Performance Impact of the Newton Iterations per Solver Call in Partitioned Fluid-Structure Interaction

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ABSTRACT

Partitioned solution schemes enjoy great popularity in the fluid-structure interaction community, as they offer high flexibility and modularity: Treated as black boxes, the two solvers employed for the fluid and the structure are coupled only via the exchange of interface data [1]. Over the last decade, significant progress was made in mitigating the inherent drawbacks of partitioned methods regarding efficiency and stability, for example using an interface quasi-Newton approach [2].

Assuming the cost for data exchange to be negligible, the efficiency of a coupling scheme is typically assessed by the number of coupling iterations, i.e., solver calls, required per time step. When coupling two nonlinear solvers, however, the computational cost of one solver call is not constant but depends on various parameters. In particular, it is closely linked to the number of Newton iterations performed.

On the one hand, this supports the conclusion that the number of Newton iterations the solvers require per time step could provide a much better measure for the overall efficiency of the partitioned scheme. On the other hand, it raises a central question: How many Newton iterations should best be performed per coupling step?

The answer is not trivial: While always iterating to full convergence produces unnecessary overhead, running just one Newton step brings the risk of impeding stability by feeding back defective data into the coupling loop. The presented work investigates the performance impact of this parameter choice for a set of numerical examples to derive guidelines and criteria on how to properly set the number of Newton steps per solver call.

REFERENCES

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