

Proper Orthogonal Decomposition for Reduced Order Feedback Control of Partial Differential Equations

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(ABSTRACT)

Numerical models of PDE systems can involve very large matrix equations, but feedback controllers for these systems must be computable in real time to be implemented on physical systems. Classical control design methods produce controllers of the same order as the numerical models. Therefore, reduced order control design is vital for practical controllers. The main contribution of this research is a method of control order reduction that uses a newly developed low order basis. The low order basis is obtained by applying Proper Orthogonal Decomposition (POD) to a set of functional gains, and is referred to as the functional gain POD basis. Low order controllers resulting from the functional gain POD basis are compared with low order controllers resulting from more commonly used time snapshot POD bases, with the two dimensional heat equation as a test problem. The functional gain POD basis avoids subjective criteria associated with the time snapshot POD basis and provides an equally effective low order controller with larger stability radii. An efficient and effective methodology is introduced for using a low order basis in reduced order compensator design. This method combines "design-then-reduce" and "reduce-then-design" philosophies. The desirable qualities of the resulting reduced order compensator are verified by application to Burgers' equation in numerical experiments.