

Abstracted Structure-Preserving Reduction of Interconnected Structural Models

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ABSTRACTED STRUCTURE-PRESERVING REDUCTION OF INTERCONNECTED STRUCTURAL MODELS

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The large order of structural, finite element models necessitates the use of model reduction techniques to allow for dynamic analysis. These models, represented by the system of linear differential equations Σ , often consist of an interconnection of substructures Σ_j , $j = 1, \dots, k$. In practice, model reduction is often performed on individual substructures Σ_j , by, e.g., component mode synthesis methods, because direct reduction of Σ is not computationally tractable. However, if the reduction of a substructure Σ_j to its reduced representation $\hat{\Sigma}_j$ does not take the dynamics of the other substructures into account, the accuracy of the interconnected, reduced-order model, $\hat{\Sigma}$, cannot be guaranteed.

In this presentation, we introduce the idea to improve the accuracy of $\hat{\Sigma}$ by reducing Σ_j in interconnection with a low-order approximation of the other substructures. Stated differently, instead of considering (and reducing) Σ_j in isolation, we consider the interconnection of Σ_j with an *abstraction* of its environment. Hereby, a reduction of Σ_j that takes this abstraction into account ensures that the reduced $\hat{\Sigma}_j$ is relevant in the scope of the overall structure.

Reduction of the interconnection of Σ_j and the corresponding abstraction using standard reduction methods, would destroy the interconnection structure and results in one unified, reduced model. Therefore, structure-preserving reduction methods, such as presented in [1], are employed to retain the interconnection structure and thus retain access to the reduced subsystems $\hat{\Sigma}_j$.

Initial results show that this method of *abstracted reduction* results in an error which is comparable to a more costly structure-preserving reduction of the complete model Σ [1]. This indicates that low-order abstractions are sufficient to capture the relation between Σ_j and Σ , while significantly improving computational tractability of the reduction.

REFERENCES

- [1] H. Sandberg and R. M. Murray, "Model reduction of interconnected linear systems," *Optimal Control Applications and Methods*, vol. 30, no. 3, pp. 225–245, May 2009.