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Reduced order modelling using a POD-based identification method for parameterized PDEs

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To reduce the computational cost of high-fidelity simulations, model reduction techniques have been developed to approximate parametrized Partial Differential Equations (PDEs) for Computational Fluid Dynamics (CFD) problems. Typically, a Galerkin projection is performed to obtain a reduced order model (ROM). In that case, the governing equations are projected onto the reduced basis space generated by applying a Proper Orthogonal Decomposition (POD) approach on snapshots of the full order simulation [1]. The main issue related to this method is its intrusiveness because the construction of the reduced matrices requires access to the full order matrices and thus knowledge of the solver's discretization and solution algorithm. Therefore, a non-intrusive reduced-order method for parametric CFD problems is proposed in this work, which is applicable regardless of the solver. This POD-based identification (PODI) method identifies reduced matrices of the same form as in the POD-Galerkin method using the least-squares technique. This identification uses the set of known time-dependent coefficients obtained by projecting all snapshots on the POD basis in the offline phase. Parameterization of the reduced system requires full order simulations for different parameter values. The resulting reduced system of equations is then solved online for a given set of parameters. The offline-online decomposition of the POD-Galerkin method is thus maintained. To demonstrate the proposed method, numerical results are presented for the convection-diffusion equation, using the finite volume method. The results are compared with the POD-Galerkin method and the benefits and limitations of the presented method are discussed. As the reduced basis is the same for the PODI method and the POD-Galerkin method, also the reduced matrices obtained through respectively identification and projection can be compared.

REFERENCES

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