

Contents

Preface xi

Acknowledgments xiii

1 Introduction to Electronic Image Processing 1

- 1.1 Historical Background 1
- 1.2 Applications of Image Processing 9
- 1.3 Introduction to Visual Perception 13
- 1.4 Image Formation 25
- 1.5 Sampling and Quantization 26
- 1.6 Image Neighbors and Distances 34
- 1.7 Typical Image Processing Systems 37

2 Transforms Used in Electronic Image Processing 40

- 2.1 The Fourier Series 40
- 2.2 The One-Dimensional Fourier Transform 44
- 2.3 The Two-Dimensional Fourier Transform 48
- 2.4 Important Functions Relating to the Fourier Transform 51
- 2.5 The Discrete Fourier Transform 55
- 2.6 Example and Properties of the Discrete Fourier Transform 59
- 2.7 Computation of the Discrete Fourier Transform 69
- 2.8 Other Image Transforms 71

3	Image Enhancement by Point Operations	90
3.1	An Overview of Point Processing	90
3.2	Constant and Nonlinear Operations	93
3.3	Operations Between Images	102
3.4	Histogram Techniques	109
4	Spatial Filtering and Fourier Frequency Methods	121
4.1	Various Types of Noise That Appear in Images	121
4.2	Spatial Filtering	129
4.3	Spatial Frequency Filtering	144
4.4	Image Restoration	158
5	Nonlinear Image Processing Techniques	173
5.1	Nonlinear Spatial Filters Based on Order Statistics	173
5.2	Nonlinear Mean Filters	197
5.3	Adaptive Filters	208
5.4	The Homomorphic Filter	221
6	Color Image Processing	228
6.1	Color Fundamentals	229
6.2	Color Models	237
6.3	Examples of Color Image Processing	276
6.4	Pseudocoloring and Color Displays	288
7	Image Geometry and Morphological Filters	294
7.1	Spatial Interpolation	294
7.2	Image Geometry	299
7.3	Binary Morphology—Dilation and Erosion	316
7.4	Binary Morphology—Opening, Closing, Edge Detection, and Skeletonization	333
7.5	Binary Morphology—Hit-Miss, Thinning, Thickening, and Pruning	347
7.6	Binary Morphology—Granulometries and the Pattern Spectrum	359
7.7	Graylevel Morphology	367

8 Image Segmentation and Representation 387

8.1 Image Thresholding 388

8.2 Edge, Line, and Point Detection 414

8.3 Region Based Segmentation 440

8.4 Image Representation 452

9 Image Compression 471

9.1 Compression Fundamentals 471

9.2 Error-Free Compression Methods 483

9.3 Lossy Compression Methods 522

Bibliography 548

Index 557