The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Accelerating quasi-Newton methods using various types of surrogate models

Nicolas Delaissé[1,*], Dieter Fauconnier[2,3] and Joris Degroote[1,3]

[1]Department of Electromechanical, Systems and Metal Engineering, Ghent University
Sint-Pietersnieuwstraat 41, 9000 Ghent, Belgium, Nicolas.Delaisse@UGent.be
[2]Department of Electromechanical, Systems and Metal Engineering, Ghent University
Technologiepark Zwijnaarde 46, 9052 Zwijnaarde, Belgium
[3]Flanders Make @ UGent – Core Lab EEDT-MP, Belgium

Keywords: *Fluid-structure interaction, Partitioned algorithm, Surrogate model, Quasi-Newton model*

Strongly coupled fluid-structure interaction problems that are solved in a partitioned way require multiple flow-structure iterations per time step to reach convergence. The manner in which these iterations are performed is determined by the coupling algorithm. In the previous decade, several algorithms have been proposed, most of which are based on a quasi-Newton principle. This means that the output of e.g. the structural solver is modified using an approximated Jacobian of the coupling, before it is passed on as input to the flow solver. One often used method is IQN-ILS [1].

The approximation of the Jacobian is based on previous solver evaluations and is therefore constructed during the calculation itself. Initially, at the start of a time step, no previous evaluations and hence no Jacobian approximation are available. It has been proposed to reuse the Jacobian from the previous time step(s) as a starting point. Although this approach seems successful, it is not feasible to apply it in a steady simulation or in the first time steps of a transient calculation.

Using a previous Jacobian as starting point is, however, not the only possibility. Indeed, one can also opt to use the Jacobian of the same problem with coarser grids, or one can opt to use the Jacobian of a simplified problem that still captures the main physics, but does not resolve all the details. The Jacobian that is used a starting point is denoted as a *surrogate Jacobian*.

This study investigates the IQN-ILSM algorithm [2]. In this framework, each of the above mentioned surrogates can be used as well as combinations thereof.

REFERENCES

[1] J. Degroote, K.-J. Bathe and J. Vierendeels. Performance of a new partitioned procedure versus a monolithic procedure in fluid–structure interaction. *Comput. Struct.*, Vol. **87(11-12)**, pp. 793–801, 2009.

[2] N. Delaissé, T. Demeester, D. Fauconnier, J. Degroote. Surrogate-based acceleration of quasi-Newton techniques for fluid-structure interaction simulations. *Comput. Struct.*, **260**, pp. 106720, 2022.