time-delay except the optimal control and the related topics. The monograph considered continuous-time and discrete-time classes of systems with time-delay. But unfortunately more emphasis has been done on delayed state and a little interest has been accorded the delayed control systems. This reviewer believes that this problem is of big interest from the practical point of view and more attention should be accorded to it in the next version of the book. Besides this problem, the class of systems with time-delay and constrained inputs which has been completely neglected and the reviewer hopes also that the author addresses this type of problems and the related problems like stabilizability, $\mathscr{H}_\infty$-control, etc., and their robustness since they reflect the real practical problems.

5. CONCLUSION

The class of systems with time-delay is an important class of dynamical systems that has attracted the interest of many researchers from the mathematical and control community and the abundant literature prove this. The present monography summarizes the advances in this topic and will be useful for the control community at large to extend the boundaries of knowledge.

To conclude, this review can claim that the present monography covers the essential on time-delay systems and it can serve as good reference for graduate students and researchers on control systems.

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INTRODUCTION TO CONTROL OF OSCILLATIONS AND CHAOS, by Alexander L. Fradkov and Alexander Yu. Pogromsky, World Scientific Pub. Co., Singapore, 1998, 391pp + xiv, ISBN 981-02-3069-9.

Chaos? Sounds like a scientific legend. What does it have to do with control engineering?

At least for one reason — the most obvious reason of stabilizing chaos when it is harmful and unwanted — control theorists and engineers have some work to do with it. In fact, this is the main theme of the book under review as far as suppressing chaos is concerned, although the book covers much more than just chaos; it is a book about modern nonlinear and adaptive control theories with applications in controlling oscillations including chaos. Unlike most adaptive control monographs and textbooks (e.g. References [1–7], to list just a few), this book has a special focus on oscillations control, with a significant portion devoted to chaos suppression control.

There are many practical reasons for controlling or suppressing chaos. First of all, chaotic system responses are extremely messy and irregular, usually containing little meaningful information content. Therefore, these systems are unlikely to be useful wherein chaos can lead them to disordered or even catastrophic situations. In such troublesome cases, chaos should be reduced as much as possible, or totally suppressed. For instance, stabilizing chaos can avoid fatal voltage collapse in power networks and deadly heart arrhythmias, guide disordered circuit arrays (e.g., multi-coupled oscillators and cellular neural networks) to reach a certain level of desirable pattern formation, regulate dynamical responses of mechanical and electronic devices (e.g., diodes, laser machines, and machine tools), help better organize an otherwise mismanaged multi-agency corporation to reach a stable equilibrium state thus achieving orderly and optimal agent performance, and so on.

"It seems it is expected that 'Coping with chaos' would cause a kind of revolution in science and technology!" This is followed immediately by the following comments: "However, analysis and control of oscillatory and chaotic systems is extremely difficult due to their intricate nonlinear dynamics. There are some interesting questions that still require unbiased scientific investigation:

- Is is possible to control chaotic systems?
- What are the most efficient methods of controlling oscillatory systems?
- What are the possibilities and limitations of controlling oscillatory and chaotic systems?

It is important to answer these questions in view of the numerous potential applications in laser and plasma technologies, communications, biology and medicine, ecology, etc." "The first question has a positive answer", the authors furthermore state in the Preface.

In an effort to provide at least some partial answers to the other two questions, the book is devoted to a careful study of many related topics, as can be visualized by its Table of Contents. Here is its simplified version that omits some of the subsection titles:

(The book has 331 references at the end).

The book then delivers excellent derivations for each of the above-listed topics.

Chapter 1 briefly introduces some ideas of control and gives some motivational examples taken from different fields of science and technology.

Chapter 2 summarizes some basic concepts and main results in nonlinear and adaptive control theories, which serve as a necessary mathematical background for the subsequent development of control theories and methodologies for oscillations.

Chapter 3 outlines some fundamental concepts and mathematical tools for the analysis of oscillatory and chaotic dynamical systems.

Chapter 4 presents, in detail, nonlinear and adaptive control algorithms and their applicability conditions for different structures, parameters, and measured outputs of the controlled oscillatory systems. Most control design methods are derived based on the fundamental concepts of Lyapunov functions, passivity, Poincare maps, speed gradient, and gradient algorithms, whereas control objectives include excitation and suppression of oscillations to the desired energy level, transition of the oscillation mode from chaotic to periodic, and oscillatory synchronization, to name a few. This chapter contains a number of theorems on system stability, robustness against disturbance, and performance, with a strong mathematical flavour.

Chapter 5 describes several methodologies and control schemes, based on the previous developments, of some typical systems such as the classical pendulums, Lorenz system, Chua's circuit, Henon map, and Duffing oscillator. Most control performances are evaluated by both theoretical analysis and computer simulations.

Chapter 6 is devoted to some interesting applications of oscillation control, including such examples as diodes, power systems, film growth, population dynamics, and business cycles. It is notable that most application examples discussed in this chapter are based on the author's own research experience, from joint projects with their colleagues in various fields.

Chapter 7 concludes the book with some brief but sharp points comprising of the author's views.

The book is an excellent collection of some valuable techniques for adaptive control with respect to oscillations in particular. It is a mathematically rigorous and well-edited volume with many good examples, suitable for both professionals and graduates as a handy reference book.

Basically, the book summarizes the main advances in the field up the mid-1990s, when chaos was still a target for suppression and this task was achieved usually by means of the 'brute force' type of controls (see the first part of Reference [7] for more historical description of this aspect). Differing from other adaptive control texts, this book makes effort to promote the 'tiny correction' idea for adaptive control with the intention of taking advantage of the 'butterfly effect' of chaos for adaptation. The authors are trying to demonstrate that adaptive control by tiny corrections is possible not only for chaotic systems but also in general, where what is really needed is recurrence or the so-called 'sampled conservativeness' property.

The preface states that 'many of the published papers on the control of chaos do make full use of the existing nonlinear theory; many results are obtained by means of computer simulations. On the other hand, most control theorists and engineers are not familiar with the potential applications of the control of chaotic systems. That is why the author's primary goal was to write a book which would give a reasonably rigorous exposition of modern nonlinear control theory as applied to various oscillatory and chaotic systems." The authors may also add that since the 'brute force' type of control is not always desirable, in order to take advantage of some very special features of chaos to make control more efficient (including the case of chaos suppression), understanding and utilizing the defining characteristics of chaos is not only desirable but also effective.

Notably, chaos control has gradually evolved into a new phase of development with interest in the utilization of its very nature to contribute to scientific and engineering applications as well as to benefit controls (see, e.g., the last part of Reference [7]). It is the topic of 'chaotification' or 'anti-control of chaos' . This, of course, is somewhat beyond the scope of the present text.

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