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Book Reviews

Statistical Spectral Analysis—A Nonprobabilistic Theory by William A. Gardner, Prentice Hall, 1987, ISBN 0-13-844572-9, 566 pp.

REVIEWED BY ENDERS A. ROBINSON[1]

This book presents a general theory and methodology for empirical spectral analysis. The treatment is original because it does not make use of the difficult concept of ergodicity to provide a link between the empirical methods and the abstract probabilistic theory of stochastic processes. Instead, it shows that all the concepts and methods of empirical spectral analysis can be explained in a more straightforward fashion in terms of a deterministic theory: a theory based on time-averages of a single time-series rather than ensemble-averages of hypothetical random samples from an abstract probabilistic model. Specifically, the fundamental concepts and methods of empirical spectral analysis are explained without use of probability calculus. This approach is in keeping with the profound and influential work of Norbert Wiener in his classic paper *Generalized Harmonic Analysis* published in 1930.

Part I of this book is intended to serve as both a graduate-level textbook and a technical reference. The only prerequisite is an introductory course on Fourier analysis. However, some prior exposure to probability and statistics would be helpful. Part I presents a thorough development of fundamental concepts and results in the theory of statistical spectral analysis of empirical time-series from constant phenomena. The approach given here is one that will be helpful to students, for it is easier to master first the deterministic theory before studying the more abstract probabilistic theory.

The first chapter addresses what spectral analysis is and why we analyze waveforms into sinusoidal components. Nonstatistical spectral analysis is presented in the second chapter, and statistical spectral analysis in the third. The fourth chapter treats analog methods, the fifth chapter fraction-of-time probabilistic analysis, and the sixth chapter presents digital methods. Cross-spectral analysis between two signals is given in the seventh chapter. The eighth chapter considers time-variant spectral analysis, and the ninth chapter parametric methods. These nine chapters make up Part 1.

The subject of Part II of the book is the statistical spectral analysis of empirical time-series from periodic phenomena. In line with the general approach of the book, the unnecessary abstraction of a probabilistic framework is avoided by extending to periodic phenomena the deterministic approach for constant phenomena developed in Part I. Part II represents the results of the author's own research on cyclostationary stochastic processes, and much of the material is new and important.

Six chapters comprise Part II. After an introduction to second-order periodicity, the author presents cyclic spectral analysis and examples of cyclic spectra. This is followed by chapters on measurement methods, applications, and cyclic fraction-of-time probabilistic analysis.

This book can be highly recommended to the engineering profession. Instead of struggling with many unnecessary concepts from abstract probability theory, most engineers would prefer to use methods that are based upon the available data. This highly readable book gives a consistent approach for carrying out this task. In this work Professor Gardner has made a significant contribution to statistical spectral analysis, one that would please the early pioneers of spectral theory and especially Norbert Wiener.

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