Preface

Applied mathematics and engineering abound with challenging situations where one wishes to control the behavior of the solution trajectories of dynamical systems. These include optimal control problems, where the goal is to choose a trajectory that optimizes a given cost criterion subject to given constraints, as well as stabilization problems, where one tries to keep the state of the system in a given set or bring the state towards a specified set. Specific issues that subsequently arise include the construction of stabilizing control mechanisms, and the analysis of Hamilton-Jacobi equations whose solutions give the minimum cost in optimal control.

It has become clear over the past two decades that classical mathematical concepts are not wholly adequate to describe and prescribe the behavior of controlled dynamical systems, largely because nonsmoothness arises naturally when min operations are present, or when nonlinear systems develop shocks. The theory of nonsmooth analysis has been developed in part to supply the requisite mathematical tools needed to systematically handle these phenomena. This has led to an explosion of recent results in nonsmooth analysis, accompanied by major breakthroughs in mathematical control theory, optimization, and control engineering.

This volume explores some of these recent developments. The twenty-four papers comprising this volume are based on the contributed and invited talks from the Louisiana Conference on Mathematical Control Theory (MCT'03), which was held at Louisiana State University in Baton Rouge in April 2003. Particular attention is paid in this volume to new results in nonsmooth analysis, and to novel applications of nonsmooth analysis in control and optimization. The contributing authors include major figures and leading young researchers who are at the cutting edge of modern control theory and nonsmooth analysis. While some of the papers collected here are announcements of important new mathematical results, or of novel applications, this volume also contains authoritative surveys by Francis Clarke, Eduardo Sontag, Andrew Teel, and others that will be of broad interest to postgraduates and

researchers in systems science, control, optimization, and applied mathematics.

The first section of this book is devoted to optimal control, and to closely related areas, such as Hamilton-Jacobi equation theory and singular perturbations. The section begins with a survey by Andy Teel on receding horizon optimal control, which is an optimization paradigm for stabilizing nonlinear systems. This is followed with a survey by Richard Vinter on feedback strategies in differential games based on the Isaacs equation. Other papers in this section include a survey of new results for systems of Hamilton-Jacobi equations by Daniel Ostrov, and new results by Zvi Artstein on limits of singular perturbations. Also included are new necessary optimality conditions for delay differential inclusions by Boris Mordukhovich and Lianwen Wang, a new value function approach to turnpike theory by Pierre Cartigny and Alain Rapaport, and new results by Gaemus Collins and William McEneaney on min-plus methods for the Hamilton-Jacobi equations associated with H_∞ problems. Finally, Boris Mordukhovich and Ilya Shvartsman discuss issues related to optimization and feedback control of constrained parabolic systems.

The next section of this book is devoted to stabilization, and to related issues such as Lyapunov function theory. The section begins with two surveys co-authored by Eduardo Sontag, the first with David Angeli on monotone systems and their applications in systems biology, and the second with Michael Malisoff on the input-to-state stabilization of asymptotically controllable systems with respect to actuator errors under small observation noise. Also included are two alternative but related approaches to stabilization for systems that lack continuous time-invariant stabilizing feedbacks, the first by Ludovic Rifford on smooth almost global stabilization, and the second by Fabio Ancona and Alberto Bressan on patchy vector field approaches. The section also includes a survey on small gain results for interconnected systems by Zhong-Ping Jiang, an alternative approach to input-to-state stabilization by Lars Grüne called input-to-state dynamical stability that takes the decay of the perturbation term explicitly into account, and a discussion by Andrey Smyshlyaev and Miroslav Krstic on boundary stabilization problems for PDEs. Finally, Bin Xian, Marcio de Queiroz, and Darren Dawson discuss a new approach to stabilizing uncertain systems.

The final section focuses on nonsmooth analysis and its numerous important applications in Hamilton-Jacobi and Lyapunov function theory and optimization. The section begins with a survey by Francis Clarke on the unifying role of nonsmooth analysis in Lyapunov and feedback theory, and in particular, the importance of semiconcave and other nonsmooth control-Laypunov functions for feedback stabilization. This is followed by an extensive two-part analysis of nonsmooth analysis on smooth manifolds by Yuri Ledyaev and Qiji Zhu, duality theory for Hamilton-Jacobi equations by Rafal Goebel and Chadi Nour, and some recent results by Tzanko Donchev, Vinicio Rios, and Peter Wolenski on dynamical systems with non-Lipschitz dynamics. The sec-

tion closes with a discussion by Boris Mordukhovich and Bingwu Wang on generalized differentials for moving sets and moving mappings.

We would like to express our gratitude to the National Science Foundation and to the Louisiana Board of Regents Enhancement Program for their generous support for our MCT'03 conference (NSF Grant DMS 0300959 and Board of Regents Contract Number LEQSF-2002-04-ENH-TR-26). This support made it possible for international scholars and young researchers without other sources of support to participate in our conference and contribute to this conference volume. We thank Dr. Mark Emmert, Chancellor of Louisiana State University, for delivering the opening remarks at the conference. We also thank the many people who helped us organize MCT'03 and compile this book. In particular, we thank Susan Oncal and Louisiana Travel for coordinating the visits of the international participants, Julie Doucet for handling the conference-related paperwork, and Dr. Thomas Ditzinger and Heather King from Springer-Verlag Heidelberg for publishing this volume.

We especially thank our referees and typesetters. Their careful and prompt work on this volume was very much appreciated. Finally, we thank Zed Pobre and Jeff Sheldon from the Louisiana State University Department of Mathematics for their expert assistance with the computer-related issues that arose during our conference and during the completion of this work.

Baton Rouge, Louisiana
December 2003

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