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Global Sensitivity Analysis of Uncertain Linear Dynamical Systems

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Sensitivity analysis allows identifying the input parameters that affect the most the output response of an uncertain structural model. A possible means for performing sensitivity analysis is calculating the Sobol' indices, which measure the fraction of the total variance of the output response that can be attributed to an input random variable (or groups of them). Undoubtedly, Sobol' indices are extremely useful for pinpointing the most influential parameters of a model; nonetheless, their evaluation is numerically demanding, as it may involve generating a large number of samples within the context of Monte Carlo simulation. In order to address this issue, this contribution presents an approach for calculating Sobol' indices most efficiently for problems involving linear dynamic structural systems. The proposed approach combines dynamic substructuring and resampling [2]. In a first step, dynamic substructuring is applied within the scope of the Component-Mode Synthesis approach [1] in order to generate a set of precomputed solutions of components of the full structural model. Then, in a second step, samples of the structural response are calculated by resampling the set of precomputed components generated at the first step. The advantage of the proposed approach is that numerical costs in the second step are reduced drastically, as analysis is carried out at the interface level only because the samples associated with each substructure have been already analyzed in the first step. Thus, it is possible to estimate the sought sensitivity indices with high numerical efficiency, even when applying Monte Carlo simulation. The application of the proposed scheme is illustrated by performing a sensitivity analysis of the spectral properties of an uncertain linear structure.

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