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Proper orthogonal Decompostion (POD) for parametric PDEs and for optimaliy systems

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POD is a powerful technique for model reduction of linear and non-linear systems. It is based on a Galerkin type discretization with basis elements created from the dynamical system itself. First, POD is used to derive low-order models for a so-called λ-ω-system that is a universal model to investigate two-species reaction-diffusion problems. In the case of fast reaction kinetics and small diffusion, these systems evolve to turbulent behavior. The performance of the POD model reduction is studied in dependence on the parameters of the λ-ω-system. With increasing turbulence more POD modes are needed to capture the dynamics of the full system in a satisfactory way. Secondly, POD is applied to estimate parameters in elliptic partial differential equations. The parameter estimation is formulated in terms of an optimal control problem that is solved by an augmented Lagrangian method combined with a sequential quadratic programming algorithm. In the context of optimal control this approach may suffer from the fact that the basis elements are computed from a reference trajectory containing features which are quite different from those of the optimally controlled trajectory. Finally, a method is proposed which avoids this problem of unmodelled dynamics in the proper orthogonal decomposition approach to optimal control. It is referred to as optimality system proper orthogonal decomposition (OS-POD). The results are joined work with M. Kahlbacher, K. Kunisch, and H. Müller at the University of Graz.