Reduced-Order Modeling Of Optimal Control Problems For Navier-Stokes Equations

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Computing approximations of solutions of nonlinear partial differential equations (PDEs) such as Navier-Stokes equations is a computationally intensive task. For realistic simulations, many thousands or even millions of degrees of freedom are often required to obtain useful approximations. The situation is even worse for optimization problems for which multiple solutions of the complex system are required or in feedback control problems for which real-time solutions of the complex system are needed. Thus, if one needs to do multiple simulations or to do a simulation in real time, the use of reduced-order modeling (ROM) should be considered.

We consider the POD and CVT approach. We focus on how to generate snapshots which hopefully will accurately represent the dynamical behavior of those solutions. Then, we will study on how to determine ROM basis using snapshots which one again hopes, can accurately capture the information contained in the snapshot set.

We also investigate optimal control problems for Navier-Stokes flows. A discussion of reduced-order modeling for Navier-Stokes flow is given to provide a context for the construction and application of reduced-order bases. Reviews of the POD (proper orthogonal decomposition) and CVT (centroidal Voronoi tessellation) approaches to reduced-order modeling are provided, including descriptions of POD and CVT reduced-order bases, their construction from snapshot sets, and their application to the ROM based optimal control problems for the Navier-Stokes system.