Nonlinear Signal Processing : A Statistical Approach, by Gonzalo R. Arce, Hoboken NJ; John Wiley, 2005, ISBN 0-471-67621-1, xx + 459 pp. +CD, $79.95.

Linear filters widely used in the signal processing is based on the assumption of Gaussian noise. And this Gaussian noise assumption is based on the Central Limit Theorem which widely accredited with the universal applicability of the linear method of smoothing the data with noises.

This book intends to broaden the signal processing by using nonlinear estimators, for the reasons that the real world noise, as exemplified in the book, which is not limited to the well behaved Gaussian distributions. And this is the place where the nice property of linear estimators broken down.

The book starts with the quick overview of non-Gaussian Random process and its nonlinear estimators followed by a detailed discussion in the Chapter 2 on the generalized Gaussian distribution, which is a special class of stable distributions.
Like Gaussian random variables, A stable random variable is defined as a class of random variables which is closed with linear operations. In another word, A Random variable X is stable if X_1 and X_2 are independent copies of X and with arbitrary positive constants a and b, there are constants c and d such that: $aX_1 + bX_2 = cX + d$. Normal distribution is a member of stable distribution, however, the stable distributions include members with infinite 2^{nd} moment. While the classical Central Limited Theorem requires the existence of a finite 2^{nd} moment.

Introduction of the class of stable distributions paved the way to state the Generalized Central Limited Theorem ; as stated; " Let X_1, X_2,...being an independent, identically distributed sequence of random variables. There existed constants a_n such as $n \rightarrow \infty$ the sum $a_n(X_1 + X_2 + ...) \rightarrow Z$ if and only if Z is a stable random variable with the dispersion parameter $0<\alpha<2$". Again in the generalized case a stable random variable Z plays the role of the normal random variable.

Ordered statistics plays the prominent role in the nonparametric methods. The properties of ordered statistics are examined in the chapter 3. Filtering as a statistical methods of estimating signal is discussed in the chapter 4. In the part II , Signal Processing with Order Statistics; which mainly dealing with various median smoothers. In part III,

Signal Processing with stable Model, introduced Myriad smoothers. The Myriad estimator of a sample sequence of stable random variables $X_1, X_2,...,X_N$ with a given positive constant K, is,

$$\beta_K = \text{MYRIAD(K, } X_1, X_2,...,X_N) = \arg \min_{\beta} \prod_{i=1}^{N} (K^2 + (X_i - \beta)^2)$$

Chapter 8 and 9 of this part are mainly to discuss the property of this estimator and its applications.

This book although addresses the issues encountered in the signal processing engineering, the reader can also treats it as an advanced statistical methods. Especially interested are the various discussions of the dealing with heavy tails distribution, or impulsive signals. Geometrical interpretation of the Myriad estimation and the K's role in determining how impulse the signal is, are especially interested. For practical reason, the author also gave an iterative algorithm to obtain best estimates of K and β from the data.

The book comes with a companion CD which contains more than 60 algorithms in MATLAB m files. These functions provide almost all major algorithms being discussed in the book. Even though it requires MATLAB to run, you can open the m files as text using Microsoft Word or any text file readers.

The proposed non-linear estimators/filters usually have a corresponding linear counter part as a special case, this lead to the construction of more universal filters which expanding the capability and the robustness of data processing. In another word this unified treatment of Non-Gaussian signal data also includes traditional Gaussian cases has greatly simplify and expand the capability of the filter design.

This comprehensive book is solid both at the statistical theory and the application. So it will be a good reference for both the trained statisticians and engineers.

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