A Time-Multiscale Model Order Reduction Method In Nonlinear Solid Mechanics

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Simulating the non-linear mechanical response of structures subjected to complex time-varying loads (such as seismic or fatigue loads with a very large number of cycles) remains computationally demanding, if not unaffordable. the objective is not only to provide an answer to such a challenge, but also to develop tools for the simulation-driven design of structures subjected to seismic or fatigue loads in which real-time simulations are mandatory.

Our response involves two levels of complexity reduction. the first, adapted to the load family under study, is a signal theory where the signal is approximated with a minimum of components that are "locally" periodic. this theory involves two time scales, each calculated signal component being defined by a macro-interpolation of macro-nodal quantities which are micro-periodic functions of the same period. The second level of complexity reduction comes from a method of model reduction based on separated representations (space, time, parameters) called the time-multiscale pgd. this is an extension of the classical pgd, capable of taking into account the two time scales; it uses the latin solver suitable for nonlinear problems, which is non-incremental and therefore works globally over the considered time interval. In addition, this strategy is written in a non-intrusive manner, i.e. it is a first attempt to be compatible with commercial fe softwares and in particular to all the facilities they offer to deal with nonlinearities.

First illustrations involving damage and viscoplasticity models will be presented for both seismic loadings and fatigue loadings.

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