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Time-Galerkin integrators for the dynamic simulation of local reduced order models.

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Over the past decades, model order reduction (MOR) techniques have aided in the efficient description of many highly computationally demanding models. One of the basic requirements for most developed approaches, is that the response of a model can be well captured by a smaller (fewer variables, less nonlinear equation evaluations, . . .) model. However, some systems exhibit such strong nonlinearities or are excited over such a wide range, that one such model cannot be constructed. In these cases regular MOR methods cannot create a sufficiently small model to obtain the required size reduction.

Local reduced order models (LROM) can offer a solution when traditional MOR techniques are not sufficient [1, 2]. In this approach a series of LROMs are constructed where each one provides good accuracy only over a subregion of the system behavior. During the online evaluation the most suitable LROM for a certain subregion is selected and evaluated. However, in a dynamic context, many jumps from one LROM to the other can occur. These changes are generally nontrivial and have to be handled properly in order to avoid parasitic dynamic effects. This is especially problematic for systems which naturally exhibit a strongly energy conserving behavior, like (nonlinear) elastodynamic systems.

In this work we propose a time-Galerkin integrator which enables a highly flexible choice in how the LROMs of (nonlinear) elastodynamic problems are handled while providing a guarantee of energy conserving behavior, even over sudden model changes. Due to the common time-points between two timeslabs, the time-Galerkin is perfectly suitable to perform model changes online. The proposed approach is demonstrated on both linear and nonlinear examples. Through these examples, good convergence and stability are demonstrated.

References

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