ADAPTIVE COMPUTATION OF LARGE SCALE EIGENVALUE PROBLEMS WITH PRECONDITIONED EIGENSOLUTION STRATEGIES

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Accurate and effective evaluation of some eigenmodes of complex engineering structures still constitutes a challenging task in structural dynamic analysis. An accurate result could be achieved if the structure can be represented by a sufficiently detailed finite element model, which however would result in a large scale eigenvalue problem to be solved, in particular for 3D cases. The current trend in tackling such large scale problems is to develop preconditioned eigensolution strategies such as those based on conjugate gradient approaches or Davidson algorithms.

The last decade or so has witnessed a major development of adaptive re-meshing techniques in finite element analysis. The ultimate goal of adaptive re-meshing is to optimise the element distribution according to some feature of the intermediate solution in order to achieve a targeted solution accuracy with a minimal number of elements. As opposed to substantial work being undertaken in other applications, little work has been devoted to the adaptive modelling of structural eigenmodes. The necessity of conducting such a simulation is based on the observation that an optimal finite element mesh should exist for a specified eigenmode, while the same mesh may not be optimal for other eigenmodes. Therefore, the first objective of the current work is to evaluate the existing error estimation procedures for eigenvalue computation and to further investigate adaptive approaches suitable for the evaluation of several smallest eigenmodes.

Adaptive re-meshing procedures, with a proper mesh control scheme, may produce a sequence of meshes with increasing number of elements, which can be effectively used as different levels of mesh grids in the multigrid method to precondition iterative solver based eigensolution procedures such as the Davidson algorithm. The effectiveness of such a multigrid-Davidson eigensolution algorithm has been demonstrated, especially for very large scale 3D problems. The second objective of the present work is to incorporate the adaptive re-meshing procedure into multigrid enhanced eigenvalue solvers to achieve a solution with a targeted accuracy using minimal computational effort. The key to the success of this integrated solution procedure lies in the development of a mesh control scheme to provide an optimal sequence of intermediate meshes.