BOOK REVIEW

Principles of Digital Image Processing

Jan Teuber, Ed., xii + 263 pages. ISBN 0-13-213364-4. Prentice Hall, Englewood Cliffs, NJ 07632 (1993) $66 softbound.

Reviewed by K. Venkatesh Prasad
Ricoh California Research Center
2882 Sand Hill Road, Suite 115
Menlo Park, California 94025-7022

Most image processing texts, within the first few introductory pages, typically present a strong case for the study of the basic principles of sampling, quantization, and compact representation of images. To motivate the study of this material, authors usually argue that unprocessed images place heavy requirements on computer memory, transmission bandwidth, and display time, and that, to be of any practical use at all, images require preprocessing, involving a careful choice of sampling, quantization, and compact representational parameters. The literature in the field of digital image processing has reached such unwieldy proportions that it seems ironically appropriate to make metaphors out of the terms "sampling," "quantization," and "compact representation" to describe what authors of modern-day textbooks in the field might have to do to convey the subject matter in a single handy book.

In writing *Principles of Digital Image Processing*, the author has clearly chosen to make several trade-offs to capture the essence of the subject matter in a rather compact and self-contained book. The author has achieved a compact representation for the book by subsampling the literature in a pedagogically constructive fashion. Those without prior exposure to the field will not detect the details that are obviously not addressed in the book. Those familiar with the field might be able to make some refreshing recapitulations.

The introductory chapter to the book contains a set of working definitions, a review of light sources and sensors, and a statistical description of image detection. The book derives both its strengths and weaknesses from its succinct nature. By choosing to describe only a small but salient set of topics, the author has been able to provide a generalized approach; for example, "signals" and "images" are treated, in many cases, in the broadest sense of their meaning—without distinction, adding to the intuitive value of the content. Material presented in this form also appears rather convincing and self-contained to the novice, which certainly is the greatest strength of this book. However, readers with prior exposure to the field will certainly detect very early on in the book that many topics are not addressed. Visual perception, the basic principles of colorimetry, and color image representation are examples of topics not mentioned at all.

The second chapter is centered around the representation and decomposition of images and signals. The author draws the reader's attention to the analogies between continuous functions in mathematics and analog signals and between vectors in linear algebra and discrete-time signals. The valuable notion of signal distance as a measure of signal (image) disparity is explained in detail. The concept of linear approximations of signals and their representation by harmonic orthonormal sets is dealt with in this chapter. Throughout the book the author has used illustrative numerical examples to introduce some concepts not addressed in the body of the text. For example, the notion of the Nyquist sampling frequency and the phenomenon of aliasing are introduced in this chapter through illustrative numerical examples.

"Transformations and Systems" form the subject matter of the third chapter. The characterization of transformations by impulse responses and the Fourier transformations of signals and their representation by phase and amplitude spectra are developed in this chapter. The author makes a restrictive definition of the term *systems* to limit the discussion to just linear systems. Highlights from linear system theory, the notion of the point spread function as a means of characterizing a system, and a description of the z-transform are provided in this chapter. Conspicuous by their absence in this book are the numerous other valuable transforms: the discrete cosine transform, the Hadamard transform, and the Karhunen-Loeve (or Hotelling) transform, to name just a few.

The subsequent chapter presents a good introduction to basic coding, quantization, and segmentation principles. The notions of information content, entropy, and optimal coding, along with an example of Huffman coding, are well illustrated. The topics of detection, recognition, and estimation are addressed in the next chapter. Topics covered include point-wise detection, area detection, recognition using templates, correlation and spectral estimation, maximum-likelihood estimation, and a detailed discussion of a fully realistic detection problem from the author's field of astrophysics. The penultimate chapter is on "Geometric Operations" covering the principles of affine mapping, projective mapping, and interpolations, and the notion of image similitude. The final chapter, entitled "Image Improvement" applies the principles developed in the earlier chapters to various pixel-level manipulations that seek to restore and enhance images. Topics covered include histogram equalization, Wiener filtering, restoration through inverse filtering, blur detection and removal, the CLEAN algorithm (used originally in radio astronomy), and the Richardson-Lucy algorithm.

Most readers with recent formal training in electrical engineering or those practitioners in the field of image and signal processing will most likely find *Principles of Digital Image Processing* rather superficial. The book is not appropriate as a textbook since many basic principles in both signal and image processing are not contained in the book. The book lacks an exhaustive bibliography and a comprehensive problem set at the end of each chapter. However, the author has thoughtfully provided in appendices a useful list of material for further reading, a comprehensive glossary of terms, and a discussion of basic statistical concepts. The most likely audience for this book is engineers and scientists in fields where signal and image processing are not formally taught.

K. Venkatesh Prasad received his BE degree in electronics and communication engineering from the University of Madras, India, in 1980. He obtained an MSEE degree from the Indian Institute of Technology, Madras, in 1984, based on research in the field of electromagnetics and antennas. In 1987 he obtained an MS degree with an emphasis in computer engineering from Washington State University, Pullman. In 1990 he received a PhD degree in electrical and computer engineering from Rutgers University, New Brunswick, New Jersey. From 1990 to 1992, he was a postdoctoral associate at Rutgers University, a visiting scientist at the California Institute of Technology (Caltech), Pasadena, and a Caltech affiliate at NASA's Jet Propulsion Laboratory, Pasadena. Since December 1992 he has been a research scientist at Ricoh Corporation's California Research Center working in the area of visual information processing applied to visual speech and document analysis.