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Book review:

Control and Estimation of Distributed Parameter Systems

by

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This book is a collection of 23 contributions selected among the communications presented at the International Conference on Control and Estimation of Distributed Parameter Systems. This conference took a place on July 14-20, 1996, at the Bildungshaus Chorherrenstift Vorau in Vorau (Austria). It was the seventh in a series of conferences that begun in 1982. There were 51 researchers from 11 coutries who contributed to drawing of a broad and diverse picture of the recent developments in optimal control and parameter identification of partial differential equations, from both theoretical and numerical viewpoints.

The contribution published in the book can be classified into four main themes. These are not completely representative of the field, of course, but shed ample light on recent research orientations and methods which are to be widely used in the future. Let us give now a summary of these themes:

1. **Optimal control of second order parabolic partial differential equation, with state constraints.** The PDEs are linear or semilinear. All of the authors (Casas-Raymond & Zidani, Fattorini, Mordukhovich & Zhang, and Rösch) are interested in optimality conditions either in the form of Pontryagin principle or second order conditions. All the results are obtained with different methods; they remain theoretical. None of these contributions deals with numerics.
2. **Controllability, identifiability and stabilisation.** There are many papers concerning various situations and PFEs. Most of them are based on the famous method of J.L. Lions for exact or approximate controllability of systems or on Carleman estimates. Let us mention Diaz & Ramos (approximate controllability for high order parabolic nonlinear equations), Fernandez-Cara & Real (controllability of some stochastic linear equations), Tataru (choice of "good" spaces for controllability) and Zhang (exact controllability of the generalized Boussinesq equation).
   The remaining papers deal with observability of coupled linear systems (Komornik-Loreti & Zuazua) or stabilization (Micu & Zuazua, Tucsnak). The results reported concern existence of solutions to the controllability

3. **Numerical methods for optimal control of PDEs.** The following papers present numerical methods for solving the optimal control problems governed by PDEs. The interesting point is the essential variety of the methods presented, none of which is the same.
   Batterman & Heinkenschloss and Bergounioux & Kunisch are interested in the same kind of problem: optimal control of linear elliptic PDEs with pointwise constraints on the state and the controls. The first paper studies the discretized problem and focuses on the preconditioning of the Kuhn-Karush-Tucker matrices; the second one uses an augmented lagrangian method to solve the continuous problem. Ito & Ravindran compute the solutions to a control problem via reduced basis method where basis functions are closely related to and generated from the problem that is being solved. Kaplan & Tichatschke consider an ill posed control problem governed by a linear parabolic equation where the cost functional is not coercive, and use a regularized penalty (proximal) method. Finally, Del Rosario & Smith study a model-based LQR method for controlling vibrations in cylindrical shells and give many numerical examples.
4. **Miscellaneous papers**
   We can also find in the book some papers that cannot be related directly to the previous categories.
   - Briani & Falcone and Cannarsa & Tessitore deal with Dynamic Programming methods. The first of these papers presents an approximation of the boundary control problem for the heat equation over finite horizon and the second one the Mayer optimal control problem for a system governed by a semilinear parabolic equation, from an Hamilton-Jacobi equations point of view.
   - Banks & Pinter and Brokate & Prejčí give results on the well-posedness (via the existence of solutions and continuity with respect to the data).
   - Cox looks for the design for optimal energy absorption of the damped wave equation.
   - Leugering gives a complete approach to the control of structures and networks (wellposedness and regularity of solutions, control problems, controllability ...).
   - Staffans' contribution concerns the algebraic Ricatti equation in discrete and continuous time.

As a conclusion, one could say that the book concerns, on the one hand, mainly optimal control of second-order parabolic PDEs (with or without state-constraints) and controllability-stabilisation of systems on the other hand. A reader will have a precise snapshot of the methods that are currently being developed, from both theoretical and numerical points of view.

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