
REVIEWED BY R. ISERMANN

After an introduction on the description of sampled data systems with impulse series and z-transformation, the state space approach is treated in detail. Taking continuous systems and using stepwise input, the description of continuous systems with sampled input and a zero order hold is given, before the state equations of sampled input and sampled output systems are considered. Also the state between the samples, nonsynchronous and nonmonotonic sampling are discussed. Controllability and observability in connection with the input-output behavior is developed. Chapters on linear transformations, canonical structures, multivariable systems and the stability of sampled data systems follow.

The design of sampled data control systems with single input and single output comprises: General discussion on the design, selection of the sampling interval, zero-pole compensation, selection of eigenvalues, design for known inputs including dead beat response. The synthesis of multivariable control systems with state space methods is also described in detail. Pole assignment by state feedback, state estimation by observers, control with feedback of observed states and the quadratic optimal control is regarded.

The book contains a comprehensive up-to-date description of linear sampled data control theory and is highly recommended.


REVIEWED BY STANLEY H. JOHNSON

Soon after Cooley and Tukey rediscovered the technique which they fashioned their Fast Fourier Transform algorithm, there came to be circulated a package of computer programs which demonstrated the use of FFT. In one example, it was used to obtain the discrete Fourier transform of an input sequence and the inverse FFT was used to reconstruct the original input data from the Fourier coefficients. It successfully did so within one part in $10^6$. The implication was that such precision validated the entire procedure. Unfortunately, the intermediate Fourier coefficients only roughly approximated the harmonic amplitudes of the input waveform. This book explains what happened. The casual user of canned data analysis programs often obtains results which conflict with naive expectations. Many such conflicts are resolved by this book. For example, it explains how locally negative power spectral densities arise from discrete analyses and how to suppress them. In fact, extensive practical experience and familiarity with the pertinent literature are condensed into this monograph.

Otnes and Enochson have succeeded in creating a digital analysis cookbook. After a review of the applicable mathematics, the reader is led through preprocessing of analog data, filtering of sampled data, analysis, and interpretation. Analysis by Fourier transform, auto/cross-correlation, or power/cross-spectral density is treated with suitable discussion of alternative methods, computation time, difficulties, and appropriate additional pre- and post-processing. Each type of analysis can be implemented in each of three ways: (1) It may be appropriate to utilize an efficient version of a straightforward computational approach, when a rough characterization is sufficient, for example; (2) if more precise information is sought, it will frequently be increased computation time which dictates the use of faster algorithms of the FFT type, or; (3) the data medium or bandwidth or special hardware may favor a hybrid approach utilizing multiple or tunable narrow pass-band filters to analyze realtime data. The explanation, selection and use of "windows" for both correlation and time-domain data are presented. The book contains generalized flowcharts for basic operations including the FFT algorithm.

Overall, the approach is mildly statistical with sufficient explanation to obviate the need for extensive background on the part of the reader. The last chapter contains examples and advertises the computing and analysis capabilities of the authors' employer. Finally, the book was produced by offset photography of right-justified typewriter output typical of monographs.


REVIEWED BY GEORGE F. OSTER

This subject of mathematical demography has largely centered around the study of two particular mathematical models, both arising from the following distributed parameter system:

\[ \frac{d^2 u}{dx^2} + f(u) = 0 \]

\[ u(x, t) \text{ represents a population density, } f(u) \text{ is a function that models the birth and death rates.} \]

\[ \text{The solution to this equation is a traveling wave solution that describes how a population spreads out over space.} \]
\[
\frac{\partial n(a, t)}{\partial t} + \frac{\partial m(a, t)}{\partial a} = -\mu(a, t)n(a, t). \tag{1}
\]

Here, \(n(a, t)\) is the population density, \(a\) the age coordinate, and \(\mu(a, t)\) the death rate. The boundary condition for (1) expresses the birthrate \(B(t) = n(0, t)\) as a functional of the adult population:

\[
B(t) = \int_0^\infty m(a', t)n(a', t)da'. \tag{2}
\]

where \(m(a, t)\) is the birthrate kernel. If (1) is solved and substituted in (2), an integral equation for the birthrate emerges. This is the Lotka model. If the system is discretized along the characteristics of (1) and the resulting difference equations cast in matrix form, a discretized equation for the population density, the Leslie model, results. The system (1), (2) may look familiar to engineers in another context: equation (1) is just the equation for convective transport of a "substance" with concentration \(n(a, t)\) along a pipe, with unit velocity and with a sink term \(\mu(a, t)n\). Equation (2) is a positive feedback functional which turns the system (1), (2) into a positive feedback distributed parameter dynamical system. Coale's book is an inquiry into the applications of this model to forecasting the age structure of human populations. After an introductory chapter discussing the factors affecting the birth and death rate functions, \(m(a, t), \mu(a, t)\), Chapter 2 focuses on the effects of birth and death rate schedules on the age distribution, with a heavy emphasis on the steady state solutions to (1), (2) (the "stable age distribution"). Chapter 3 treats the convergence of \(n(a, t)\) to the stable age distribution assuming time independent birth and death rates. Chapter 4 studies the system dynamics under the time-varying input:

\[
m(a, t) = m(0, 0)e^{at}, \quad \text{but} \quad \mu(a, t) = \mu(a)
\]

and develops approximate solutions. Chapter 5 studies the reverse situation: birth rates are constant, but death rates vary as:

\[
\mu(a, t) = \mu(a, 0) - \Delta \mu(a).
\]

Chapter 6 studies the frequency response of the system to periodic variations in the birthrate, and the existence of population "resonances" in the age structure is demonstrated. Chapter 7 generalizes the input functions to the birthrate using Fourier methods. Finally, Chapter 8 recapitulates the substance of the entire book in a nonmathematical fashion. Throughout, the book is clearly written, with mathematical developments always subordinated to clear, heuristic discussions. For engineers interested in population dynamical systems, Coale's book is one of the best introductions to mathematical demography.