

Book review

From Plant Data to Process Control: Ideas for Process Identification and PID Design

By Liuping Wang and William R. Cluett. Published by Taylor & Francis, ISBN: 0 74840701 4, Price £50

This book summarizes research on process identification and control that the authors conducted and published during the period, 1989–1998. Thus, it is a monograph on selected topics rather than a general textbook on process identification or process control. The monograph is concerned with specific identification and control techniques for linear, dynamic systems.

Chapter 2 is concerned with identification of dynamic models that are expressed in terms of Laguerre functions. These models offer the advantage that the model parameters can be estimated independently due to the orthonormal nature of the Laguerre polynomials. The statistical properties of the estimated model are thoroughly analyzed and a systematic procedure is proposed for specifying the single design parameter, the time scaling factor. Chapter 3 describes least squares estimation based on orthogonal decomposition. A new computational procedure is presented for calculating the PRESS (prediction error sum of squares) statistic. The authors use PRESS to determine the structure of multivariable process models and disturbance models.

In the next section of the book, the use of frequency sampling filters (FSF) in process identification is considered. Step response models are identified based on filtered values of the manipulated input, u . The FSF filters are narrow band-limited filters that have identical frequency responses except for the location of the center frequencies. Like standard step response models, the FSF model approach requires limited a priori information, the open-loop settling time. The advantage of the FSF approach is that the resulting reduced-order FSF models are more parsimonious than the corresponding step response or FIR models. The statistical properties of the estimated model are analyzed and confidence intervals derived for both step responses and frequency responses. The identification techniques based on Laguerre polynomials and FSF models are extended to multiple-input, single-output models. Several industrial applications are described.

The material on process identification in the first two portions of the book is clearly written and includes a nice blend of theory and practical examples. However, I

have two minor criticisms of the notation. The choice of the symbol, $\hat{g}(t)$, for the measured step response is unfortunate because the circumflex ($\hat{}$) is widely used to denote an estimated quantity in the applied statistics and system identification literature. Thus, denoting a measured response by $\hat{g}(t)$ may cause some confusion.

Another unfortunate choice of notation concerns the use of the symbol z to represent both the forward shift operator (page 70) and the z -transform variable (p. 79). As noted by Åström and Wittenmark [1], it is important to distinguish between these two different concepts. While the authors' intent will be clear to the experienced reader, using the same symbol for both a time-domain operator and a complex variable may be confusing for novices.

The third portion of the book is concerned with a novel frequency domain design technique for PID controllers. The authors propose a model-based technique based on specification of the desired closed-loop transfer function between the controller output and the set-point. Thus, the approach is closely related to existing design methods such as Direct Synthesis, Internal Model Control, and Pole Placement [2,3]. Unfortunately, the authors do not analyze the relationships between their proposed approach and these standard techniques. A novel advantage of the proposed approach is that it is applicable to high order systems. The authors specify the desired open-loop frequency response (OLFR) and then estimate the PID controller parameters by least squares estimation in the frequency domain. In particular, the desired OLFR only needs to be specified at two frequencies that are related to the desired closed-loop settling time. The proposed PID controller design method is compared to existing methods in a series of simulation examples and an experimental application to a stirred-tank heater system. Tuning rules are proposed for common process models.

The final chapter of the book proposes a modification of the standard relay auto-tuning technique. An FSF model is identified by switching between a relay and a relay plus an integrator. The proposed identification method is evaluated for several simulation examples. Unfortunately, the extensive literature on relay auto-tuning for identification and control is not cited [4].

Despite a few shortcomings, this monograph provides an interesting and well written summary of the authors' innovative research on selected topics in identification

and control. In particular, the process identification material on Laguerre polynomial and FSF models serves as an excellent introduction to these topics.

References

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- [4] C.-C. Yu, *Autotuning of PID Controllers*, Springer-Verlag, NY, 1999.

Dale Seborg
Department of Chemical Engineering
University of California
Santa Barbara, CA 93106, USA
E-mail address: seborg@engineering.ucsb.edu