

# Application of Higher Order Runge-Kutta Time Integrators in Partitioned Fluid-Structure Interaction Simulations

**Sander van Zuijlen, Hester Bijl**

Faculty of Aerospace Engineering  
Delft University of Technology, P.O. Box 5058, 2600 GB Delft, The Netherlands  
e-mail: [A.H.vanZuijlen@lr.tudelft.nl](mailto:A.H.vanZuijlen@lr.tudelft.nl)

In the present study we focus on higher order time integration methods applied to fluid-structure interaction (FSI) simulations. At present partitioned FSI solvers use second order time integrators at most. It is our opinion that efficiency can be gained by application of higher order Runge-Kutta time integrators even when only engineering levels of accuracy are required. In flow computations, this has already been demonstrated in [1].

Since flow and structural solvers have largely been developed and optimized separately, we advocate a partitioned approach for solving FSI problems. This way we can make use of each solver's strength by selecting an off-the-shelf product, saving the efforts put in the development of these codes. By making only minor changes and additions to the codes a coupling between the fluid and structural domains is realized.

In this paper both the fluid and the structure are integrated using implicit, third to fifth order ARK (Additive Runge-Kutta) schemes. Coupling is obtained using a Gauss-Seidel type of partitioning, i.e. the structure is advanced first and the fluid sequentially. A possibility of sub-iterating exists to obtain a stronger coupling. The ARK schemes have an explicit counterpart which were originally developed for problems with a distinct separation between stiff and non-stiff terms [2]. However, since these schemes allow a consistent, explicit treatment of the coupling flux of the fluid on the structure, they have been adopted here for the computation of FSI.

The resulting implicit/explicit (IMEX) scheme is tested on a linear piston problem [3] to demonstrate its capabilities. Results showed that large efficiency gains can be made compared to the popular second order Backward Differentiation Formula (BDF) scheme.

At present we focus our attention on a two-dimensional galloping problem [4] which is the next test for the IMEX scheme. Validation of numerical results with experimental data will demonstrate the effectiveness of the IMEX scheme for a more realistic FSI application.

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