
This book is concerned with linear least-squares estimation problems for signals with known finite-dimensional linear state-space models. It presents the trends and the most recent research results in the field, as well as an overview of the most important pioneer contributions in linear estimation, primarily focused on the works of Wiener and Kalman.

The material consists of 17 chapters, together with an appendix, bibliography, and an author and subject index. The first five chapters are introductory. The first chapter briefly reviews the concept of the asymptotic observer and describes the major issues and results to be presented in the book. Chapter 2 deals with the deterministic least-squares problem, emphasizing the geometric formulation. The recursive least-squares (RLS) algorithm and some variants of it are given next. The linear least-mean-squares estimation problem is presented in chapter 3, which also focuses on the geometric approach. The equivalence between the stochastic and deterministic frameworks is presented at the end of the chapter. In chapter 4, the concept of the innovations process is introduced, which is applied in stochastic and deterministic least-squares problems. In chapter 5, state-space models are presented and the reasons for their success explained. The chapter ends with a discussion of the backward Markovian models.

The next three chapters address the estimation of stationary processes. Chapter 6 introduces the computation of the innovations for scalar-valued stationary processes via spectral factorization, ending with a presentation of the difficulties encountered for vector-valued processes. Chapter 7 discusses Wiener theory for the estimation of scalar processes. The continuous and discrete-time Wiener smoothing problem is addressed first, and the discrete-time Wiener-Hopf equations are given. The chapter ends with a discussion of the innovations approach to the Wiener filter. Chapter 8 examines the recursive Wiener filtering problem for vector stationary processes, where spectral factorization is computed in state-space form. Equivalent factorization results are obtained using covariance data.

Chapters 9 and 10 describe non-stationary processes. Chapter 9 presents the Kalman filter, again emphasizing the geometric approach and extending the results to nonlinear discrete-time state-space systems. Approximate nonlinear filters are given, as well as Kalman recursions for backward Markovian models. Chapter 10 explores the smoothing problem using the innovations approach, and well-known smoothing algorithms are derived. The Hamiltonian equations for the smoothing problem are also presented.

The next three chapters focus on fast algorithms and square-root forms of the algorithms described in the previous chapters. Chapter 11 presents fast algorithms for solution of the discrete-time Riccati equation. Chapter 12 discusses array algorithms for alleviating the problems arising from the round-off errors in computation of the covariance matrices. Array algorithms for the information filter and for smoothing are given in the last sections of the chapter. Chapter 13 presents array forms of the fast algorithms of chapter 11.

The final chapters of the book are concerned with more advanced concepts. More specifically, chapter 14 focuses on the steady-state behavior of the Kalman filter, and the approach adopted in the chapter can be extended to more general Riccati recursions (i.e., those encountered in H∞). Chapter 15 describes the concepts of duality, dual bases, and orthogonal complements. Equivalence relationships between stochastic and deterministic least-squares problems are given, and the concept of duality is extended to the frequency domain. The estimation problem on complementary state-space models is also studied. Chapter 16 covers the fundamentals of state-space filtering and smoothing for continuous-time state-space models, and the continuous-time Kalman filter equations are derived, along with the continuous-time smoothed estimators. The asymptotic behavior of the Riccati differential equation is examined, and the steady-state filter is given. The last chapter examines a different approach to state-space estimation theory using the scattering theory framework. The authors present numerous estimation algorithms, which arise smoothly using the scattering framework but would otherwise require considerable algebraic manipulation.

The book contains numerous end-of-chapter problems, making it attractive as a class text. The problems are carefully chosen to present additional results and promote a better understanding of the material in each chapter. Also at the end of the chapters are sections that offer interesting historical notes. The reader is expected to be...
reasonably familiar with basic concepts in random processes, matrix theory, linear algebra, and linear systems theory. Pertinent background material is provided in the six appendices at the end of the book. The bibliography identifies several hundred relevant sources and provides a starting point for further exploration on many subjects covered by the book.

One key feature of the book is the extensive use of a geometric viewpoint in the estimation problems. This approach provides the reader with greater insight and simplifies derivation of the algorithms compared to algebraic approaches. Another feature is the extensive coverage of the array formulations of algorithms in the book. The text also emphasizes that equivalence and duality concepts can be used as alternatives for solving adaptive filtering, estimation, and control problems.

The authors have presented a comprehensive view of linear estimation theory. The book’s main value is that it accurately captures the diversity of approaches currently under study in this field, presenting the main theoretical issues, as well as viewpoints that yield new insights. In summary, Linear Estimation is an excellent textbook not only for graduate students, but also for researchers and those involved in applications.


This book gives an overview of the range of disciplines (thermodynamics, mechanical engineering, control, instrumentation, etc.) required to understand the control systems found at a modern power station. Because of its breadth, it must necessarily be shallow; indeed, it contains little analysis and is qualitative in its approach. The IEE Control Engineering Series is generally a good source of advanced reference material for professional engineers, so at first sight this book resides uneasily within a series aimed at professionals. It lacks solid academic analysis, and in any particular chapter the expert will find detailed points of dispute with the author, because there is much variety in plant design and operational requirements.

On the positive side, the author makes the important point that the trend toward reducing physical plant size leads to greater demands on the performance of the control systems, and so cutting costs in this area is undesirable. The book also contains good illustrations of power station components, but the author tends to avoid using graphs to describe behavior. For example, while discussing the milling plant and its load line, he neglects to give a load line graph to reinforce the points he makes.

Control and instrumentation is still the Cinderella of power station engineering. At commissioning, it has prominence (and so is often blamed for delays in commissioning), and many years later, when refurbishment is considered, it is very difficult to show cost benefits. Power stations are usually designed to last well in excess of 20 years—several generations of computers and control systems—so by the time most power stations are commissioned, the equipment is already obsolete. In the final chapter, the author discusses aspects of this dilemma and ways to manage this issue.

Who is this book aimed at? It definitely is not reference material, but is written with enthusiasm by an engineer who obviously has much experience in the construction of power stations. It would be a good introduction for young engineers or technicians new to the power generation industry, probably in the construction or operation of plants. It may also serve as a guide for particular specialists (e.g., software designers) to open their eyes to the wider picture of power plant control and instrumentation.

Books for Review

The following books are available for review. Anyone interested should contact the Associate Editor. Details of the Springer publications can be found via http://www.springer.co.uk.

- **Topics in Multidimensional Linear System Theory** (Lecture Notes in Control and Information Sciences 256) by Eva Zerz, Springer-Verlag, 2000, 164 pp.
- **An Introduction to Space Robotics** by Alex Ellery, Springer-Verlag, 2000, 663 pp.
- **Control of Movement for the Physically Disabled** by Dejan Popovic and Thomas Sinkjaer, Springer-Verlag, 2000, 481 pp.