Wavelets and Signal Processing. Lokenath Debnath (ed.). Birkhauser Verlag, P.O. Box 133, CH-4010, Basel, Switzerland. 2003. 435 pp. Price not mentioned.

Since so many books on wavelets have already appeared, it is appropriate to ask: *In what sense is the book* (in the Birkhauser series on *Applied and Numerical Harmonic Analysis*) under review distinct from the rest of the literature? Whom will it benefit: a course student or a researcher? What does one need to know before one makes an attempt to read this book?

First of all, the editor has to be commended for having brought together (at the NSF-CBMS conference in Orlando, 1998) specialists in mathematics and engineering to contribute to the common theme of wavelet transforms and their applications.

The book, which is a collection of 13 articles by pure and applied mathematicians (or engineers), offers not much in the form of novel material.

Except for the soul-searching first chapter by Cohen (see the introduction and conclusions in this chapter), the contents of the book are pedagogically unsatisfactory (and hence cannot be used as a text-book for courses). Some specialists may find the book helpful in unearthing references. But the general reader requires considerable mathematical background to utilize any part of the book.

The numbering of sections in the chapters is quite a strain on the reader who has to contend with 4 digits (separated by dots). In chapter 6, the section numbered 6.1.1 (page 135) starts immediately after the title of sec. 6.1, without so much as even a single sentence. The same is true of chapters 9 and 10. Such a numbering scheme jars the sense of smoothness in text.

The critical remarks below are *primarily* those of an engineer. There is a broad coverage of applications coupled with some basic mathematical material on wavelet transforms. However, coherence among the chapters is lacking.

For instance, chapter 2 on multiwavelets in R^n seems to have no relationship with chapter 3, also on multiwavelets. The self-similarity idea invoked in chapter 2 has no place in chapter 11 which deals with self-similarity in stochastic processes. Can we analyse fractals using the results of chapter 2?

Even though the conclusions (pages 16–17) in chapter 1 are expected to awaken the ardent devotees of wavelet transforms, it is puzzling to note that the author (L. Cohen) falls short of declaring that the wavelet transform has not really solved the problem of localizing the desired properties (or *features*) of signals (in one or two or more dimensions) in the spatial and spectral domains.

It would have been useful if the authors of chapter 2 had shown how to apply their ideas to physical problems.

In chapter 3, with reference to paragraph 2 of sec. 3.1, it would have been helpful to students if items like Hardy spaces had been explained before invoking them. What a strange reference to Hardy: 'Here $\mathcal{H}$ stands for Hardy'!

What is the practical motivation for dealing with biorthogonal pairs in the context of analysing Navier–Stokes equations? After all, the authors declare in the first paragraph of sec. 3.1: '... (the nonexistence of biorthogonal pairs)... does not impart severe obstacles to the application of wavelet-Galerkin methods for (*sic*) Navier–Stokes systems'.

In chapter 4, it is not clear whether the framework of (Osiris) wavelet transforms is required (as a tool) to prove the existence or otherwise of some 'extraneous' fixed points as states.

Chapter 5 is interesting and well presented. How would the author's wavelet-transform-based strategy of denoising compare with the one based on (signal-dependent) Karhunen–Loeve transform? Even though a cursory reference has been made to this aspect on page 105, some explicit and detailed illustrations would have helped the reader get a better insight into the effectiveness of the results of this chapter. This is all the more necessary in the light of the conclusions of chapter 1.

Instead of presenting the standard abstract material (found in all the books) on multi-resolution analysis, it would have been more convincing if a typical wavelet primitive (employed subsequently by the authors) were shown to have all the required properties for signal decomposition. It is surprising to note that the authors resort to sanctification of the operation of plain thresholding (used so frequently in signal processing) by the high-sounding expression, 'wavelet shrinkage'.

Chapter 6, which deals with time-frequency representations (TFR) and their applications, is incoherent and belaboured. More importantly, there are many serious flaws in it. A few of them are listed below.

No reference has been made to windowed transforms (in sec. 6.1) which preceded TFR.

Even though the word 'nonstationary' (page 136) has been used by a few authors to characterize signals (like 'music played on the radio'), it seems to be somewhat inappropriate. This is because the same word has been more frequently used by mathematicians dealing with stochastic processes. A better qualifier could be 'variable frequency'.

Further, the choice of the word 'asymptotic' (page 136) to describe signals of 'finite duration T and nearly finite bandwidth B' is unsatisfactory: *asymptotic to what*?

Section 6.1.2 is mathematically faulty. The spectrum of a (real) time-function is, in general, complex. Therefore, when we wish to compare the spectra of two time-signals, we need to compare both its real and imaginary parts (or both, its magnitude and phase). As a consequence, the author's reference to 'The limitation of "classical" spectral representations' is misplaced. For the same reason, the second paragraph on page 138 is not sound.

In example 6.1, the signal $s_a(t)$ is of finite duration. Therefore, its spectrum *cannot* have compact support. But figure 6.1 shows its spectrum to be *compactly supported*. On the other hand, the spectrum of $s_b(t)$ is an ideal bandpass filter, i.e. its spectrum is flat and displaced on either side of the vertical axis by an amount equal to $2\pi f_c$, the modulating frequency (since the signal is merely the modulated sinc function). Contrast this with figure 6.2(b) which shows an entirely different function as the magnitude of the spectrum of $s_b(t)$.

On page 139, a reference is made to Wigner–Ville distribution defined by eq. (6.1.16) on page 144, i.e. five pages later. Similarly, after having made many references to time-frequency (TF) analysis up to sec. 6.1.4, we find sec. 6.1.4.2 devoted to TF representation. All this is *unsatisfactory* mathematics.

Section 6.1.4.2.2: In the earlier part of chapter 6, one gets the impression that TFR scheme was meant to overcome the localization problem (LP) *inherent* to either time- or frequency-representation scheme. In this section, we realize that we are still firmly in LP's grips. One wonders, then, what the achievements of TF analysis *indeed* are.

Section 6.2 presents a bird song signal as the starting example (figure 6.8), but forgets it (in the maze of performance specifications and synthetic signals) until sec. 6.3.2.2 when it becomes 'Noisy Minor song signal'. The original time-function should have been given before figure 6.8 (Is figure 6.20(a) this time-function?). How about a comparison with windowed Fourier transform as applied to this signal? By the way, is the bird song an illustration of an FM signal?

Among mathematicians, a natural tendency is to generalize the latest results (obtained mostly by pioneers) to various spaces of functions. But it is not made clear how these generalizations can solve the existing practical problems.

Chapter 7 deals with certain classes of TFR having, what the authors call, *co-variance property* with respect to 'TF displacement operators'. The mathematics is interesting and impressive but it is not clear what practical implications the proposed (generalized) framework has (as applied, for instance, to speech signal processing).

Chapter 8 describes a 'reassignment principle' meant to 'sharpen' TFR and time-scale representations. When do we know whether reassignment is required or not? Is it by human visual pre-processing or what? Can we decide upon stationarity, or otherwise, of a signal automatically?

In what sense is equation (8.3) 'closely related' to equation (8.2)? Why cannot primitive wavelet functions be synthesized to extract 'chirps' from signals (as presented in sec. 8.2.1)?

The general comments, first on page 236 (before the start of sec. 8.2.2) with respect to the limitations of (a) short-time Fourier and wavelet transforms and (b) Wigner–Ville distributions; and next, on page 264, while critically examining the implementation of the proposed reassignment principle, are revealing.

Chapter 9, which deals with TFR and array signal processing contains a clear description of the linear mathematical models for signal-to-noise ratio enhancement and blind source separation, among others. It would be interesting to know how the second and higher-order statistics (of signals) are related to TFR?

Chapter 10 examines a class of TFRs that are covariant to time shifts matching changes in the group delay function of the signal under consideration. It is strange that *no* (a) reference to and (b) comparison with short-time Fourier transforms have been made. Given a signal, how would one know what TF structure it corresponds to (so as to be able to choose the appropriate class of TFR schemes, from among the multitude in figure 10.4)? The listing of so many classes of TFR without motivation is confusing. Only one real-life example of the impulse response of a steel beam is given, and this too without the time-plot of the signal under consideration! What is the goal of analysing such a signal? How did the author choose the TFR schemes?

Chapters 11 and 12 seem to be out of place in this collection. How are self-similarity (SS) and intermittency properties of certain stochastic processes in any sense related to TFR? What is the motivation for choosing wavelet decomposition to deal with SS in Gaussian processes? Why not TFR? In Chapter 12, what is the role of wavelet transform-based compression in TF analysis? What has localization of signal properties to do with thresholding and compression?

Chapter 13 contains an interesting application of 'wavelet filtering' (due to Donoho and Johnstone) to the extraction of 'coherent structures' of turbulent flows (described by Navier–Stokes equations). It is not clear how accurate the results in practice are, and whether there is any 'compromise between accuracy in coherent vortex simulation and computational cost' in the light of comments made in the introduction (of this chapter).

To summarize, the book is of doubtful value to students and of marginal utility to specialists.

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Environmental Science. S. Ignacimuthu. Phoenix Publishing House Pvt. Ltd. 21, Prakash Apartments, 5, Ansari Road, Daryaganj, New Delhi 110 002. 2003. 274 pp. Price not mentioned.

Environmental science, with its multidisciplinary approach, has attained significant position as a scientific discipline. It is important for each citizen to understand about his surroundings. There is enormous information emerging from economic, ecological, political, sociological anthropological, legal and ethical considerations and there is need to bring in latest information and developments such as biosensors, role of biotechnology in remediation and conservation, global warming, carbon cestration and spin-off of various other disciplines such as nanotechnology.

The book under review serves as source material for students and teachers of environmental science. The book has been divided into five units: structure and function, environmental resources, environmental factors, environmental pollution and remedies, and environmental laws and ethics. After each chapter, a study outline, questions and references have been provided.

Each unit is again subdivided into several chapters. Unit 1 deals with ecosystem structure and functions, energy flow, bio-geo chemical cycle in the environment and habitats.

Unit II deals with environmental resources such as natural resources, biological resources and human resources. Natural resources include mineral resources, forest resources, land, water, atmosphere and energy. Biological resources contain crop and animal resources, but details of conservation and endangered species, gene bank and plant tissue culture which have been included here, should have been treated separately as tools to enhance resources. Chapter 6 on human resources deals with human population, health, disease causative agents and impact on animals and vegetation. These aspects should have been treated as a separate chapter on human ecology rather than on human resources.

Unit III deals with abiotic and biotic factors. The basic information for readers will help them to understand about various resources in a better manner. Hence these aspects should have been placed as Unit II.

Environmental pollution and remedial measures, and environmental biotechnology are placed in Unit IV. These chapters have been presented well compared to all other chapters, explaining the various polluting agents, waste treatment, biodegradation, restoration of degraded land, etc.

Unit V deals with environmental laws and ethics and environmental education. These chapters provide a brief account of existing environmental laws and acts.