MODEL REDUCTION FOR NONLINEAR CONTROL SYSTEMS

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Abstract. Optimal control problems for non-linear differential equations are often hard to tackle numerically so that the need for developing novel techniques emerges. On the other hand, also the implementation of non-linear feedback strategies requires the solution of large scale, non-linear system. One such technique is given by reduced order methods. Recently the application of reduced-order models to optimal control problems for partial differential equations has received an increasing amount of attention. The reduced-order approach is based on projecting the dynamical system onto subspaces consisting of basis elements that contain characteristics of the expected solution. This is in contrast to, e.g., finite element techniques, where the elements of the subspaces are uncorrelated to the physical properties of the system that they approximate.

The goal of this session is to present recent developments in the theory of model reduction for non-linear control systems. The focus will be on non-linear balancing approaches as well as on proper orthogonal decomposition (POD). Non-linear blancing techniques for non-linear systems are based on finding an energy function which simultaneously contains information about the controllability and the observability of the system, similar to the cross-Gramian in the linear case. POD provides a method for deriving low order models of dynamical systems. It was successfully used in a variety of fields including signal analysis and pattern recognition, fluid dynamics and coherent structures, more recently in control theory and inverse problems. Here, POD is used to derive a Galerkin approximation in the spatial variable, with basis functions corresponding to the solution of the physical system at pre-specified time instances. These are called the snapshots. Due to possible linear dependence or almost linear dependence, the snapshots themselves are not appropriate as a basis. Rather a singular value decomposition (SVD) is carried out and the leading generalized eigenfunctions are chosen as a basis, referred to as the POD basis.

Talks.

1) Tudor Ionescu, University of Groningen: *Model reduction based on a cross-energy function for non-linear systems*
2) Arie Verhoeven, TU Eindhoven: *Model order reduction for nonlinear IC models*
3) M. Kahlbacher, University of Graz: *Parameter estimation in non-linear elliptic systems utilizing POD*
4) S. Volkwein, University of Graz: *POD for optimality sytems*

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