Adaptive parametric model order reduction technique for optimization of vibro-acoustic models: Application to hearing aid design - DTU Orbit (14/08/2019)

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Finite Element (FE) models of complex structural-acoustic coupled systems can require a large number of degrees of freedom in order to capture their physical behaviour. This is the case in the hearing aid field, where acoustic-mechanical feedback paths are a key factor in the overall system performance and modelling them accurately requires a precise description of the strong interaction between the light-weight parts and the internal and surrounding air over a wide frequency range. Parametric optimization of the FE model can be used to reduce the vibroacoustic feedback in a device during the design phase; however, it requires solving the model iteratively for multiple frequencies at different parameter values, which becomes highly time consuming when the system is large. Parametric Model Order Reduction (pMOR) techniques aim at reducing the computational cost associated with each analysis by projecting the full system into a reduced space. A drawback of most of the existing techniques is that the vector basis of the reduced space is built at an offline phase where the full system must be solved for a large sample of parameter values, which can also become highly time consuming. In this work, we present an adaptive pMOR technique where the construction of the projection basis is embedded in the optimization process and requires fewer full system analyses, while the accuracy of the reduced system is monitored by a cheap error indicator. The performance of the proposed method is evaluated for a 4-parameter optimization of a frequency response for a hearing aid model, evaluated at 300 frequencies, where the objective function evaluations become more than one order of magnitude faster than for the full system.

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