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Combining the Vortex Particle-Mesh method with a Multi-Body System solver for the simulation of self-propelled articulated swimmers
CAROLINE BERNIER, Institute of Mechanics, Materials and Civil Engineering, Université catholique de Louvain, MATTIA GAZZOLA, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, RENAUD RONSSE, PHILIPPE CHATELAIN, Institute of Mechanics, Materials and Civil Engineering, Université catholique de Louvain — We present a 2D fluid-structure interaction simulation method with a specific focus on articulated and actuated structures. The proposed algorithm combines a viscous Vortex Particle-Mesh (VPM) method based on a penalization technique and a Multi-Body System (MBS) solver. The hydrodynamic forces and moments acting on the structure parts are not computed explicitly from the surface stresses; they are rather recovered from the projection and penalization steps within the VPM method. The MBS solver accounts for the body dynamics via the Euler-Lagrange formalism. The deformations of the structure are dictated by the hydrodynamic efforts and actuation torques. Here, we focus on simplified swimming structures composed of neutrally buoyant ellipses connected by virtual joints. The joints are actuated through a simple controller in order to reproduce the swimming patterns of an eel-like swimmer. The method enables to recover the histories of torques applied on each hinge along the body. The method is verified on several benchmarks: an impulsively started elastically mounted cylinder and free swimming articulated fish-like structures. Validation will be performed by means of an experimental swimming robot that reproduces the 2D articulated ellipses.

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