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Book Review

Publishers are invited to send books for review to Dr. I: Michael Ross; Code: AA/Ro; Department of Aeronautics and Astronautics; Naval Postgraduate School; Monterey; CA 93943:

Applied System Identification

Jer-Nan Juang; Prentice–Hall; Englewood Cliffs; NJ; 394 pp:; hardcover; $76:00;
ISBN 0-13-079211-X

This book is intended to serve as a textbook for a first-year graduate or last-year undergraduate course or as a reference and self study in mechanical system identification: The book is written as an introduction and as such presents a common basis for the many disciplines that make up the topic of identification: The text is based on the author's years of experience working in and contributing to the area; as well as courses he has taught: Although the language is general; the text is clearly aimed at combining the system and control approach to system identification with structural identification and modal analysis common to the mechanical sciences; in a unified manner. The book contains example problems and homework exercises; rendering it useful as a classroom text:

The author's style is informal; not including proofs but rather presenting results and examples: Thus the text is very readable; the results are guided by physical knowledge and logic so that no loss of rigor results; rendering the work useful to the researcher. For those wishing to advance the theory; the author provides an up-to-date collection of previous and relevant work in identification; complete with comparisons of competing methods:

Other important features of the text include compatibility with modern software (Matlab and Matrix$_x$): In addition; the examples include real systems (and data) so that students see that this stuff actually works and is useful in practice and researchers have a clearer understanding of how to apply the algorithms to meaningful test data:

The book opens with a chapter providing an overview of the disciplines of modal testing and system identification: Chapters 2 and 3 present both time and frequency domain models used in system identification: Important elements such as system and observer Markov parameters are defined: Commonly used models; and the relationships between them; are presented and discussed:

Chapter 4 focuses on the basics of the frequency response function: Fundamental functions are defined and explained; including the input/output correlation; the discrete Fourier transform of the correlation function; and the coherence function: The computation of system Markov parameters is clearly described in terms of the inverse discrete Fourier transform; a point not well discussed in the literature:

In Chapter 5; realization theory is used to unify and correlate previous modal analysis time domain methods: This is a particularly useful presentation and puts many previously ad hoc presentations on firm theoretical ground: It starts with the Ho and Kalman realization theory and moves forward to current time domain modal analysis methods: It is followed by the introduction of observer-based theory in Chapter 6: The ergodic property of stationary random processes is used to establish the relationship between the identified deadbeat observer and a Kalman filter. As a practical example; flight data from the Hubble Space Telescope are used to demonstrate the use of observer Markov parameters:

Chapter 7 presents a frequency domain version of the material in Chapter 6: The effects of noisy and distorted data are discussed here: Chapter 8 examines the use of system identification methodology as applied to mechanical systems that are operated under closed-loop control: This leads to the realization of the open-loop state matrix; the gain matrix; and the observer gain matrix:

In Chapter 9; the classical scalar autoregressive model is extended to handle the multivariable case: This allows the treatment of on-line system identification problems in an effective manner. The text is rounded off with three appendices: fundamentals of matrix algebra relevant to the text; random variables and the Kalman filter; and the data acquisition process:

Ljung[1] addresses a more general plant identification problem but his book is not as useful to engineers working on the control of structures and mechanical components: The excellent text by Ewins[2] addresses the details of modal testing but does not dwell on the theory of identification: The Juang book addresses problems of more interest to the readership of the *Journal of Guidance; Control; and Dynamics* and in my opinion does so in a clear; usable manner. The Ewins and Juang books taken together provide a complete guide to testing and analysis of test data for those involved with structural dynamics and control of structures:

This is a very useful work for those interested in learning about system identification for mechanical systems: It is also suitable for use in the classroom:

References

[1]Ljung; L:; *System Identification: Theory for the User*; Prentice–Hall; Englewood Cliffs; NJ; 1987:

[2]Ewins; D: J:; *Modal Testing: Theory and Practice*; Research Studies Press Ltd:; Letchworth; Hertfordshire; England; UK; 1984:

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