Systems & Control: Foundations & Applications

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Editors

Current Trends in Nonlinear Systems and Control

In Honor of Petar Kokotović and Turi Nicosia

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To Petar and Turi

Foreword

This Birkhäuser series *Systems and Control: Foundations and Applications* publishes top quality state-of-the art books and research monographs at the graduate and post-graduate levels in systems, control, and related fields. Books in the series cover both foundations and applications, with the latter spanning the gamut of areas from information technology (particularly communication networks) to biotechnology (particularly mathematical biology) and economics. The series is primarily aimed at publishing authored (that is, not edited) books, but occasionally, and very selectively, high-quality volumes are published, which can be viewed as records of important scientific meetings.

One such event took place back on June 3 and 4, 2004, at Villa Mondragone in Monteporzio Catone, Rome, Italy. Several control scientists conducting cutting-edge research gathered at a workshop, "Applications of Advanced Control Theory to Robotics and Automation" (ACTRA), to present their most recent work, and more significantly, to honor two prominent control scientists, **Petar Kokotović** and **Turi Nicosia**, on the occasion of their seventieth birthdays. The meeting was very successful on all accounts, and the scientific program featured many high-quality presentations. It was therefore a foregone conclusion that this material should be made available to a broader readership—which led to the present volume.

ACTRA organizers Laura Menini, Luca Zaccarian, and Chaouki T. Abdallah undertook the task of putting together this volume by collecting individual chapters from speakers at ACTRA and some other selected authors. They were successful in producing a coherent whole with chapters organized around common themes and contributing to both theory and applications. I thank them for editing such a fine volume, which should serve as a rich source of information on the topics covered for years to come.

Tamer Başar, *Series Editor*
Urbana, IL, USA
March 1, 2005

Preface

The chapters of this book reflect the talks given during the workshop "Applications of Advanced Control Theory to Control and Automation" (ACTRA), which was held on June 3 and 4, 2004, at Villa Mondragone (Monteporzio Catone, Rome, Italy). The workshop was an opportunity to jointly honor the scientific careers of Petar Kokotović and Turi Nicosia, who coincidently reached their seventies that year, and to celebrate the significant intersection between the sets of their students and collaborators. Petar and Turi have many interests in the field of automatic control, covering many topics in control theory and several different applications. Such a variety is reflected in this book, where contributions ranging from mathematics to laboratory experiments are included. Although each chapter is self-contained, the book has been organized such that theme-related chapters are grouped together, and, in some cases, convenient reading sequences are suggested to the reader (see, e.g., the last two chapters in Part II).

The chapters in Part I deal with observer designs for nonlinear systems and linear time-delay systems, and with identification techniques for linear, nonlinear, piecewise linear, and hybrid systems. Part II is devoted to theoretical results concerned with the analysis and control of dynamic systems; its first chapter focuses on Lyapunov tools for linear differential inclusions which is followed by a chapter dealing with oscillators and synchronization. The next two chapters deal with the control of constrained systems while the last two deal with finite-time stability. Part III, devoted to robotics, is concerned with new studies concerning robot manipulators of various kinds. The first two chapters deal explicitly with parameter identification for control, the third and the fourth with advanced control techniques for robot manipulators, the fifth and sixth with mobile robots, and the last two with different classes of coordination problems. Part IV contains some modern control techniques, including interconnection and damping assignment passivity-based control, decentralized control and adaptive control, and their application to multimachine power systems, web processing systems, a real testbed for a PVTOL

aircraft, and two different marine vehicles. Part V groups together topics that have more recently been addressed by the control community: applications of the maxplus algebra to system aggregation, scheduling for machines with significant setup times and limits in the buffer capacity, and inventory control with cooperation between retailers. Finally, Part VI is devoted to the emerging control theory topic of networked control systems, i.e., systems in which the communication between different parts is affected by delays or by information losses. The chapters of Part VI deal with different analysis and design problems involving networked control systems and give a broad overview of the techniques that can be used to study such dynamic systems.

Although the scope of the book, which mirrors the interests of the two honorees, is very broad, the methodologies used by the different authors and the related tools have much in common. The book is divided into parts based on what the editors felt were major themes, keeping in mind the significant connections between the various parts. As an example, the last two chapters of Part II deal with the concept of finite-time stability, which is receiving renewed attention just in view of its recent application to networked control systems, described in the last chapter of Part VI. Another example is the problem of coordinated control of many subsystems, which is the major topic of the last chapter of Part III (focused on coordination of robot teams) but also of one of the examples in the second chapter of Part II (focused on oscillators and synchronization).

We believe that the great variety of topics covered in this book and the almost tutorial writing style that many of the authors have used will render this book pleasant reading both for experts in the field and for young researchers who seek a more intuitive understanding of these relevant topics in our research area.

We wish to thank all the speakers of the workshop ACTRA and the contributors to this volume for their constant support and encouragement during both the organization of the workshop and the editorial work for the preparation of this volume.

Rome, Italy
October 2005

Laura Menini
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