Contents

Preface v
Editor vii
Contributors ix

SECTION I Introduction

1.1 Introduction to Digital Image and Video Processing *Alan C. Bovik* 3

SECTION II Basic Image Processing Techniques

2.1 Basic Gray-Level Image Processing *Alan C. Bovik* 21
2.2 Basic Binary Image Processing *Alan C. Bovik* 39
2.3 Basic Tools for Image Fourier Analysis *Alan C. Bovik* 57
2.4 Image Processing Education *Umesh Rajashekar, Alan C. Bovik, Daniel Sage, Michael Unser, Lina J. Karam, and Reginald L. Lagendijk* 73

SECTION III Image and Video Processing

Image and Video Enhancement and Restoration

3.1 Basic Linear Filtering with Application to Image Enhancement *Alan C. Bovik and Scott T. Acton* .. 99
3.2 Nonlinear Filtering for Image Analysis and Enhancement *Gonzalo R. Arce, Jan Bacca, and José L. Paredes* 109
3.3 Morphological Filtering for Image Enhancement and Feature Detection *Petros Maragos* 135
3.4 Wavelet Denoising for Image Enhancement *Dong Wei, Umesh Rajashekar, and Alan C. Bovik* 157
3.5 Basic Methods for Image Restoration and Identification *Reginald L. Lagendijk and Jan Biemond* 167
3.6 Regularization in Image Restoration and Reconstruction *W. Clem Karl* 183
3.7 Multichannel Image Recovery *Nikolas P. Galatsanos, Miles N. Wernick, Aggelos K. Katsaggelos, and Rafael Molina* 203
3.8 Multi-Frame Image Restoration *Timothy J. Schulz* 219
3.9 Iterative Image Restoration *Aggelos K. Katsaggelos and Chun-Jen Tsai* 235
3.10 Motion Detection and Estimation *Janusz Konrad* 253
3.11 Video Enhancement and Restoration *Reginald L. Lagendijk, Peter M.B. van Roosmalen, Jan Biemond, Andrei Rareş, and Marcel J.T. Reinders* 275

Reconstruction from Multiple Images

3.12 Local and Global Stereo Methods *Yang Liu and J.K. Aggarwal* 297
3.13 Image Sequence Stabilization, Mosaicking, and Superresolution *Rama Chellappa, S. Srinivasan, G. Aggarwal, and A. Veeraraghavan* 309

SECTION IV Image and Video Analysis

Image Representations and Image Models

4.1 Computational Models of Early Human Vision *Lawrence K. Cormack* 325
4.2 Multiscale Image Decompositions and Wavelets *Pierre Moulin* 347
4.3 Random Field Models *P. Fieguth, and J. Zhang* 361
4.4 AM-FM Image Models: Fundamental Techniques and Emerging Trends *Joseph P. Havlicek, Peter C. Tay, and Alan C. Bovik* 377
4.5 Image Noise Models *Charles Boncelet* 397
4.6 Color and Multispectral Image Representation and Display *H.J. Trussell* 411
4.7 Statistical Modeling of Photographic Images *Eero P. Simoncelli* 431

Image and Video Classifications and Segmentation

4.8 Statistical Methods for Image Segmentation *Sridhar Lakshmanan* 443
4.9 Multiband Techniques, Texture Classification, and Segmentation *B.S. Manjunath, G.M. Haley, Wei-Ying Ma, and S.D. Newsam* 455
4.10 Video Segmentation *A. Murat Tekalp* 471
4.11 2D and 3D Motion Tracking in Digital Video *Georgios Stamou, Michail Krinidis, Evangelos Loutas, Nikos Nikolaidis, and Ioannis Pitas* 491
4.12 Adaptive and Neural Methods for Image Segmentation *Joydeep Ghosh* 519

Edge and Boundary Detection in Images

4.13 Gradient and Laplacian Edge Detection *Phillip A. Mlsna and Jeffrey J. Rodríguez* 535

Partial Differential Equation-Based Image Processing

4.14 Diffusion Partial Differential Equations for Edge Detection *Scott T. Acton* 555
4.15 Shape Smoothing and PDEs *Frédéric Guichard, Lionel Moisan, and Jean-Michel Morel* 573
4.16 PDEs for Morphological Scale Spaces and Eikonal Applications *Petros Maragos* 587
4.17 Geometric Active Contours for Image Segmentation *Vicent Caselles, Ron Kimmel, and Guillermo Sapiro* 613

Algorithms for Image Processing

4.18 Software for Image and Video Processing *K. Clint Slatton and Brian L. Evans* 629

SECTION V Image Compression

5.1 Lossless Coding *Lina J. Karam* 643
5.2 Block Truncation Coding *Paul Salama, Martha Saenz, and Edward J. Delp* 661
5.3 Fundamentals of Vector Quantization *Mohammad A.U. Khan, and Mark J.T. Smith* 673
5.4 Wavelet Image Compression *Zixiang Xiong and Kannan Ramchandran* 689
5.5 Lossy Image Compression: The JPEG and JPEG2000 Standards *Rashid Ansari, Christine Guillemot, and Nasir Memon* 709
5.6 The JPEG Lossless Image Compression Srandards *Nasir Memon, Christine Guillemot, and Rashid Ansari* 733
5.7 Multispectral Image Coding *Daniel Tretter, Nasir Memon, and Charles Bouman* 747
5.8 Recover Methods for Post Processing for Compressed Images *Yongyi Yang, Nikolas P. Galatsanos, and Aggelos K. Katsaggelos* 761

SECTION VI Video Compression

6.1 Basic Concepts and Techniques of Video Coding and the H.261 Standard *Barry Barnett* 777
6.2 Interframe Subband/Wavelet Scalable Video Coding *John W. Woods, Peison Chen, Yongjun Wu, and Shih-Ta Hsiang* 799
6.3 Digital Video Transcoding *Shizhong Liu and Alan C. Bovik* 819
6.4 MPEG-1 and MPEG-2 Video Standards *Supavadee Aramvith and Ming-Ting Sun* 833
6.5 MPEG-4, H.264/AVC, and MPEG-7: New Standards for the Digital Video Industry *Berna Erol, Adriana Dumitraş, Faouzi Kossentini, Anthony Joch, and Gary Sullivan* 849
6.6 Embedded Video Codecs *Minhua Zhou and Raj Talluri* 877

SECTION VII Image and Video Acquisition

7.1 Image Scanning, Sampling, and Interpolation *Jan P. Allebach* 895
7.2 Video Sampling and Interpolation *Eric Dubois* 911

SECTION VIII Image and Video Rendering and Assessment

8.1 Image Quantization, Halftoning, and Printing *Ping Wah Wong* 925
8.2 Perceptual Criteria for Image Quality Evaluation *Thrasyvoulos N. Pappas, Robert J. Safranek, and Junqing Chen* 939
8.3 Structural Approaches to Image Quality Assessment *Zhou Wang, Alan C. Bovik, and Eero P. Simoncelli* 961
8.4 Information Theoretic Approaches to Image Quality Assessment *Hamid R. Sheikh and Alan C. Bovik* 975

SECTION IX Image and Video Storage, Retrieval, and Communication

9.1 Image and Video Indexing and Retrieval *Michael A. Smith and Tsuhan Chen* 993
9.2 A Unified Framework for Video Summerization Browsing, and Retrieval *Ziyou Xiong, Yong Rui, Regunathan Radhakrishnan, Ajay Divakaran, and Thomas S. Huang* 1013
9.3 Video Communication Networks *Dan Schonfeld* 1031
9.4 Wireless Video *Fan Zhai, Yiftach Eisenberg, and Aggelos K. Katsaggelos* 1065
9.5 Watermarking Techniques for Image Authentication and Copyright Protection *Anastasios Tefas, Nikos Nikolaidis, and Ioannis Pitas* 1083
9.6 Visual Cryptography: The Combinatorial and Halftonning Frameworks *Gonzalo Arce, Giovanni Di Crescenzo, and Zhi Zhou* 1111

SECTION X Applications of Image Processing

10.1 Synthetic Aperture Radar Algorithms *Ron Goodman and Walter Carrara* 1131
10.2 Computed Tomography *R.M. Leahy and R. Clackdoyle* 1155
10.3 Cardiac Image Processing *Joseph M. Reinhardt and William E. Higgins* 1175
10.4 Computer-Aided Detection and Diagnosis in Mammography *Mehul P. Sampat, Mia K. Markey, and Alan C. Bovik* 1195
10.5 Fingerprint Classification and Matching *Anil Jain and Sharath Pankanti* 1219

10.6 Face Recognition from Still Images and Videos *Shaohua Kevin Zhou and Rama Chellappa* 1235
10.7 How Iris Recognition Works *John Daugman* 1251
10.8 Exploiting Visual Information in Automatic Speech Processing *Petar S. Aleksic, Gerasimos Potamianos, and Aggelos K. Katsaggelos* 1263
10.9 Confocal Microscopy *Fatima A. Merchant, Keith A. Bartels, Alan C. Bovik, and Kenneth R. Diller* 1291
10.10 Computer-Assisted Microscopy *Fatima A. Merchant and Kenneth R. Castleman* 1311
10.11 Statistical Models for Bayesian Object Recognition *Anuj Srivastava, Michael I. Miller, and Ulf Grenander* 1341

Index 1355