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A generalized multi-time-step method for a wide range of numerical scheme applied to transient nonlinear structural dynamics

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ABSTRACT

Coupled multi-physics problems are extremely challenging because of the disparity in the length and time scales that are usually involved. Usually, the structural domain is discretized in space with finite elements and a single numerical time integration scheme is used with a single time-step for all the domain. Using an uniform time step for the entire mesh to meet stability and accuracy requirements is computationally very inefficient. We present an efficiently coupling multiple time scales for non-linear dynamic analysis of large structures with complex geometries. With this approach, one can divide a large structural mesh into two or more subdomains and allows to formulate the time-step and/or the numerical time scheme according to the individual requirement of a subdomain. The present multi-time-step coupling method is of the dual Schur type and uses the Lagrange multipliers to enforce velocitiy continuity at the interfaces between the subdomains. We propose a general formalism for a wide range of time numerical schemes which enables to couple subdomains with their own time integration scheme with large ratio of time scales. The algorithms for multi-scale applications are detailed for linear and non linear problems. The effectiveness and the robustness of the method are illustrated through linear and nonlinear multi-time-scale examples. This approach leads to lower CPU times and better control of the accuracy and allows to take into account multi-time-scale effects. It also offers important improvement for industrial software with easy implementation.

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