solid Structures

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ABSTRACT

Parameter dependent eigenvalue problems arise in the context of many different application areas. The direct solution of such systems is very costly, and in many cases it is necessary to simulate the same large eigenvalue problem numerous times, using different material parameter values in each simulation during a design/optimization process.

A scenario in which it is important to solve such problems is the vibro-acoustical analysis of solid structures. The main part of it is the modal analysis, which not only takes the first eigenvalue into account, but all eigenvalues less or equal to a certain frequency.

In this talk, we will show the strength and the advantages of a new reduced basis method for the simultaneou s approximation of several eigenvalues in the framework of complex solid structures. Therefore we introduce an a posteriori asymptotically error estimator for eigenvalues and a method to build a single reduced space for the simultaneous variational approximation of the eigenvalue problem as can be found in [2]. Moreover the introduced eigenvalue reduced basis method will be used in the context of a component mode synthesis. This allows to establish a component library in the offline phase, which can be used to simulate large composed structures in the online phase.

As a first test problem, we consider a timber building with several floors discretized by classical conforming low order finite elements. While this geometry is rather simple and affine element mappings are suitable, for more complex geometries, such as, e.g., a violin bridge, isogeometric approaches [1] might be attractive. We thus investigate the eigenvalues for a violin bridge by combining isogeometric mortar techniques with our eigenvalue reduced basis method.

References

[1] E. Brivadis, A. Buffa, B. Wohlmuth, and L. Wunderlich. Isogeometric mortar methods. Comput. Methods Appl. Mech. Eng., 284:292–319, 2015.
[2] T. Horger, B. Wohlmuth, and T. Dickopf. Simultaneous reduced basis approximation of parameterized elliptic eigenvalue problems. submitted to M2AN, 2015.