

Contents

Preface	xvii
Author	xix
Chapter 1 Introduction	1
1.1 Image Basics	2
1.1.1 Image Representation and Display	2
1.1.2 Spatial Resolution and Amplitude Resolution	5
1.1.3 Image Quality	7
1.1.4 Half-Tone and Dithering Technology	11
1.2 Image Technology	16
1.2.1 Image Engineering	16
1.2.2 Classification of Image Technology	17
1.2.3 Image Processing System	18
1.3 Characteristics of This Book	19
1.3.1 Writing Motivation	19
1.3.2 Material Selection and Contents	20
1.3.3 Structure and Arrangement	22
1.4 References	23
Chapter 2 Image De-Noising	25
2.1 Noise Types and Characteristics	26
2.1.1 Different Noises	26
2.1.2 Noise Characteristics and Description	29
2.2 Image Enhancement and De-Noising	32
2.2.1 Spatial Noise Filter	33
2.2.2 Frequency Domain Periodic Noise Filter	41
2.3 Selective Filter	45
2.4 Switching Median Filter	48
2.4.1 The Principle of Switching Median Filter	48
2.4.2 Switch-Based Adaptive Weighted Mean Filter	52
2.4.3 Further Improvements	55
2.5 Some Recent Developments and Further Researches	58
2.5.1 Non-Switching Random Impulse Noise Cancellation	58
2.5.2 De-Noise Feature Extraction	59
2.5.3 Strong Noisy Image De-Noising	60
2.5.4 Classify Noise Filtering Results in Seismic Images	61
2.6 References	62
Chapter 3 Image De-Blurring	63
3.1 Overview of Image De-Blurring	64
3.1.1 General Image Degradation Model	64
3.1.2 Blurring Degradation	66
3.1.3 Blur Kernel Estimation	68
3.2 Image Restoration and De-Blurring	70
3.2.1 Inverse Filtering	71
3.2.2 Wiener Filtering	76
3.2.3 Constrained Least Squares Restoration	79
3.2.4 Interactive Restoration	79
3.3 Estimating Motion Blur Kernel	82
3.3.1 Fast Blind Deconvolution	82
3.3.2 CNN-Based Method	86
3.4 Low-Resolution Image De-Blurring	90
3.4.1 Network Structure	92

3.4.2	Loss Function Design and Effects	94
3.4.3	Multi-Class Generative Adversarial Network	97
3.5	Some Recent Developments and Further Researches	99
3.5.1	Various De-Blurring Approaches	100
3.5.2	Treating Blurred Images in Applications	104
3.6	References	109
Chapter 4	Image Repairing	111
4.1	Image Repairing Overview	112
4.1.1	Discrimination and Analysis of Image Repairing	112
4.1.2	Principle of Image Repairing	115
4.1.3	Image Inpainting for Small-Scale Repairing	117
4.1.4	Image Completion for Large-Scale Repairing	120
4.2	Algorithms Combined with Sparse Representation	123
4.2.1	Principle of Sparse Representation	123
4.2.2	Basic Sparse Representation Algorithm	125
4.2.3	Improvements for Sparse Representation Algorithm	127
4.3	Weighted Sparse Non-Negative Matrix Factorization	131
4.3.1	Weighted Non-Negative Matrix Factorization	131
4.3.2	Filling Algorithm	132
4.3.3	WSNMF Based on EM process	134
4.4	Context-Driven Hybrid Approach	135
4.4.1	Overall Flowchart	136
4.4.2	Pre-Processing Step	137
4.4.3	Sample-Based Repairing Step	138
4.4.4	Diffusion-Based Repairing Step	140
4.5	Some Recent Developments and Further Researches	140
4.5.1	Categorization of Repairing Methods	140
4.5.2	AE and GAN in Image Repairing	141
4.6	References	144
Chapter 5	Image De-Fogging	147
5.1	Summary of Image De-Fogging Approaches	149
5.1.1	Methods Based on Image Enhancement	149
5.1.2	Methods Based on Image Restoration	151
5.2	Dark Channel Prior De-Fogging Algorithm	152
5.2.1	Atmospheric Scattering Model	152
5.2.2	Dark Channel Prior Model	154
5.2.3	Some Practical Problems	155
5.3	Improvement Ideas and Techniques	156
5.3.1	Determination of Global Atmospheric Light Region	156
5.3.2	Global Atmospheric Light Value Correction	158
5.3.3	Scale Adaptation	160
5.3.4	Atmospheric Transmittance Estimation	163
5.3.5	Dense Foggy Image De-Fogging	165
5.4	Integrated Algorithm for Reducing Distortion	169
5.4.1	Algorithm Flowchart	169
5.4.2	T Space Conversion	170
5.4.3	Atmospheric Scattering Map in Transmittance Space	171
5.4.4	Sky Region Detection	172
5.4.5	Contrast Enhancement	173
5.5	Evaluation of De-Fogging Effects	174
5.5.1	Objective Evaluation Index	175
5.5.2	Examples of Evaluations Combining Subjective and Objective Indices	179
5.6	Some Recent Developments and Further Researches	183
5.6.1	Night-Time Fog Removal	183
5.6.2	More General Fog Removal Techniques	186
5.7	References	188
Chapter 6	Image Reconstruction from Projection	193

6.1	Projection Reconstruction Forms	194
6.1.1	Transmission Tomography	195
6.1.2	Emission Tomography	196
6.1.3	Reflection Tomography	198
6.1.4	Electrical Impedance Tomography	200
6.1.5	Magnetic Resonance Imaging	201
6.2	Principles of Reconstruction from Projection	202
6.2.1	Basic Model	202
6.2.2	Radon Transform	203
6.3	Inverse Fourier Transform Reconstruction	204
6.3.1	The Basic Steps and Definitions	204
6.3.2	Fourier Transform Projection Theorem	205
6.3.3	Model Reconstruction	206
6.4	Back-Projection Reconstruction	208
6.4.1	Principles of Back-Projection Reconstruction	208
6.4.2	Convolutional Back-Projection Reconstruction	210
6.4.3	Other Back-Projection Reconstruction Methods	216
6.5	Iterative Reconstruction	220
6.5.1	Iterative Reconstruction Model	220
6.5.2	Algebraic Reconstruction Technique	221
6.5.3	Maximum Likelihood-Maximum Expectation Reconstruction Algorithm	225
6.6	Combined Reconstruction	228
6.7	Some Recent Developments and Further Researches	229
6.7.1	Metal Artifact Reduction	229
6.7.2	4-D Cone-Beam CT Reconstruction	234
6.8	References	238
Chapter 7	Image Watermarking	241
7.1	Overview of Watermarking	243
7.1.1	Embedding and Detection of Watermark	243
7.1.2	Watermark Characteristics	244
7.1.3	Watermark Classification	247
7.2	Watermark Measurement Index	249
7.2.1	Saliency/Perception Measurement	250
7.2.2	Robustness Measurement	252
7.2.3	Security and Watermark Attack	253
7.3	DCT Domain Watermarking	255
7.3.1	Features and Principles	255
7.3.2	Meaningless Watermarking Algorithm	256
7.3.3	Meaningful Watermarking Algorithm	260
7.4	DWT Domain Watermarking	264
7.4.1	Features and Process	264
7.4.2	Human Visual Characteristics	265
7.4.3	Wavelet Watermarking Algorithm	269
7.5	Some Recent Developments and Further Researches	272
7.5.1	Zero-Watermarking	272
7.5.2	More Extensive Watermarking Technology	279
7.6	References	284
Chapter 8	Image Super-Resolution	287
8.1	Principle of Image Super-Resolution	288
8.1.1	Basic Model and Technology Classification	288
8.1.2	Super-Resolution Restoration Based on Single Image	292
8.1.3	Super-Resolution Reconstruction Based on Multiple Images	294
8.2	Super-resolution Technology Based on Learning	297
8.2.1	Conventional Process	297
8.2.2	Example-Based Single-Frame Super-Resolution	298
8.2.3	Example-Based Multi-Frame Super-Resolution	302
8.2.4	Method Combined with Total Variation Regularization	304
8.2.5	Learning-Based Method	305

8.3	Super-resolution Reconstruction Based on Sparse Representation	306
8.3.1	Reconstruction Process	306
8.3.2	Sparse Coding	307
8.3.3	Dictionary Learning	308
8.3.4	Image Reconstruction	308
8.4	Super-resolution Reconstruction Based on Locally Constrained Linear Coding	309
8.4.1	Locally Constrained Linear Coding	309
8.4.2	Super-Resolution Reconstruction Algorithm Based on Locally Constrained Linear Coding	310
8.4.3	Multi-Mrame Image Super-Resolution Reconstruction	311
8.4.4	Reconstruction Results and Method Comparison	312
8.5	Some Recent Developments and Further Researches	315
8.5.1	Overview of Super-Resolution Based on Deep Learning	315
8.5.2	Loss Functions and Evaluation Indicators	319
8.6	References	322
	Index	325