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On the development and performance of multitime-step coupling methods for transient multiscale problems

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ABSTRACT

An ever-increasing number of scientific and engineering applications require modeling and computer simulation of coupled (interaction-type) problems. In such problems, disparate spatial and temporal scales are present because of the occurrence of different physical phenomena. This feature renders the task of developing numerical methods for simulation of coupled problems rather challenging. In the past few decades, many attempts have been devoted to study the computational aspects of coupled problems. However, majority of them suffer from stability and convergence issues. Limitations on number of subdomains and time steps are some of the other drawbacks. Our aim, in this poster presentation, is to identify the main causes of the aforementioned restrictions. Furthermore, we will introduce a Differential/Algebraic Equation (DAE) perspective towards coupled problems. A new computational framework [1] based on the theory of DAEs will be presented that allows arbitrary number of subdomains, different time steps, time integrators, and different numerical formulations in different regions of the computational domain. These methods will be shown to be stable and accurate. Several numerical examples will be shown to demonstrate the versatility and performance of the proposed framework.

REFERENCE

[1] Karimi, S. and Nakshatrala, K.B. On multi-time-step monolithic coupling algorithms for elastodynamics. arXiv:1305.6355, 2013.