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Book review:

SYSTEMS AND CONTROL IN THE TWENTY-FIRST CENTURY

by

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The book contains 24 papers presented at the 12th International Symposium on the Mathematical Theory of Networks and Systems held in St. Louis, Missouri, in June 24-28, 1996. The editors gave the book the title "Systems and Control in the Twenty-First Century" in order to stress that contributed papers provide the study and investigation guidelines on modern systems and control theory including possible applications. Several leading specialists in various areas of system and control theory contributed to the book. The following areas are considered: inverse spectral problems, numerical and applications aspects of the control and system theory, stabilizability problems, stochastic systems, set valued mappings and differential inclusions applied to general control problems.

The contents of the contributed papers will now be briefly sketched.

Three papers are devoted to various *inverse spectral problems.* D. Alpay and I. Gohberg study the problem of recovering the so called potential of a first order differential operator given so called scattering matrix function that is assumed to be rational. The problem appears to be relevant to a partial realization problem. The results obtained are based on the state space method from system theory. Y.M. Ram considers the problem of constructing a band symmetric matrix from spectral data that may be regarded as a problem of assigning the poles and zeros of certain frequency response function by passive control. J. Rosenthal and X.A. Wang survey some recent advances in the area of inverse eigenvalue problems based on several theorems from algebraic geometry.

Numerical aspects of control and system theory are studied in five papers. D. Boley and B.N. Datta point out the difficulties in computational setting associated with numerical methods for linear control systems. The best methods from numerical point of view are also outlined, and sensitivity issues of some numerical problems are indicated. R.W. Freud considers circuit simulation techniques and describes the computation of Padé - based reduced order models of large linear networks via Lanczos - type algorithms. U. Helmke nad K. Hüper contribute a survey paper on a generalization of the classical Jacobi method for symmetric matrix diagonalization. Rather than trying to develop the new Jacobi method

applicability for examples from linear algebra and system theory. A. Srivastava, M.I. Miller and U. Grenander are studying ergodic algorithms on special Euclidean groups for automated target recognition. The goal of the paper is to demonstrate an intrinsic geometric technique for constructing stochastic flows through the curved manifolds of Lie groups. Specific examples of estimation of the orientation of a truck or an airplane from an image and the trajectory of a flying airplane from a sequence of images are also examined. J. C. Willems considers for given data sequences a recursive computation of so the called most powerful unfalsified models, which are certain discrete time linear dynamical systems.

Application of control and system theory in engineering modelling and design are presented in three papers. H.T. Banks and N. Lybeck describe the modelling methodology for elastomer dynamics and discuss a dynamic partial differential equation formulation based on large deformation theory elasticity as an alternative approach to the strain energy function formulation for models of rubber like materials. B.K. Ghosh, E.P. Loucks, C.F. Martin and L. Schovanec introduce a dynamical systems approach to the estimation the motion parameters of a moving target and to dynamical control of the orientation of a visual system. K.A. Wise is studying some aspects of the design of the next generation of fighter aircraft and summarizes important issues directed at the control of high performance fighter aircraft.

Stabilization problems are considered in four papers. R. Sepulchre, M. Janković and P.V. Kokotović reformulate feedback stabilization as feedback passivation and show how the two building blocks of recursive Lyapunov designs: backstepping and forwarding complement each other to overcome the obstacles to feedback passivation: a relative degree one and a minimum phase property. A.R. Teel focuses on the input-output method of stability analysis of nonlinear systems and describes recent results on input-output stability in the L_∞ setting. G. Weiss is trying to track a periodic signal or reject a periodic disturbance acting on a linear control system so as to have an exponentially stable feedback system. I. Lasiecka concetrates on the questions related to stabilizability and control of interactive structures and presents the stability theory pertinent to nonlinear thermoelastic plates and boundary control problems addressed to several models of linear thermoelastic plates.

Four papers are devoted to *stochastic systems*. B.D.O. Anderson considers a special class of finite-dimensional linear systems where the underlying matrices in the state-variable descriptions contain nonnegative entries. His paper is focused on the problems of the so called positive linear system realization, exponential forgetting of initial conditions, an associated smoothing issue in hidden Markov models and the problem of realization of a hidden Markov model given by the collection of probabilities of output strings. R. Brocket introduces stochastic proceses on manifolds pointing out possible applications of stochastic analysis in computer vision problems. C.I. Byrnes and A. Lindquist surveys re-

the need to construct stochastic models from a finite window of correlation coefficients and leads to several problems including stochastic realization problem and duality between filtering and interpolation. S.I. Marcus, E. Fernández-Gaucherand, D. Hernández-Hernández, S. Coraluppi and P. Fard descibe problems of minimization of an expected value of an exponential of the sum of costs for discrete time Markov decision processes, which therefore depend not only on the expected cost, but on higher moments as well and consequently are called risk sensitive control problems. The infinite horizon average cost for perfect and partial state observation of finite state Markov processes is then considered.

Set valued mappings and differential inclusions with various applications to control theory are studied in three papers. H. Frankowska presents applications of set valued mappings to optimal synthesis, viability problem, solutions to Hamilton-Jacobi-Bellman equation and the properties of interior and boundary of reachable sets. H.J. Sussmann announces an abstract version of maximum principle using multidifferentials of set valued mappings, from which he shows various known versions of the maximum principle. A.B. Kurzhanski considers the problems of guaranteed control synthesis and set value estimation for systems that operate under "set membership uncertainty" with unknown but bounded inputs and disturbances.

The book is therefore without any doubt interesting and it covers an essential part of the current work in modern control and system theory.

Still, when compared to the programs of the annual IEEE Conferences on Decision and Control the book misses or underrepresents some important subareas. One might therefore hardly expect that the book will provide for an unexperienced reader the complete set of guidelines to the control and system theory in the twenty first century. Such title and perspective would require a more detailed analysis by a larger group of leading specialists. From this point of view the role of the book may seem to be exaggerated and overestimated.

On the other hand it is worth pointing out that a number of papers adequately survey known results and often rise open problems. Some papers contain recent contributions of the authors, usually of truly a high quality.

Summarizing, in my opinion the book is a valuable publication and may constitute a well received gift for every control and system specialist.

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