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A COMPUTATIONAL TOOL FOR PARAMETRIC DESIGN OF MICROSWIMMERS

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Understanding the swimming patterns of microorganisms at low Reynolds number is a key aspect to design artificial bio-inspired microrobots. To achieve self-propulsion, microswimmers rely on large geometric deformations. The simulation of this behaviour entails the solution of multiple queries of the Stokes equations, for many different geometric configurations. In order to ease the computational burden of these simulations, reduced order methods (ROM) can be employed to construct a generalised solution of the resulting parametric flow equations. In this talk, different strategies to construct proper generalised decomposition (PGD) approximations of the Stokes equations in geometrically parametrised domains are presented, including an a priori PGD approach [1] and a sampling-based a posteriori PGD algorithm [2]. The PGD parametric solutions inherit the accuracy, stability and robustness properties of the employed spatial solver. In this context, both low-order face-centred finite volume [3] and high-order hybridisable discontinuous Galerkin [4] solvers are considered. The resulting PGD-ROMs are exploited to construct separated response surfaces of quantities of physical interest (e.g., the drag force), as a function of the parameters describing the geometric configurations of the microswimmers. The PGD-based surrogate models of such functionals thus provide a virtual framework to efficiently perform parametric studies of incompressible flows in microfluidics and to drive the design and optimisation of bio-inspired microswimmers.

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