

IV

Image and Video Analysis

Image Representations and Image Models

- 4.1 Computational Models of Early Human Vision** *Lawrence K. Cormack*..... 325
Introduction • The Front End • Early Filtering and Parallel Pathways • The Primary Visual Cortex and Fundamental Properties of Vision • Concluding Remarks • References
- 4.2 Multiscale Image Decompositions and Wavelets** *Pierre Moulin*..... 347
Overview • Pyramid Representations • Wavelet Representations • Other Multiscale Decompositions • Conclusion • Acknowledgment • References
- 4.3 Random Field Models** *P. Fieguth and J. Zhang*..... 361
Introduction • Random Fields — Overview • Multiscale Random Fields • A Nonlinear/Non-Gaussian Model: the Gaussian Mixture • Acknowledgment • References
- 4.4 AM-FM Image Models: Fundamental Techniques and Emerging Trends** *Joseph P. Havlicek, Peter C. Tay and Alan C. Bovik*..... 377
Introduction • Fundamentals of AM-FM Image Modeling • Practical Techniques for AM-FM Image Modeling • Emerging Trends in AM-FM Image Modeling • Conclusion • Acknowledgment • References
- 4.5 Image Noise Models** *Charles Bonchelet*..... 397
Summary • Preliminaries • Elements of Estimation Theory • Types of Noise and Where They Might Occur • CCD Imaging • Speckle • Conclusions • References
- 4.6 Color and Multispectral Image Representation and Display** *H.J. Trussell*..... 411
Introduction • Preliminary Notes on Display of Images • Notation and Prerequisite Knowledge • Analog Images as Physical Functions • Colorimetry • Sampling of Color Signals and Sensors • Color I/O Device Calibration • Summary and Future Outlook • Acknowledgment • References
- 4.7 Statistical Modeling of Photographic Images** *Eero P. Simoncelli*..... 431
Introduction • The Gaussian Model • Wavelet Marginal Models • Wavelet Joint Models • Discussion • References

Image and Video Classifications and Segmentation

- 4.8 Statistical Methods for Image Segmentation** *Sridhar Lakshmanan*..... 443
Introduction • Image Segmentation: The Mathematic Problem • Image Statistics for Segmentation • Statistical Image Segmentation • Discussion • References
- 4.9 Multiband Techniques for Texture Classification and Segmentation** *B.S. Manjunath, G.M. Haley, Wei-Ying Ma, and S.D. Newsam*..... 455
Introduction • Gabor Functions • Microfeature Representation • The Texture Model • Experimental Results • Image Segmentation Using Texture • Image Retrieval Using Texture • Texture Motifs • Summary • Acknowledgments • References
- 4.10 Video Segmentation** *A. Murat Tekalp*..... 471
Introduction • Scene Change Detection • Spatio-Temporal Change Detection • Motion Segmentation • Simultaneous Motion Estimation and Segmentation • Semantic Video Object Segmentation • Examples • Acknowledgments • References
- 4.11 2D and 3D Motion Tracking in Digital Video** *Georgios Stamou, Michail Krinidis, Evangelos Loutas, Nikos Nikolaidis, and Ioannis Pitas*..... 491
Introduction • Rigid Object Tracking • Articulated Object Tracking • Acknowledgment • References

4.12	Adaptive and Neural Methods for Image Segmentation <i>Joydeep Ghosh</i>	519
	Introduction • Artificial Neural Networks • Perceptual Grouping and Edge-Based Segmentation • Adaptive Multi-Channel Modeling for Texture-Based Segmentation • An Optimization Framework • Image Segmentation via Adaptive Clustering • Oscillation-Based Segmentation • Integrated Segmentation and Recognition • Concluding Remarks • Acknowledgments • References	

Edge and Boundary Detection in Images

4.13	Gradient and Laplacian Edge Detection <i>Phillip A. Mlsna, and Jeffrey J. Rodriguez</i>	535
	Introduction • Gradient-based Methods • Laplacian-based Methods • Canny's Method • Approaches for Color and Multispectral Images • Summary • References	

Partial Differential Equation-based Image Processing

4.14	Diffusion Partial Differential Equations for Edge Detection <i>Scott T. Acton</i>	555
	Introduction and Motivation • Background on Diffusion • Anisotropic Diffusion Techniques • Application of Anisotropic Diffusion to Edge Detection • Using Vector Diffusion and Parametric Active Contours to Locate Edges • Conclusions • References	
4.15	Shape Smoothing and PDEs <i>Frédéric Guichard, Lionel Moisan, and Jean-Michel Morel</i>	573
	Principles for Shape Smoothing • Algorithm 1: Dynamic Shape • Algorithm 2: Iterated Weighted Median Filter • Algorithm 3: Heat Equation on Curves • Algorithm 4: Renormalized Heat Equation on Curves • Algorithm 5: Iterated Affine Erosion • Bibliographical Notes • Acknowledgments • References	
4.16	PDEs for Morphological Scale Spaces and Eikonal Applications <i>Petros Maragos</i>	587
	Introduction • Multidimensional Morphological Systems and Slope Transforms • Partial Differential Equations for Morphological Scale Spaces • Curve Evolution, Level Sets, and Morphological Flows • Distance Transforms • Eikonal Partial Differential and Distance Propagation • Applications of Eikonal Partial Differential Equations • Conclusions • Acknowledgments • References	
4.17	Geometric Active Contours for Image Segmentation <i>Vicent Caselles, Ron Kimmel, and Guillermo Sapiro</i>	613
	Introduction • Mathematic Notations and Problem Formulation • From Edge Detectors to Geometric Evolutions • Calculus of Variations for Geometric Measures • Gradient Descent in Level Set Formulation • Efficient Numeric Schemes • Examples • Additional Comments on Related Developments • Summary • Acknowledgments • References	
4.18	Software for Image and Video Processing <i>K. Clint Slatton and Brian L. Evans</i>	629
	Introduction • Algorithm Development Environments • Compiled Libraries. Source Code • Specialized Processing and Visualiza- tion Environments • Other Software • Conclusion • Acknowledgments • References	