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Book Review

The Fourier Transform in Biomedical Engineering, edited by J. H. T. Bates, G. B. Pike, and P. Munger. Boston: Birkhouser, 1998, 200 pp., ISBN 0817639411, $64.50.

The authors' goal is to describe the Fourier transform in simple language without getting overly bogged down in the mathematics. This is an ambitious proposition, but one which they generally accomplish quite well. For the most part, they present enough mathematical detail to be accurate in their descriptions, yet they also present plain-language interpretations of the equations so that those less comfortable with the mathematics will understand the general idea. Moreover, they demonstrate many of these points using real-world examples of interest to scientists and engineers in the biomedical field.

The book contains six chapters. The first two introduce basic topics including complex exponentials, convolution, Fourier transform, point-spread function, sampling and aliasing, power spectrum, deconvolution and system identification. Chapters 3 and 4 describe how Fourier transforms are used in computed tomography (CT) and magnetic resonance (MR) imaging. These chapters do not assume familiarity with CT or MR and present basic introductions to the relevant imaging physics. Chapter 5 presents the wavelet transform and its relation to the Fourier transform through the windowed Fourier transform. This material is particularly timely and includes a discussion of the use of the wavelet transform in image compression. The final chapter covers the discrete Fourier transform and the fast Fourier transform. It introduces some of the computational issues associated with using these transforms.

The chapters are well written, are in a uniform format, and flow together well. Later chapters often refer to topics covered in previous chapters. In general, I found the book easy to read and noticed few typographical errors.

My critiques of this book are related to the hazards of minimizing mathematical details. This leads to some possible ambiguities with regard to interpretation of some statements. For example, on page 82 they make general statements about commutative properties of ''cascaded linear operations.'' However, they do not give a precise definition of cascaded linear operations.

I was disappointed by the authors' mistake in the definition of the Nyquist rate. On page 36, they state that: ''All the information in a signal, band-limited to a frequency f_0, can be captured in its samples taken at a rate of greater than $2f_0$,'' which is known as Shannon's sampling theorem. The critical frequency f_0 is known as the Nyquist rate. This is not correct: f_0 is the Nyquist *frequency* and $2f_0$ is the Nyquist *rate*. (See Oppenheim and Schafer, Discrete-Time Signal Processing. Englewood Cliffs, NJ: Prentice–Hall, 1989; and Rabiner *et al.*, Terminology in digital signal processing. *IEEE Trans. Audio Electroacoust.* 20(5):322–337, 1972.) While the difference may be subtle, it is important, especially in written communications.

In summary, the book is well suited as an introduction to Fourier transforms for scientists and engineers. Although the book lacks sufficient mathematical detail to be a primary text for a signal-processing course, it would be an excellent source of supplementary material for both the student and the instructor.

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Raymond F. Muzic, Jr.
Departments of Radiology and Biomedical Engineering
Case Western Reserve University
Cleveland, OH
rfm2@po.cwru.edu