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SECOND-ORDER TIME-ACCURATE EXPLICIT SCHEMES FOR THE INTERACTION OF A THIN-WALLED STRUCTURE WITH AN INCOMPRESSIBLE FLUID

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Second-order time-accuracy in incompressible fluid-structure interaction can be achieved via implicit and (geometrically) semi-implicit coupling schemes (see, e.g., [6]). However, the development of explicit coupling schemes delivering such high-order accuracy appears to be an open problem. A fundamental difficulty that has to be faced is related to the fact that the combination of second-order time-marching in each sub-system with a enhanced consistency at the interface can spoil the stability properties of the original first-order coupling scheme (see, e.g., [1]).

In this work we consider the case of the coupling with thin-walled structures and the explicit Robin-Neumann schemes proposed in [2, 5], which are known to deliver overall first-order accuracy. We will show that this explicit coupling paradigm tolerates, in terms of stability, second-order time-stepping in the fluid and in the solid (e.g., via Crank-Nicholson or BDF2 time-stepping). The rationale of these fundamental stability properties will be provided within a simplified setting.

The resulting coupling schemes can be viewed as interface kinematic perturbations of an underlying second-order implicit scheme. Hence, in order to achieve overall second-order time-accuracy, two approaches are investigated: second-order extrapolation and defect-correction. Numerical experiments show that both approaches yield second-order time-accuracy. We will present also the formulation of these high-order schemes within the fully decoupled state-computation framework recently proposed in [3, 4].

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