The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

RECENT ADVANCES ON SPECTRAL-SUBMANIFOLD-BASED MODEL REDUCTION: INTERNAL RESONANCES AND CONFIGURATION CONSTRAINTS

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Keywords: *Reduced Order Model, Invariant Manifolds, Internal Resonance, Constrained Mechanical Systems*

Spectral submanifolds (SSMs) have laid a solid foundation for rigorous and exact model reduction for nonlinear high-dimensional mechanical systems. Previous studies have focussed on the applications of only two-dimensional SSMs on systems where the equations of motion are in the form of ordinary differential equations. In this contribution, we derive reduced-order models on higher-dimensional SSMs, which are required for analyzing systems with internal resonances. Specifically, a $2m$-dimensional SSM is computed for a mechanical system with internal resonance involving m natural frequencies. The reduced-order model on the SSM is also of the dimension $2m$, independently of the dimension of the full system. We perform continuation of equilibria (limit cycles) of the reduced-order model to obtain periodic (quasi-periodic) response of the full system and predict their bifurcations. We futher show how SSMs can be constructed and used for the analysis of mechanical systems with configuration constraints, whose governing equations are in the form of differential-algebraic equations. SSM-based reduced-order models enable us efficiently extract backbone and forced response curves of the constrained mechanical systems. We demonstrate the effectiveness and efficiency of this reduction with examples of high-dimensional systems from finite element models and multibody systems.