

BOOK REVIEW

Robot Vision. BERTHOLD HORN. MIT Press, Cambridge, Mass., 1986. 509 pp. \$39.50.

This book is an outgrowth of a course on robot vision which Professor Horn teaches at MIT. The book is clearly written and is at a level appropriate for advanced juniors, seniors, and graduate students. The book has about 430 references to the vision literature and 174 figures. Every chapter has exercises, which expand upon material related to that chapter. The exercises are mostly applied mathematics exercises and are not computer vision laboratory or project exercises.

The chapters on binary image processing discuss moments, signatures (projections), runlength coding, and the determination of moments from signatures. These chapters are very well written. The chapter on segmentation is shallow and the only hint about creating a binary image from a gray scale image is the generality of choosing a valley between the histogram modes. More analytic suggestions have been relegated to the exercises.

There are two chapters which discuss topics from linear system theory, Fourier transform, filtering, convolution, correlation, the discrete Fourier transform, and restoration and enhancement. There is one chapter on stereo.

The chapter on edge detection discusses edge detection mainly from the perspective of the Laplacian operator. But Horn redeems himself by recognizing in an exercise that there are better approaches and that the Laplacian approach discussed in the chapter has a relatively poor signal-to-noise ratio.

The chapters on reflectance maps, photometric stereo, the extended Gaussian image, shape from shading, optic flow, and structure from motion are the shining glories of the book. They are superbly written in a consistent notation and reflect a deep fundamental understanding of these topics to which Horn has been an important contributor.

The chapter on pattern classification is quite brief. The chapter on polyhedral objects is a good summary. The chapter on bin picking utilizes a photometric stereo technique to determine surface orientation and orientation histogram (extended Gaussian image) for determining the attitude of the object. To solve the segmentation problem Horn suggests detecting shadows and looking for large estimated surface orientation changes.

The Appendix contains some useful mathematics: vector algebra, vector differentiation, least squares solutions to linear equations, Lagrange multipliers, and the calculus of variations.

Of the 174 figures, the book has 13 figures which contain images either before or after processing. Of these 13 figures, only a few could be understood as being related to images associated with the industrial setting of visually guided robot assembly or inspection. This is a bit of a disappointment for a book whose title is Robot Vision.

The table of contents is: Chapter 1, Introduction; Chapter 2, Image Formation and Image Sensing; Chapter 3, Binary Images: Geometrical Properties; Chapter 4, Binary Images: Topological Properties; Chapter 5, Regions and Image Segmentation; Chapter 6, Image Processing: Continuous Images; Chapter 7, Image Processing:

Discrete Images; Chapter 8, Edges and Edge Finding; Chapter 9, Lightness and Color; Chapter 10, Reflectance Map: Photometric Stereo; Chapter 11, Reflectance Map: Shape from Shading; Chapter 12, Motion Field and Optical Flow; Chapter 13, Photogrammetry and Stereo; Chapter 14, Pattern Classification; Chapter 15, Polyhedral Objects; Chapter 16, Extended Gaussian Images; Chapter 17, Passive Navigation and Structure from Motion; Chapter 18, Picking Parts out of a Bin; and Appendix; Useful Mathematical Techniques.

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