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POD-Galerkin methods for parametrized problems in flow control and fluid-structure interaction

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We discuss a computational reduction framework based on POD-Galerkin projections for parametrized problems in computational fluid dynamics with an offline/online computational splitting between a high fidelity model (offline) and a reduced order one (online). Special attention is paid to the stabilization of the resulting online system, and shape parametrization maps to efficiently handle deformation of the computational domain. The results focus on some applications of the proposed framework to optimal flow control problems, and to a fluid-structure interaction formulation. A simultaneous reduction of both fluid and structural equations is sought; coupling of the multiphysics system on the interface is handled by means of shape parametrization maps. In this context, domain-decomposition based reduced order models are exploited and take advantage of the existing parametrized framework for optimal control problems. They enforce the minimization of the jump of the velocity on either the physical interface (between fluid and structure) or computational interfaces (between different partitions of the domain). Cardiovascular flows problems provide a real-life computational challenge for the developed methodology.