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I. INTRODUCTION

This decade there has been renewed interest in research on time-delay systems (TDS) due to the major influence of delays, particularly in communication networks, on control systems. Thus many applied and theoretical research works have been carried out recently on time-delay systems [1], [2], [3], [4], [5], [6].

The book intends to "present a systematic and comprehensive treatment of robust H_∞ control of TDS in the frequency-domain". However the book only considers SISO systems with a single and constant input delay. It ignores the body of work in the time-domain, using the well-know Lyapunov-Krasovskii approach, concerning H_∞ control for systems with delays (sometimes time-varying) in the state variables, [7], [8], [9], etc ... On the other hand, it is true that most studies in the time-domain only tackle the state feedback control design problem because dynamic output feedback controllers are much more complex to design [10], [11].

II. BOOK OVERVIEW

The book ISBN-13 978-1-84628-264-5 is composed of 231 pages, an introduction and two parts. Part I is entitled "Controller design" and contains 9 chapters (156 pages) while Part II "Controller Implementation" contains 3 chapters (43 pages). The References and Index conclude the book. This structure shows that the main objective of the book is the solution to the robust controller design problem for TDS. The originality of Part II of the book makes it a good reference for engineers and researchers who may be afraid of implementing time-delay controllers.

This book joins a number of others that have appeared in the past ten years on TDS. These present various theoretical and application results [12], [13], [14], and the monograph [15] contains, in addition to stability analysis, many application examples and some interesting results on closed-loop systems (Popov theory, passivity ...). The book [16] (see a complete review in [17]) provides good insights for the stability of TDS in both the frequency and time domains. Finally the very recent book [18] is of interest due to the study of the stabilization problem, in particular using a modified Smith predictor.

III. BOOK DESCRIPTION AND ANALYSIS

A concise summary and analysis of each chapter is presented in what follows.

Olivier Sename is with GIPSA-Lab, Departement of Control Systems (former LAG), Grenoble INP, ENSIEG - BP46, 38402 Saint Martin d'Hres - Cedex FRANCE, Olivier.Sename@gipsa-lab.inpg.fr

Chapter 1 "Introduction" presents some examples of TDS, a brief review of the control of TDS and the book overview. Although the example of an underwater vehicle is well described and interesting, others such as those on chemical processes or communication networks are not sufficiently developed to be of real utility for the reader. It would have been more interesting to present a single and detailed example (which could have been followed throughout the book). Concerning the review on control, the author limits himself to the H_∞ control problem in a standard form. One would have wished that the review had concerned different approaches for single input delay systems including time-domain ones [19], [20], [21], etc.

Part I begins with chapter 2 "Classical control of time-delay systems". A detailed presentation of Smith predictor-based methods, and the connection with Finite-Spectrum Assignment (FSA) are given. This chapter is very well written, and is well illustrated by some examples. It should be of great interest for graduate students. At the research level, while FSA is not the heart of this book, one might regret that the practical stability of the predictor w.r.t delay uncertainties is not covered in more detail [22].

Chapter 3 is dedicated to the "Preliminaries". Many concepts such as FIR operators, chain-scattering, linear-fractional and homographic transformations, are defined. A review of Algebraic Riccati Equations is given, as well as the definition of the Σ matrix, that plays an important role in the book.

Chapter 4 presents the "J-spectral factorization of regular para-hermitian transfer matrices", which is a basic tool of H_∞ control for finite-dimensional and infinite-dimensional systems as well. The existence and construction of such a factorization is developed as well as an illustrative example. While it is informative, the introduction of the J-spectral factorization might be better motivated through the H_∞ problem.

Chapter 5 is devoted to the "Delay-type Nehari problem" which is solved in the frequency-domain, and for possibly unstable systems, as the existence of some J-spectral factorization of a transfer matrix. A very illustrative detailed numerical example is given that emphasizes the way in which the optimal performance index can be determined as a function of the delay value.

The "Extended Nehari problem" is treated in chapter 6, where, instead of requiring the stability of the compensator as in chapter 5, the closed-loop transfer matrix has to be stable. The solvability condition is still based on the singularity of the Σ matrix as a function of the value of the optimal performance index γ .

Chapter 7 (resp. 8) deals with the "Standard (resp. Trans-

formed) H_∞ problem". First the solution relies on transforming the problem, using the chain-scattering representation, into both a standard delay-free H_∞ problem and a one-block problem (i.e. an extended Nehari problem) to be solved separately. In chapter 8, as done in [23], the closed-loop system is transformed into a generalized dead-time compensator (i.e. including a modified Smith predictor). An illustrative example is developed where the results are compared to the paper of Meinsma-Zwart [24].

Chapter 9, "2 DOF controller parametrization" presents the parametrization of all stabilizing controllers and the analysis of the corresponding set-point and disturbance responses. The result is then applied to an integral process with dead time.

Part I ends with chapter 10 "Unified Smith predictor", which extends [23] by building a predictor-based control structure, where the modified Smith predictor is designed only for the unstable modes of the system, the stable ones being controlled through a classical Smith predictor. This solution is much more interesting from an implementation viewpoint since it avoids some problems in the calculation of a matrix exponential. The parametrization of all stabilizing controllers and the standard H_2 problem are solved. A solution to the transformed H_∞ problem is given in a similar way to that in chapter 8.

Part II "Controller Implementation", is motivated by the fact that the previous control methods include a modified Smith predictor (i.e. a distributed delay), for which the implementation scheme may lead to instability problems. It begins with chapter 11 "Discrete-delay implementation of distributed delay in control laws". After reviewing the usual bad approximation of the distributed delay, two kinds of approximation in the s-domain are proposed, using either the backward or forward rectangular rules. Then implementation solutions, in both the s and z-domains, are described and the stability issues are analyzed. The different solutions are then compared on a typical example from the literature.

Chapter 12 "Rational implementation inspired by the δ -operator", proposes a structure of chained low-pass filters, for which the convergence is proved. It is followed by chapter 13 "Rational implementation based on the bilinear transformation" where a Tustin-type transformation is defined for the matrix case. It allows building a structure of chained nodes. The convergence is proved and all the methods are compared on the same example used in the three chapters.

IV. FINAL COMMENTS

I found this book very interesting and informative. It contains recent results on robust control for single input delay systems and will be very useful for PhD students and researchers. Different methods of H_∞ control for single input delay systems, using the frequency domain approach, have been presented, which is new and original. Also part II contains many solutions to the implementation problem of distributed delay control laws, that are detailed, analyzed and illustrated. This unifies the existing results of the literature on this key topic.

My remarks mainly concern the presentation and not the contents of the book. Chapters 3, 4, 5 and 6 are presented

independently of the control design which allows the clear statement of the solution to the considered problems but loses clarity w.r.t the entire process of H_∞ control design. An introductory chapter presenting the whole design methodology for H_∞ control of TDS would have helped motivate the reader. This would avoid making the reader wait until chapter 7 before encountering the true objective of the book.

As a main drawback in relation to the dissemination, this book lacks (in Part I) illustrative examples where different methods are compared, and particularly of a single example, for which different results given in the book could have been explored. This would have been very interesting for students. This weakness may surely shrink the audience to specialists in robust control and in time-delay systems.

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