

DEPARTMENTS

BOOK REVIEWS

Noninvasive Diagnostic Techniques in Ophthalmology

Barry R. Masters, ed., xxxii + 649 pp., illus., color plates, index, references, list of contributors, appendix of additional topics and resources. ISBN 0-387-96992-6. Springer-Verlag, 175 Fifth Ave., New York, NY 10010 (1990).

Reviewed by James S. Tiedeman, M.D., Duke Eye Center, P.O. Box 3802, Durham, NC 27710.

This book covers an extremely wide range of diagnostic techniques, some of which are commonly available to the practitioner, others of which are available only in the most specialized of research settings. It is a valuable reference work directed toward the basic scientist interested in equipment development as a science of its own, as well as the ophthalmologist who wants to expand his or her horizons of diagnostic technology.

From the medical viewpoint, the eye is a unique organ in that its optical properties allow imaging techniques that are impossible in other organs or systems, and historically, much of diagnostic ophthalmology has been oriented along the goals of new imaging techniques. Fully one-half of the 32 chapters in *Noninvasive Diagnostic Techniques in Ophthalmology* are devoted to various optical and nonoptical techniques of imaging the eye and orbit.

Three chapters discuss nonoptical imaging techniques. Chapters 2 and 3 are devoted to excellent discussions of the physics of magnetic resonance imaging (MRI), as well as particular applications to pathological conditions of the eye and orbit. Chapter 4 deals with ultrasonographic imaging techniques and explains the complementary utility of these techniques. Comparison of these modalities with the more invasive radiographic studies (CT scan) is discussed nicely.

The bulk of the imaging techniques covered are quite naturally optical, and Chap. 1 starts with an overview of image processing techniques covering the entire gamut from signal acquisition to data storage and retrieval systems. Some of the specialized aspects of digital processing are expanded and explored in greater depth in the excellent discussion in Chap. 29. These techniques might well find future applications to many of the topics covered in other chapters. Specific imaging techniques includ-

ing specular microscopy, confocal microscopy, the Scheimpflug camera, scanning laser ophthalmoscopy, and infrared choroidal angiography are covered in 10 chapters with the detail and completeness expected in a reference volume.

Aside from imaging techniques, details of the metabolic activity or function within the living cell can be probed noninvasively by optical means, and this quite possibly represents the most exciting direction for development of diagnostic technology. The technique depends on absorption and fluorescence differences of intracellular chemical species, dependent on their oxidative state. Probing optically allows determination of oxidation reduction or redox potential. Chapter 14 discusses applications of the technique to the corneal endothelial and epithelial cells in various diseased and environmental states of the eye. In Chap. 25, the use of similar optical probes to assess oxidative metabolism in the retina and optic nerve is explored. Such developing technologies may yield new insight into mechanisms of disease in glaucoma and ischemic retinopathies.

Because the eye itself is an imaging device, a great deal of interest is placed on its characteristics and limitations as such. The structures of the eye with the greatest variability in optical properties are the cornea and lens. Variability can occur in terms of their topography, refractive homogeneity, and transparency or light scattering properties. These facets are dealt with in Chaps. 5, 6, and 12. With regard to the cornea, knowledge of the corneal curvature and transparency can aid in diagnosis and in guidance of surgical technique in corneal transplantation and cataract surgery.

Functional testing of the eye and visual system are covered in Chap. 13 (Evaluation of Corneal Sensitivity) and Chap. 23 (Clinical Visual Psychophysics Measurements). Fluorescent tracer studies are discussed in Chaps. 15, 17, and 30, dealing with the anterior and posterior segments of the eye. The remainder of the book is devoted to a potpourri of topics including fractal analysis of the retinal blood vessels (Chap. 27) and neural network technology (Chap. 31).

In summary, the work fills a unique spot by distilling a vast and diverse set of topics with broad applications in ophthalmology. These topics will be of ever-increasing interest to the

clinician and basic scientist, and the book bridges some of the gaps between these groups in a way that has not previously existed.

Image Analysis Applications

Rangachar Kasturi and Mohan M. Trivedi, eds., xii + 436 pp., illus., index, references, author biographies. Part of Dekker's Optical Engineering Series, Brian J. Thompson, series editor. ISBN 0-8247-8198-8. Marcel Dekker, 270 Madison Ave., New York, NY 10016 (1990) \$115 hardbound.

Reviewed by Brian G. Schunck, University of Michigan, Artificial Intelligence Laboratory, 1101 Beal Ave., Ann Arbor, MI 48109-2110.

This book provides a nice selection of topics covering the applications of machine vision. The range of topics includes documents, drawings, maps, medical applications, aerial images, mobile robots, and fingerprints. The text includes an excellent sample of applications of machine vision and would be a necessary addition to the library of anyone interested in machine vision applications. Machine vision topics are scattered throughout the chapters covering specific applications. Although vision techniques are not gathered into a single presentation, the coverage of vision is impressive, and the book could be used as a supplementary text in an introductory machine vision course.

The first four chapters complement one another and provide excellent coverage of applications of machine vision in document processing. The first chapter, by Richard G. Casey and Kwan Y. Wong, covers document processing architectures. Standard techniques for segmenting portions of a document into text and graphics are summarized. The chapter includes brief overviews of optical character recognition and techniques for interpreting graphics and document structure. Two example systems for text document analysis and circuit diagrams are covered. While the first chapter emphasizes methods for text, the second chapter, by Sing-tze Bow and Rangachar Kasturi, provides a thorough description of a system for recognizing diagrams containing elementary shapes. The results are impressive, and the second chapter complements the material presented in the first chapter.

Chapter 3 by Masakazu Ejiri, Shigeru Kakumoto, Takafumi Miyatake, Shigery Shimada, and Kazuaki Iwamura on automatic recognition of engineering drawings continues the topic begun in the second chapter. Chapter 3 thoroughly describes a system for drawing recognition with careful attention to the details that are critical for successful application. The material in this chapter, as well as the first two chapters, is very timely, given the increasing interest in applying machine vision to electronic media. Example drawings include an LSI cell diagram, printed circuit board, logic circuit, and a chemical plant diagram. The last portion of Chap. 3 on recognizing maps should suggest many applications for imagery analysis to the reader, and it leads into the fourth chapter on geographic information systems.

Chapter 4 by Rangachar Kasturi provides an overview of geographic information systems and describes in detail a system for extracting information from maps. Given the increasing interest in geographic information systems, the material in this chapter is very timely.

The first four chapters occupy about 160 pages and constitute a valuable monograph on machine vision methods for document processing.

The next three chapters provide snapshots of applications of machine vision in medical image processing. The material in Chaps. 5 through 7 would also be valuable to workers in geoscience and remote sensing and leads into Chap. 8 on aerial imagery.

Chapter 5 by Lyndon S. Hibbard covers the problem of reconstructing neural structure and provides a concrete example of image analysis in the larger area of medical reconstruction. Chapter 6 by Sunanda Mitra and Thomas F. Krile covers image processing methods in the analysis of retinal structure. The chapter discusses standard techniques for registration, normalization, and edge detection in the context of an interesting application that is representative of numerous applications in medical image processing, geoscience, and remote sensing, and many other areas. The way in which this chapter covers these basic methods is an example of the remarkable job the editors have done in covering machine vision through careful selection of interesting applications. Hopefully, the price of this book will not deter instructors from using this text as a supplement in machine vision courses; the range of applications illustrates the ideas in machine vision.

While Chaps. 5 and 6 cover low-level methods in medical image processing, Chap. 7 approaches medical image processing from the other end of the scale: blackboard architectures for knowledge-based vision. Terry E. Weymouth and Amir A. Amiri present the blackboard architecture as a framework for designing systems for scene interpretation. The blackboard structure allows knowledge about the scene to be organized by spatial structure and level of resolution, with local knowledge at the lower levels of the blackboard and global knowledge at the higher levels. Blackboards provide a

modular structure for organizing scene interpretation knowledge. Knowledge sources for interpretation interact only through the blackboard, and interpretation can proceed either top-down or bottom-up as needed. Declarative knowledge about an object is combined with interpretation strategies that control the application of the knowledge to reduce computation cost. Cheap interpretation strategies are applied first to focus attention on promising areas of the scene, where more expensive procedures are applied locally. The chapter includes a careful delineation of the problems that are appropriate for blackboard architectures and presents examples of the use of blackboards for interpreting outdoor scenes and images of inner ear hair cells. The detailed description of selected knowledge sources for interpreting images of inner ear hair cells gives the reader a more detailed glimpse of knowledge sources in real applications.

Chapter 8 by Mohan M. Trivedi on aerial imagery provides a brief overview of methods for analyzing aerial images. The presentation of segmentation and cluster analysis may be too brief, but the chapter covers reflectance adequately and the material can motivate the coverage of these topics in a machine vision course. The focus of the chapter is an algorithm for high resolution analysis of aerial images based on pyramid structures. Chapter 9 on three-dimensional vision by Dragana Brzakovic and Rafael C. Gonzales covers camera models, with a brief mention of calibration, and methods for sensing the structure of surfaces in the scene, including structured light, laser ranging, shape from shading, shape from texture, and binocular stereo. The chapter presents a complete system that combines binocular stereo, shape from shading, and shape from texture.

Chapter 10 by Thomas Krile and John F. Walkup covers methods for image enhancement, including histogram methods, digital filters, and optical techniques, in the context of the application of processing images of fingerprints. Finally, Chap. 11 by Robert M. Haralick, Xinhua Zhuang, Charlotte Lin, and James Lee presents theorems on the sampling constraints for a multiresolution approach to morphological operations, which are an important class of techniques in binary and gray-level image processing applications.

The book provides a valuable collection of applications of machine vision that should stimulate readers to develop solutions to their own image analysis problems. The contributions have been carefully selected and organized so that the presentation of topics flows easily from one chapter to the next. Although the book is an edited selection of contributions, it reads as if it were written by a single author. Readers looking for an up-to-date collection of modern applications of machine vision will be pleased with this volume, and the book can serve as a supplementary text for courses in machine vision by presenting topics in the context of interesting and useful applications.

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