A quasi-Newton accelerated multirate coupling scheme for partitioned simulation

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ABSTRACT

The partitioned approach combines already existing solvers – for example, a flow and a structure solver – to simulate a coupled problem. This allows us to use different discretizations across partitions in space (multiresolution) and time (multirate). Therefore, we can choose the optimal discretization for each part of the coupled problem.

Three major difficulties can occur if the partitioned approach is applied: (i) Multiresolution setups lead to non-matching meshes at the coupling interface, thus appropriate mapping schemes are needed. (ii) The realization of multirate time-stepping requires the implementation of special coupling schemes that support non-matching time discretizations and conserve the order of the time-stepping scheme [1, 2]. (iii) Tightly coupled phenomena require an iterative scheme to avoid instabilities. A state-of-the-art approach to avoid high iteration numbers is, for instance, the use of a quasi-Newton acceleration scheme [3].

In this contribution, we study a combined approach for rigorously treating (ii) and (iii). Our approach uses waveform relaxation for high order multirate time-stepping and is accelerated by a quasi-Newton method. We investigate this approach in an exemplary manner for a model problem and present results showing that high order can be conserved for time-stepping in the coupled simulation. Additionally, our experiments give us insight into how to generally implement the proposed algorithm and how the proposed multirate coupling scheme influences the number of coupling iterations of the quasi-Newton acceleration scheme.

REFERENCES

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