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Book review

The Illustrated Wavelet Transform Handbook by Paul S. Addison, Institute of Physics Publishing, Bristol, 2002, pp. xiii + 353, price £45, US$65, ISBN 0-7503-0692-0

This is an excellent book and one that I (mainly) enjoyed reading very much. It is composed of essentially two parts. In the first part, which comprises three chapters, the reader is introduced to the basic theory of the wavelet transform in the continuous-time and discrete-time cases. The second part, which is composed of four chapters, provides a fairly comprehensive review of wavelet applications in a number of domains.

The first part is an excellent pedagogical introduction to wavelets. After a brief introduction, Chapter 2 is devoted to the continuous wavelet transform (CWT). To simplify matters, the discussion is centred on a real mother wavelet, namely the Mexican Hat. The author illustrates the CWT for a number of basic signal classes: harmonic signals, chirps, impulses and edges. The explanation is extremely clear and the figures are very helpful. The author describes how to construct the energy spectrum of the wavelet and sketches the relationship with the more familiar Fourier-based spectrum. The wavelet analogue of the power spectrum is then introduced before the first complex mother wavelet is given in the form of the Morlet wavelet. There is a little technical discussion, i.e. conditions on mother wavelets, when the full form of the Morlet wavelet is needed, but this does not interrupt the flow of ideas. There follows a number of more specialized topics; I found the comparison of the CWT with the short-time Fourier transform and the description of the matching pursuits algorithm to be particularly interesting. All of the discussion is conducted at a level where a basic engineering background in mathematics will suffice for complete understanding. This is one of the strengths of the text; many of the recommended introductions to this field are pitched at a much more mathematical level. Chapter 3 raises the mathematical stakes a little in order to describe the discrete wavelet transform (DWT). Although there are valuable illustrations here, the main body of the chapter is concerned with the pyramidal algorithm for computing the fast wavelet transform. This is introduced in the least painful way possible by initially concentrating on the Haar wavelet, but the rest of the Daubechies family are introduced later and described in some detail. There are excellent sections on the use of 2D orthogonal wavelets for image analysis and the wavelet packet algorithm.

The second part of the book has the feel of a number of review articles. Although there is a certain amount of more fundamental material covered, how the reader feels about the material will largely depend on the level of his or her interest in the fields concerned. Chapter 4 is concerned with fluids and because of my own personal tastes (a main interest in dynamics), I found the going rather heavy, although at the beginning of the chapter there is some interesting basic material on wavelet coefficient statistics that can be put to good use in a number of fields. Chapter 5 is a little

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more varied and ranges over various aspects of engineering testing, characterization and monitoring. It is this chapter that contains the main discussions on dynamics and is therefore likely to be of interest to the general readership of this journal. Chapter 6 is concerned with medicine, but will be of interest to practitioners in condition monitoring as many of the applications are centred on the need to diagnose anomalies on the basis of complex noisy signals. Chapter 7 covers fractals, finance and geophysics amongst other subjects. The discussion on fractals is very interesting and, in my opinion, would have benefited from a little more room. My general comment on the later chapters is that they are rather dry compared to the earlier pedagogical material. The author is extremely good at explaining the theory and I would have welcomed more material of that nature rather than the review. As always with review material, there is not enough room to cover all the terminology, so the reader is occasionally left a little bewildered by sentences like "Verhelst (1998) has also interrogated seismic data using the *matching pursuits* method with *Gabor atoms* and found phase attributes that could be related to *facies* types in a *delta system*" (my italics). The author explains the first two italicized terms in earlier chapters — and explains them very well — but the second two are presumably only understandable to a geophysicist. Having said all this, I don't feel that it is a serious enough complaint to discourage anyone from seeking out this book.

The book ends with a short appendix that directs the reader to other resources including other books on wavelets. I agree with his choice of books completely. In fact I would recommend that a wavelet novice should begin his or her studies with the painless overview by Hubbard [1] and move towards the more comprehensive text by Mallat [2]. However, in my opinion, Addison's book bridges the gap between these two perfectly, and should form the middle stage of this program of study. (The more mathematically inclined could happily start with this book.) For an expert in wavelet signal processing, the book can also be recommended as a place to see a range of applications, as long as their interests coincide with the fields covered. The book is extremely well put together and lavishly illustrated (as one might infer from the title). Despite this fact, it is very competitively priced, and represents excellent value. To end where I began, I largely enjoyed reading this book and I strongly recommend it to anyone with an interest in wavelets, or in the general field of signal processing for that matter.

References

[1] B.B. Hubbard, *The World According to Wavelets*, Wellesley, Peters, MA, 1996.
[2] S. Mallat, *A Wavelet Tour of Signal Processing*, Academic Press, San Diego, 1998.

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