Book reviews

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Large Scale Systems Decentralization: Structure Constraints and Fixed Modes

Lecture Notes in Control and Information Sciences 120.
Springer–Verlag, Berlin – Heidelberg – New York – London – Paris 1989.
XIV + 384 pages; 40 figures; DM 87,–.

The monograph surveys the methodology in the analysis of stabilizibity and pole placement under decentralized constraints, in the control policy determination solving the problem of stabilization or pole placement in the case when decentralized dynamic compensation fails and in the control laws design under considered constraints. It consists of Preface, 7 Chapters, 6 Appendices, References, Author and Subject Indices. Chapter 1 (Centralized Control: Stabilization and pole placement) presents an overview of the well-known results in stabilization and pole assignment of linear time invariant continuous time systems. Chapter 2 (Structurally Constrained Control: Stabilization and Pole Placement) deals with the problem of stabilization and pole assignment for prespecified restricted information pattern of feedback control structure emphasizing the concept of fixed modes. The existence conditions of its solution derived by Wang and Davison (on fixed modes), and Corfmat and Morse are presented. An extension to arbitrary structural constraints of feedback is considered and two algorithms for the evaluation of fixed modes are presented. Chapter 3 (Characterization of Fixed Modes) characterizes fixed modes in terms of transmision zeros, presents algebraic characterization of fixed modes in the time domain and in the frequency domain. A classification of different types of fixed modes follows. Structural and parametric fixed modes are distinguished and characterized according to their origin. Numerous results based on a graph-theoretic characterization of fixed modes using digraphs are surveyed here. In Chapter 4 (Decentralized Stabilization in Presence of a Structurally Fixed Modes) only controllable systems with unstable structurally fixed modes are supposed to stabilize them by time-varying or non-linear structurally constrained feedback control laws. The use of sample and hold, the application of piecewise constant or sinusoidal feedback laws, and the introduction of almost periodic vibrations of the system parameters or feedback elements are presented. Chapter 5 (Choice of Feedback Structure to Avoid Fixed Modes) presents different algorithms for the design of constraint feedback structure without fixed modes and with minimum number of feedback links (or the sum of their associated costs) by relaxing the structural constraints as the most convenient way to solve the stabilization and pole placement problem in presence of fixed modes. Two cases are distinguished. Algorithms eliminating fixed modes by supplementary information exchanges for controller structures with fixed modes naturally arising from the partitioning of the system due to physical considerations form the first case. Algorithms providing all controller structures to find minimal control structure for which the system has no fixed modes without considering any initial controller structure form the second case. This case in fact includes the first one by setting to zero costs associated to the local feedbacks. Chapter 6 (Design Techniques – Parametric Robustness) deals with the problem of synthesis of feedback gains under structural constraints. A survey of near optimum design techniques is presented. It includes decentralized control with parametric optimization, robust decentralized controllers for systems with less structured parametric uncertainties, decentralized control via hierarchical calculations and that one for systems with overlapping information sets. Chapter 7 (Structural Robustness) deals with the consequencies of structural perturbations on stabilizability or pole assignability by using structurally constrained feedback. Structural perturbations affecting both the systems and the controller

(integrity) are considered. The design of a robust control feedback structure minimizing the associated information transfer is presented. Appendix 1 describes multivariable system zeros, Appendices 2–4 include Fortran subroutines for fixed modes determination by using open-loop and closed-loop system poles, by using their sensitivities and determination of only real poles which is based on their algebraic characterization in the time domain. In Appendix 5 the determination of the gradient matrix of the performance index for LQ problems by using variation calculus is derived. Appendix 6 includes Fortran routine to determine state and static output feedback by solving the LQ problem.

The monograph is a useful survey of the methods for analysing and designing decentralized linear time invariant continuous time deterministic systems. It includes probably the most complete material concerning the problems of fixed modes though some classes of systems could not included in 1989, for instance singular systems.

Lubomír Bakule

ROSS CRESSMAN

The Stability Concept of Evolutionary Game Theory. A Dynamic Approach

Lecture Notes in Biomathematics 94.
Springer–Verlag, Berlin – Heidelberg – London 1992.
vii + 128 pages; 16 figures; bibliography; index of essential notions.

The referred booklet presents some up-to-date results achieved in a relatively new transdisciplinary field of research. If necessary, it could be included into the area of biomathematics and biocybernetics. Anyhow, the crossing of mathematical game theory and biological evolutionary dynamics model will be surprising for many potential readers.

The main subject of the work is the investigation of biological, namely evolutionary, processes by means of the non-cooperative game theory. The evolutionary dynamics and natural evolutionary processes are presented as strategies of species in their interaction with environmental conditions.

The text is divided into six main sections including brief Introduction. The following sections are subjected to Frequency–Dependent Evolution in a Single Haploid Species, Two–Species Haploid System, and Randomly–Mating Diploid Species (Sections 2, 3, 4, respectively), to the Frequency– and Density–Dependent Evolution in a Haploid Species (Section 5), and to Evolutionary Stable Sets and Constant Information (Section 6).

Any transdisciplinary work covering wide spectrum of methods and approaches, has to rely upon the ability of readers to absorb a variety of different *stimuli*. In this case he should be able to accept the mathematical formalism of the non-cooperative game theory and the concepts of modern biology connected with the stability of evolutionary processes.

Both of those — so distant — fields of scientific interest are in the booklet offered in acceptable doses anyhow they vary in different sections. It is honest to admit that this reference is written from the point of view of a mathematician, and it could be interesting to know also biologists' opinion on this subject.

The referred book is written for biomathematicians for whom it summarizes the research results obtained in a rapidly developing area. But also for a mathematical game-theoretician, who simply likes biology and its views on the world, the book represents an interesting contact with something new and attractive.

Milan Mareš