Multidimensional Signal, Image and Video Processing and Coding, by John W. Woods, Academic Press, 2006, ISBN: 0-12-088516-6. *Reviewed by Janusz Konrad (jkonrad@bu.edu), Department of Electrical and Computer Engineering, Boston University.*

DVD players, digital cameras and, more recently, flat-panel HDTVs have become some of the most sought-after high-tech products in the last few years. A luxury item several years ago, the digital camera is now a commodity routinely embedded in cell phones. Although manufacturing efficiency is one of the reasons for this digital imaging revolution, the very core of its success stems from advances in image and video capture, processing, and transmission techniques over the last two decades. In the vast body of literature on image and video processing and coding, several researchers stand out as hallmarks of excellence. John W. Woods, a professor at Rensselaer Polytechnic Institute, is among them. Woods brings us a new book on the processing and coding of multidimensional signals, in particular, still images and video.

Multidimensional Signal, Image and Video Processing and Coding presents a signal processing approach to image and video problems. Although a number of books related to images and image sequences are available, many of them focus on image analysis or, as Woods states in the introduction to the text, "image-in/analysis-out" problems. The focus of Woods' book is on "image-in/ image-out" problems solved using a chest of signal processing tools. The text requires a solid background in one-dimensional (1-D) digital signal processing (DSP) and stochastic processes.

As a resource for graduate education, the book is very valuable as it combines multidimensional signal processing theory with practice by means of an included CD-ROM. The textbook provides dozens of examples (amply illustrated by plots and images) and over 130 homework exercises. The CD-ROM contains MATLAB programs, test images and videos, and video processing and compression results. A companion Web site (at www.textbooks.elsevier.com) contains the current errata and allows instructors to access the electronic solutions manual (with registration). As a resource for practicing video engineers, the book is valuable as it nicely links various theoretical concepts with commonly used video formats and standards. For example, Section 10.1 sheds light on luminance/chrominance interference in composite and S-video analog signal formats; the appendix to Chapter 10 describes the main digital video formats; and Section 11.1.2 discusses a ubiquitous, but less well known, DV compression scheme.

In terms of structure, the first five chapters extend 1-D DSP concepts to two dimensions (signals and systems, sampling, transforms, and filter design). The next chapter presents background material on luminance, color, human visual system properties, and image capture and display. It concludes with simple, but popular, image operators cast in the context of two-dimensional (2-D) finite impulse response (FIR) filtering, an example of how 2-D DSP material from earlier chapters can unify concepts extensively used in computer vision. Following this prerequisite material, two chapters concentrate on still images. While one chapter discusses problems in image estimation and restoration based on linear estimation theory (Wiener and Kalman solutions) and Markov random field models, the other plunges into compression, discussing the basic steps of transformation, quantization, and entropy coding and exploring DCT-based, subband, and fully-embedded (EZW, SPIHT, EZBC) coders.

The remaining four chapters concentrate on video. First, signals and systems concepts are extended to three dimensions and applied to spatiotemporal filtering and restoration; the three dimensions are treated equally. In the subsequent chapter, the temporal dimension is treated preferentially; motion estimation and motion compensation are introduced and then applied to motion-compensated video filtering as well as Wiener- and Kalman-based video restoration. The final two chapters offer an overview of state-of-the-art video compression (including recent developments in spatio-temporal subband/wavelet and scalable coding) and error resilience issues in video transmission over networks. A number of video sequences demonstrating efficacy of various restoration and compression techniques are included on the CD-ROM.

One topic that this reviewer believes could have been addressed in more depth is color. Although Woods provides some rudimentary material on the human visual system's response to different light distributions as well as some basic color-signal transformations, a discussion of chromaticities, color spaces, and their benefits is missing. This is not an easy topic, and would probably require a separate chapter. Yet it is an important subject for a future engineer working with images.

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Given the book structure and content, it is difficult to imagine that a one-semester course could cover the entire book's material. One possibility is an introductory graduate course on still-image processing and compression, covering the first five chapters on 2-D DSP and following with the next three chapters on imaging background material, image restoration, and compression. An alternative would be an advanced graduate course on video processing and compression covering the first six chapters and the last four chapters. Some other chapter combinations are possible as well; detailed explanations are provided by Woods in the introduction.

In terms of aesthetics and functionality, the book is very well designed. The formatting is well organized, the examples stand out from the text, and the notation is transparent. The only drawback to this transparency is that many equations become quite long, as double and triple summations and integrals must be used. A vector notation could make many formulas more compact, although at some cost to transparency.

From a timeliness standpoint, the book comes at a very opportune time. It fills a large void left by the excellent, but outdated, *Fundamentals of Digital Image Processing* (1989) by Anil K. Jain, and it is also a good alternative to the current benchmark text *Video Processing and Communications* by Yao Wang, Joern Ostermann, and Ya-Qin Zhang. Whereas the latter focuses solely on video, the text by Woods offers a balanced treatment of both still images and video sequences. It also covers 2-D and 3-D DSP foundations in more depth and is richer in image and video examples. Admittedly, the book's wider scope results in a more superficial treatment of some video processing topics such as deinterlacing, frame rate conversion, and motion estimation.

Overall, *Multidimensional Signal, Image and Video Processing and Coding* is a well-written text which fills the current void in the image processing and coding literature. The fact that it takes a signal processing, rather than computer vision, viewpoint to image manipulation will make the book a valuable resource for researchers and students in the signal processing community working with images and video. It is the opinion of this reviewer that Woods' book will have a lasting impact on those involved in image- and video-related research and education. SP