

Contents

Part I Image Fundamentals

- 1 Image Basics {324}
 - 1.1 Basic Concepts of Image {31}
 - 1.1.1 Image and Image Space {16}
 - 1.1.2 Digital Image and Computer-Generated Image {15}
 - 1.2 Image Decomposition {46}
 - 1.2.1 Image Decomposition {11}
 - 1.2.2 Pixel and Voxel {17}
 - 1.2.3 Various Elements {18}
 - 1.3 All Kinds of Image {74}
 - 1.3.1 Images with Different Wavelengths {19}
 - 1.3.2 Different Dimensional Images {16}
 - 1.3.3 Color Image {20}
 - 1.3.4 Images for Different Applications {19}
 - 1.4 Special Attribute Images {109}
 - 1.4.1 Images with Various Properties {16}
 - 1.4.2 Image with Specific Attribute {20}
 - 1.4.3 Depth Images {14}
 - 1.4.4 Image with Variant Sources {19}
 - 1.4.5 Processing Result Image {20}
 - 1.4.6 Others {20}
 - 1.5 Image Representation {47}
 - 1.5.1 Representation {9}
 - 1.5.2 Image Property {19}
 - 1.5.3 Image Resolution {19}
 - 1.6 Image Quality {17}
- 2 Image Engineering {160}
 - 2.1 Image Engineering Technology {40}
 - 2.1.1 Image Engineering {11}
 - 2.1.2 Image Processing {16}
 - 2.1.3 Image Analysis {6}
 - 2.1.4 Image Understanding {7}
 - 2.2 Similar Disciplines {64}
 - 2.2.1 Computer Vision {16}
 - 2.2.2 Machine Vision {11}
 - 2.2.3 Computer Graphics {20}
 - 2.2.4 Light Field {17}
 - 2.3 Related Subjects {56}
 - 2.3.1 Fractals {14}
 - 2.3.2 Topology {14}
 - 2.3.3 Virtual Reality {10}
 - 2.3.4 Others {18}
- 3 Image Acquisition Devices {436}
 - 3.1 Device Parameters {49}
 - 3.1.1 Camera Parameters {18}
 - 3.1.2 Camera Motion Description {16}
 - 3.1.3 Camera Operation {15}
 - 3.2 Sensors {72}
 - 3.2.1 Sensor Models {16}
 - 3.2.2 Sensor Characteristics {17}
 - 3.2.3 Image Sensors {14}
 - 3.2.4 Specific Sensors {12}
 - 3.2.5 Commonly Used Sensors {13}
 - 3.3 Cameras and Camcorders {88}
 - 3.3.1 Conventional Cameras {18}
 - 3.3.2 Camera Models {15}
 - 3.3.3 Special Structure Cameras {20}
 - 3.3.4 Special Purpose Cameras {21}

3.3.5 Camera Systems {14}	
3.4 Camera Calibration {49}	3.4.1 Calibration Basics {17}
3.4.2 Various Calibration Techniques {18}	
3.4.3 Internal and External Camera Calibration {14}	
3.5 Lens {85}	3.5.1 Lens Model {16}
3.5.2 Lens Types {20}	
3.5.3 Lens Characteristics {17}	
3.5.4 Focal Length of Lens {16}	
3.5.5 Lens Aperture and Diaphragm {16}	
3.6 Lens Aberration {31}	3.6.1 Lens Distortions {15}
3.6.2 Chromatic Aberration {16}	
3.7 Other Equipment and Devices {62}	3.7.1 Input Devices {17}
3.7.2 Filters {14}	
3.7.3 Microscopes {11}	
3.7.4 RADAR {10}	
3.7.5 Other Devices {10}	
4 Image Acquisition Modes {381}	4.1 Imaging and Acquisition {157}
4.1.1 Image Capture {20}	
4.1.2 Field of View {18}	
4.1.3 Camera Models {16}	
4.1.4 Imaging Methods {18}	
4.1.5 Spectral Imaging {13}	
4.1.6 Coordinate Systems {12}	
4.1.7 Imaging Coordinate Systems {16}	
4.1.8 Focal Length and Depth {14}	
4.1.9 Exposure {15}	
4.1.10 Holography and View {15}	
4.2 Stereo Imaging {57}	
4.2.1 General Methods {13}	
4.2.2 Binocular Stereo Imaging {12}	
4.2.3 Special Methods {17}	
4.2.4 Structured Light {15}	
4.3 Light Source and Lighting {81}	
4.3.1 Light and Lamps {16}	
4.3.2 Light Source {15}	
4.3.3 Lighting {19}	
4.3.4 Illumination {17}	
4.3.5 Illumination Field {14}	
4.4 Perspective and Projection {62}	
4.4.1 Perspective {14}	
4.4.2 Perspective Projection {17}	
4.4.3 Projective Imaging {18}	
4.4.4 Various Projections {13}	
4.5 Photography and Photogrammetry {24}	
4.5.1 Photography {13}	
4.5.2 Photogrammetry {11}	
5 Image Digitization {83}	
5.1 Sampling and Quantization {44}	
5.1.1 Sampling Theorem {21}	
5.1.2 Sampling Techniques {17}	
5.1.3 Quantization {6}	
5.2 Digitization Scheme {39}	
5.2.1 Digitization {20}	
5.2.2 Digitizing Grid {19}	
6 Image Display and Printing {71}	

6.1	Display {35}
6.1.1	Image Display {16}
6.1.2	Display Devices {19}
6.2	Printing {36}
6.2.1	Printing Devices {10}
6.2.2	Printing Techniques {12}
6.2.3	Halftoning Techniques {14}
7	Image Storage and Communication {50}
7.1	Storage and Communication {22}
7.1.1	Image Storage {12}
7.1.2	Image Communication {10}
7.2	Image File Format {28}
7.2.1	Bitmap Images {14}
7.2.2	Various Formats {14}
8	Related Knowledge {370}
8.1	Basic Mathematics {169}
8.1.1	Analytic and Differential Geometry {13}
8.1.2	Functions {18}
8.1.3	Matrix Decomposition {16}
8.1.4	Set Theory {14}
8.1.5	Least Squares {16}
8.1.6	Regression {19}
8.1.7	Linear Operations {15}
8.1.8	Complex Plane and Half-Space {19}
8.1.9	Norms and Variations {20}
8.1.10	Miscellaneous {19}
8.2	Statistics and Probability {118}
8.2.1	Statistics {18}
8.2.2	Probability {17}
8.2.3	Probability Density {19}
8.2.4	Probability Distributions {18}
8.2.5	Distribution Functions {14}
8.2.6	Gaussian Distribution {17}
8.2.7	More Distributions {15}
8.3	Signal Processing {50}
8.3.1	Basic Concepts {16}
8.3.2	Signal Responses {18}
8.3.3	Convolution and Frequency {16}
8.4	Tools and Means {33}
8.4.1	Hardware {10}
8.4.2	Software {11}
8.4.3	Diverse Terms {12}

Part II Image Processing

9	Pixel Spatial Relationship {175}
9.1	Adjacency and Neighborhood {49}
9.1.1	Spatial Relationship Between Pixels {12}
9.1.2	Neighborhood {19}
9.1.3	Adjacency {18}
9.2	Connectivity and Connected {42}
9.2.1	Pixel Connectivity {13}
9.2.2	Pixel-Connected {20}
9.2.3	Path {9}
9.3	Connected Components and Regions {29}
9.3.1	Image Connectedness {18}
9.3.2	Connected Region in Image {11}
9.4	Distance {55}
9.4.1	Discrete Distance {20}
9.4.2	Distance Metric {11}
9.4.3	Geodesic Distance {13}

9.4.4	Distance Transform {11}
10	Image Transforms {231}
10.1	Transformation and Characteristics {30}
10.1.1	Transform and Transformation {18}
10.1.2	Transform Properties {12}
10.2	Walsh-Hadamard Transform {26}
10.2.1	Walsh Transform {17}
10.2.2	Hadamard Transform {9}
10.3	Fourier Transform {66}
10.3.1	Variety of Fourier Transform {15}
10.3.2	Frequency Domain {16}
10.3.3	Theorem and Property of Fourier Transform {18}
10.3.4	Fourier Space {17}
10.4	Discrete Cosine Transform {8}
10.5	Wavelet Transform {43}
10.5.1	Wavelet Transform and Property {13}
10.5.2	Expansion and Decomposition {11}
10.5.3	Various Wavelets {19}
10.6	Karhunen-Loëve Transform {40}
10.6.1	Hotelling Transform {20}
10.6.2	Principal Component Analysis {20}
10.7	Other Transforms {18}
11	Point Operations for Spatial Domain Enhancement {249}
11.1	Fundamentals of Image Enhancement {42}
11.1.1	Image Enhancement {8}
11.1.2	Intensity Enhancement {10}
11.1.3	Contrast Enhancement {12}
11.1.4	Operator {12}
11.2	Coordinate Transformation {87}
11.2.1	Spatial Coordinate Transformation {13}
11.2.2	Image Transformation {8}
11.2.3	Homogeneous Coordinates {8}
11.2.4	Hierarchy of Transformation {13}
11.2.5	Affine Transformation {13}
11.2.6	Rotation Transformation {17}
11.2.7	Scaling Transformation {7}
11.2.8	Other Transformation {8}
11.3	Inter-image Operations {34}
11.3.1	Image Operation {6}
11.3.2	Arithmetic Operations {18}
11.3.3	Logic Operations {10}
11.4	Image Gray-Level Mapping {38}
11.4.1	Mapping {9}
11.4.2	Contrast Manipulation {7}
11.4.3	Logarithmic and Exponential Functions {15}
11.4.4	Other Functions {7}
11.5	Histogram Transformation {48}
11.5.1	Histogram {13}
11.5.2	Histogram Transformation {12}
11.5.3	Histogram Modification {14}
11.5.4	Histogram Analysis {9}
12	Mask Operations for Spatial Domain Enhancement {175}
12.1	Spatial Domain Enhancement Filtering {37}
12.1.1	Spatial Domain Filtering {19}
12.1.2	Spatial Domain Filters {18}
12.2	Mask Operation {35}
12.2.1	Mask {20}
12.2.2	Operator {15}
12.3	Linear Filtering {39}
12.3.1	Linear Smoothing {15}

12.3.2	Averaging and Mean {14}
12.3.3	Linear Sharpening {10}
12.4	Nonlinear Filtering {42}
12.4.1	Nonlinear Smoothing {17}
12.4.2	Mid-point, Mode, and Median {15}
12.4.3	Nonlinear Sharpening {10}
12.5	Gaussian Filter {22}
12.5.1	Gaussian {17}
12.5.2	Laplacian of Gaussian {5}
13	Frequency Domain Filtering {76}
13.1	Filter and Filtering {26}
13.1.1	Basic of Filters {11}
13.1.2	Various Filters {15}
13.2	Frequency Domain Filters {50}
13.2.1	Filtering Techniques {10}
13.2.2	Low-Pass Filters {10}
13.2.3	High-Pass Filters {9}
13.2.4	Band-Pass Filters {9}
13.2.5	Band-Reject Filters {6}
13.2.6	Homomorphic Filters {6}
14	Image Restoration {215}
14.1	Fundamentals of Image Restoration {56}
14.1.1	Basic Concepts {18}
14.1.2	Basic Techniques {13}
14.1.3	Simulated Annealing {10}
14.1.4	Regularization {15}
14.2	Degradation and Distortion {46}
14.2.1	Image Degradation {19}
14.2.2	Image Geometric Distortion {7}
14.2.3	Image Radiometric Distortion {20}
14.3	Noise and Denoising {91}
14.3.1	Noise Models {15}
14.3.2	Noise Sources {15}
14.3.3	Distribution {17}
14.3.4	Impulse Noise {10}
14.3.5	Some Typical Noises {20}
14.3.6	Image Denoising {14}
14.4	Filtering Restoration {22}
14.4.1	Unconstrained and Constrained {10}
14.4.2	Harmonic and Anisotropic {12}
15	Image Repair and Recovery {83}
15.1	Image Inpainting {8}
15.2	Image Completion {10}
15.3	Smog and Haze Elimination {25}
15.3.1	Defogging and Effect {14}
15.3.2	Atmospheric Scattering Model {11}
15.4	Geometric Distortion Correction {40}
15.4.1	Geometric Transformation {17}
15.4.2	Grayscale Interpolation {14}
15.4.3	Linear Interpolation {9}
16	Image Reconstruction from Projection {101}
16.1	Principle of Tomography {57}
16.1.1	Tomography {15}
16.1.2	Computational Tomography {25}
16.1.3	Historical Development {17}
16.2	Reconstruction Methods {14}
16.3	Back-Projection Reconstruction {9}
16.4	Reconstruction Based on Series Expansion {21}
16.4.1	Algebraic Reconstruction Technique {11}
16.4.2	Iterative Back-Projection {10}

17	Image Coding {213}
17.1	Coding and Decoding {83}
17.1.1	Coding and Decoding {17}
17.1.2	Coder and Decoder {14}
17.1.3	Source coding {13}
17.1.4	Data Redundancy and Compression {19}
17.1.5	Coding Types {20}
17.2	Coding Theorem and Property {31}
17.2.1	Coding Theorem {12}
17.2.2	Coding Property {19}
17.3	Entropy Coding {18}
17.3.1	Entropy of Image {5}
17.3.2	Variable-Length Coding {13}
17.4	Predictive Coding {20}
17.4.1	Lossless and Lossy {12}
17.4.2	Predictor and Quantizer {8}
17.5	Transform Coding {10}
17.6	Bit Plane Coding {19}
17.7	Hierarchical Coding {13}
17.8	Other Coding Methods {19}
18	Image Watermarking {156}
18.1	Watermarking {74}
18.1.1	Watermarking Overview {18}
18.1.2	Watermarking Embedding {16}
18.1.3	Watermarking Property {20}
18.1.4	Auxiliary Information {9}
18.1.5	Cover and Works {11}
18.2	Watermarking Techniques {38}
18.2.1	Technique Classification {13}
18.2.2	Various Watermarking Techniques {20}
18.2.3	Transform Domain Watermarking {5}
18.3	Watermarking Security {44}
18.3.1	Security {17}
18.3.2	Watermarking Attacks {17}
18.3.3	Unauthorized Attacks {10}
19	Image Information Security {45}
19.1	Image Authentication and Forensics {13}
19.1.1	Image Authentication {9}
19.1.2	Image Forensics {4}
19.2	Image Hiding {32}
19.2.1	Information Hiding {6}
19.2.2	Image Blending {7}
19.2.3	Cryptography {10}
19.2.4	Other Techniques {9}
20	Color Image Processing {253}
20.1	Colorimetry and Chromaticity Diagram {86}
20.1.1	Colorimetry {19}
20.1.2	Color Chart {15}
20.1.3	Primary and Secondary Color {10}
20.1.4	Color Mixing {16}
20.1.5	Chromaticity Diagram {13}
20.1.6	Diagram Parts {13}
20.2	Color Spaces and Models {76}
20.2.1	Color Models {16}
20.2.2	RGB-Based Models {18}
20.2.3	Visual Perception Models {14}
20.2.4	CIE Color Models {10}
20.2.5	Other Color Models {18}
20.3	Pseudo-color Processing {19}
20.3.1	Pseudo-color Enhancement {8}

20.3.2 Pseudo-Color Transform {11}
20.4 True Color Processing {72}
20.4.1 True Color Enhancement {15}
20.4.2 Saturation and Hue Enhancement {18}
20.4.3 False Color Enhancement {6}
20.4.4 Color Image Processing {14}
20.4.5 Color Ordering and Edges {10}
20.4.6 Color Image Histogram {9}
21 Video Image Processing {191}
21.1 Video {70}
21.1.1 Analog and Digital Video {16}
21.1.2 Various Video {15}
21.1.3 Video Frame {15}
21.1.4 Video Scan and Display {10}
21.1.5 Video Display {14}
21.2 Video Terminology {35}
21.2.1 Video Terms {16}
21.2.2 Video Processing and Techniques {19}
21.3 Video Enhancement {31}
21.3.1 Video Enhancement {12}
21.3.2 Motion-Based Filtering {11}
21.3.3 Block Matching {8}
21.4 Video Coding {40}
21.4.1 Video Codec {16}
21.4.2 Intra-frame Coding {7}
21.4.3 Inter-frame Coding {17}
21.5 Video Computation {15}
21.5.1 Image Sequence {6}
21.5.2 Video Analysis {9}
22 Multi-resolution Image {75}
22.1 Multi-resolution and Super-Resolution {24}
22.1.1 Multi-resolution {16}
22.1.2 Super-Resolution {8}
22.2 Multi-scale Images {26}
22.2.1 Multi-scales {13}
22.2.2 Multi-scale Space {7}
22.2.3 Multi-scale Transform {6}
22.3 Image Pyramid {25}
22.3.1 Pyramid Structure {18}
22.3.2 Gaussian and Laplacian Pyramids {7}

Part III Image Analysis

23 Segmentation Introduction {195}
23.1 Segmentation Overview {61}
23.1.1 Segmentation Definition {16}
23.1.2 Object and Background {12}
23.1.3 Method Classification {14}
23.1.4 Various Strategies {19}
23.2 Primitive Unit Detection {60}
23.2.1 Point Detection {20}
23.2.2 Corner Detection {20}
23.2.3 Line Detection {13}
23.2.4 Curve Detection {7}
23.3 Geometric Unit Detection {50}
23.3.1 Bar Detection {8}
23.3.2 Circle and Ellipse Detection {10}
23.3.3 Object Contour {13}
23.3.4 Hough Transform {19}
23.4 Image Matting {24}
23.4.1 Matting Basics {9}

23.4.2	Matting Techniques {15}
24	Edge Detection {157}
24.1	Principle {25}
24.1.1	Edge Detection {17}
24.1.2	Sub-pixel Edge {8}
24.2	Various Edges {28}
24.2.1	Type of Edge {13}
24.2.2	Edge Description {15}
24.3	Gradients and Gradient Operators {57}
24.3.1	Gradient Computation {9}
24.3.2	Differential Edge Detector {13}
24.3.3	Gradient Operators {12}
24.3.4	Particle Gradient Operators {12}
24.3.5	Orientation Detection {11}
24.4	High-Order Detectors {47}
24.4.1	Second-Derivative Detectors {20}
24.4.2	Gaussian-Laplacian Detectors {11}
24.4.3	Other Detectors {16}
25	Object Segmentation Methods {245}
25.1	Parallel-Boundary Techniques {40}
25.1.1	Boundary Segmentation {15}
25.1.2	Boundary Points {13}
25.1.3	Boundary Thinning Techniques {12}
25.2	Sequential-Boundary Techniques {90}
25.2.1	Basic Techniques {7}
25.2.2	Graph Search {19}
25.2.3	Active Contour {13}
25.2.4	Snake {18}
25.2.5	General Active Contour {13}
25.2.6	Graph Cut {20}
25.3	Parallel-Region Techniques {58}
25.3.1	Thresholding {17}
25.3.2	Global Thresholding Techniques {12}
25.3.3	Local Thresholding Techniques {13}
25.3.4	Clustering and Mean Shift {16}
25.4	Sequential-Region Techniques {40}
25.4.1	Region Growing {18}
25.4.2	Watershed {12}
25.4.3	Level Set {10}
25.5	More Segmentation Techniques {17}
26	Segmentation Evaluation {64}
26.1	Evaluation Scheme and Framework {13}
26.2	Evaluation Methods and Criteria {46}
26.2.1	Analytical Methods and Criteria {11}
26.2.2	Empirical Goodness Methods and Criteria {12}
26.2.3	Empirical Discrepancy Methods and Criteria {14}
26.2.4	Empirical Discrepancy of Pixel Numbers {9}
26.3	Systematic Comparison and Characterization {5}
27	Object Representation {188}
27.1	Object Representation Methods {28}
27.1.1	Object Representation {20}
27.1.2	Spline {8}
27.2	Boundary-Based Representation {85}
27.2.1	Boundary Representation {16}
27.2.2	Boundary Signature {11}
27.2.3	Curve Representation {13}
27.2.4	Parametric Curve {16}
27.2.5	Curve Fitting {14}
27.2.6	Chain Codes {15}
27.3	Region-Based Representation {75}

27.3.1	Polygon {14}
27.3.2	Surrounding Region {20}
27.3.3	Medial Axis Transform {18}
27.3.4	Skeleton {9}
27.3.5	Region Decomposition {14}
28	Object Description {159}
28.1	Object Description Methods {32}
28.1.1	Object Description {16}
28.1.2	Feature Description {16}
28.2	Boundary-Based Description {32}
28.2.1	Boundary {17}
28.2.2	Curvature {15}
28.3	Region-Based Description {40}
28.3.1	Region Description {20}
28.3.2	Moment Description {20}
28.4	Descriptions of Object Relationship {22}
28.4.1	Object Relationship {16}
28.4.2	Image Topology {16}
28.5	Attributes {16}
28.6	Object Saliency {17}
29	Feature Measurement and Error Analysis {110}
29.1	Feature Measurement {59}
29.1.1	Metric {10}
29.1.2	Object Measurement {19}
29.1.3	Local Invariance {15}
29.1.4	More Invariance {15}
29.2	Accuracy and Precision {18}
29.3	Error Analysis {33}
29.3.1	Measurement Error {17}
29.3.2	Residual and Error {16}
30	Texture Analysis {174}
30.1	Texture Overview {42}
30.1.1	Texture {10}
30.1.2	Texture Elements {9}
30.1.3	Texture Analysis {14}
30.1.4	Texture Models {9}
30.2	Texture Feature and Description {29}
30.2.1	Texture Features {14}
30.2.2	Texture Description {15}
30.3	Statistical Approach {28}
30.3.1	Texture Statistics {15}
30.3.2	Co-occurrence Matrix {13}
30.4	Structural Approach {19}
30.4.1	Structural Texture {13}
30.4.2	Local Binary Pattern {6}
30.5	Spectrum Approach {12}
30.6	Texture Segmentation {12}
30.7	Texture Composition {32}
30.7.1	Texture Categorization {15}
30.7.2	Texture Generation {17}
31	Shape Analysis {175}
31.1	Shape Overview {26}
31.1.1	Shape {6}
31.1.2	Shape Analysis {20}
31.2	Shape Representation and Description {43}
31.2.1	Shape Representation {13}
31.2.2	Shape Model {10}
31.2.3	Shape Description {8}
31.2.4	Shape Descriptors {12}
31.3	Shape Classification {17}

- 31.4 Shape Compactness {21}
 - 31.4.1 Compactness and Elongation {6}
 - 31.4.2 Specific Descriptors {15}
- 31.5 Shape Complexity {11}
- 31.6 Delaunay and Voronoï Meshes {57}
 - 31.6.1 Mesh Model {15}
 - 31.6.2 Delaunay Meshes {8}
 - 31.6.3 Voronoï Meshes {17}
 - 31.6.4 Maximal Nucleus Cluster {17}
- 32 Motion Analysis {229}
 - 32.1 Motion and Analysis {63}
 - 32.1.1 Motion {11}
 - 32.1.2 Motion Classification {12}
 - 32.1.3 Motion Estimation {12}
 - 32.1.4 Various Motion Estimations {14}
 - 32.1.5 Motion Analysis and Understanding {14}
 - 32.2 Motion Detection and Representation {27}
 - 32.2.1 Motion Detection {13}
 - 32.2.2 Motion Representation {14}
 - 32.3 Moving Object Detection {21}
 - 32.3.1 Object Detection {11}
 - 32.3.2 Object Trajectory {10}
 - 32.4 Moving Object Tracking {74}
 - 32.4.1 Feature Tracking {13}
 - 32.4.2 Object Tracking {14}
 - 32.4.3 Object Tracking Techniques {14}
 - 32.4.4 Kalman Filter {20}
 - 32.4.5 Particle Filtering {13}
 - 32.5 Motion and Optical Flows {44}
 - 32.5.1 Motion Field {12}
 - 32.5.2 Optical Flow {9}
 - 32.5.3 Optical Flow Field {10}
 - 32.5.4 Optical Flow Equation {13}
- 33 Image Pattern Recognition {346}
 - 33.1 Pattern {18}
 - 33.2 Pattern Recognition {55}
 - 33.2.1 Recognition {12}
 - 33.2.2 Recognition Categories {11}
 - 33.2.3 Image Recognition {13}
 - 33.2.4 Various Recognition Methods {19}
 - 33.3 Pattern Classification {45}
 - 33.3.1 Category {11}
 - 33.3.2 Classification {21}
 - 33.3.3 Test and Verification {13}
 - 33.4 Feature and Detection {30}
 - 33.4.1 Feature {15}
 - 33.4.2 Feature Analysis {15}
 - 33.5 Feature Dimension Reduction {30}
 - 33.5.1 Dimension Reduction {14}
 - 33.5.2 Manifold and Independent Component {16}
 - 33.6 Classifier and Perceptron {56}
 - 33.6.1 Classifier {16}
 - 33.6.2 Optimal Classifier {11}
 - 33.6.3 Support Vector Machine {18}
 - 33.6.4 Perceptron {11}
 - 33.7 Clustering {19}
 - 33.7.1 Cluster {9}
 - 33.7.2 Cluster Analysis {10}
 - 33.8 Discriminant and Decision Function {46}
 - 33.8.1 Discriminant Function {16}

- 33.8.2 Kernel Discriminant {11}
- 33.8.3 Decision Function {19}
- 33.9 Syntactic Recognition {20}
 - 33.9.1 Grammar and Syntactic {13}
 - 33.9.2 Automaton {7}
- 33.10 Test and Error {27}
 - 33.10.1 Test {7}
 - 33.10.2 True {7}
 - 33.10.3 Error {13}
- 34 Biometric Recognition {152}
 - 34.1 Human Biometrics {14}
 - 34.2 Subspace Techniques {13}
 - 34.3 Face Recognition and Analysis {58}
 - 34.3.1 Face Detection {14}
 - 34.3.2 Face Tracking {12}
 - 34.3.3 Face Recognition {17}
 - 34.3.4 Face Image Analysis {15}
 - 34.4 Expression Analysis {25}
 - 34.4.1 Facial Expression {11}
 - 34.4.2 Facial Expression Analysis {14}
 - 34.5 Human Body Recognition {17}
 - 34.5.1 Human Motion {12}
 - 34.5.2 Other Analysis {5}
 - 34.6 Other Biometrics {25}
 - 34.6.1 Fingerprint and Gesture {14}
 - 34.6.2 More Biometrics {11}

Part IV Image Understanding

- 35 Theory of Image Understanding {57}
 - 35.1 Understanding Models {32}
 - 35.1.1 Computational Structures {17}
 - 35.1.2 Active, Qualitative, and Purposive Vision {15}
 - 35.2 Marr's Visual Computational Theory {25}
 - 35.2.1 Theory Framework {11}
 - 35.2.2 Three-Layer Representations {14}
- 36 3-D Representation and Description {224}
 - 36.1 3-D Point and Curve {42}
 - 36.1.1 3-D Point {12}
 - 36.1.2 Curve and Conic {17}
 - 36.1.3 3-D Curve {13}
 - 36.2 3-D Surface Representation {105}
 - 36.2.1 Surface {14}
 - 36.2.2 Surface Model {10}
 - 36.2.3 Surface Representation {18}
 - 36.2.4 Surface Description {14}
 - 36.2.5 Surface Classification {19}
 - 36.2.6 Curvature and Classification {10}
 - 36.2.7 Various Surfaces {20}
 - 36.3 3-D Surface Construction {26}
 - 36.3.1 Surface Construction {11}
 - 36.3.2 Construction Techniques {15}
 - 36.4 Volumetric Representation {51}
 - 36.4.1 Volumetric Models {21}
 - 36.4.2 Volumetric Representation Methods {17}
 - 36.4.3 Generalized Cylinder Representation {13}
- 37 Stereo Vision {164}
 - 37.1 Stereo Vision Overview {78}
 - 37.1.1 Stereo {10}
 - 37.1.2 Stereo Vision {20}
 - 37.1.3 Disparity {12}

37.1.4	Constraint {10}
37.1.5	Epipolar {13}
37.1.6	Rectification {13}
37.2	Binocular Stereo Vision {44}
37.2.1	Binocular Vision {18}
37.2.2	Correspondence {18}
37.2.3	SIFT and SURF {8}
37.3	Multiple-Ocular Stereo Vision {42}
37.3.1	Multibaselines {12}
37.3.2	Trinocular {11}
37.3.3	Multiple-Nocular {11}
37.3.4	Post-processing {8}
38	Multi-image 3-D Scene Reconstruction {94}
38.1	Scene Recovery {35}
38.1.1	3-D Reconstruction {12}
38.1.2	Depth Estimation {14}
38.1.3	Occlusion {9}
38.2	Photometric Stereo Analysis {19}
38.2.1	Photometric Stereo {7}
38.2.2	Illumination Models {12}
38.3	Shape from X {40}
38.3.1	Various reconstructions {14}
38.3.2	Structure from Motion {15}
38.3.3	Shape from Optical Flow {11}
39	Single-Image 3-D Scene Reconstruction {66}
39.1	Single-Image Reconstruction {13}
39.2	Various Reconstruction Cues {53}
39.2.1	Focus {8}
39.2.2	Texture {15}
39.2.3	Shading {11}
39.2.4	Shadow {13}
39.2.5	Other Cues {6}
40	Knowledge and Learning {198}
40.1	Knowledge and Model {68}
40.1.1	Knowledge Classification {16}
40.1.2	Procedure Knowledge {19}
40.1.3	Models {13}
40.1.4	Model Functions {20}
40.2	Knowledge Representation Schemes {41}
40.2.1	Knowledge Representation Models {14}
40.2.2	Knowledge Base {11}
40.2.3	Logic System {16}
40.3	Learning {61}
40.3.1	Statistical Learning {17}
40.3.2	Machine Learning {17}
40.3.3	Zero-Shot and Ensemble Learning {12}
40.3.4	Various Learning Methods {15}
40.4	Inference {28}
40.4.1	Inference Classification {15}
40.4.2	Propagation {13}
41	General Image Matching {196}
41.1	General Matching {45}
41.1.1	Matching {17}
41.1.2	Matching Function {13}
41.1.3	Matching Techniques {15}
41.2	Image Matching {68}
41.2.1	Image Matching Techniques {9}
41.2.2	Feature Matching Techniques {12}
41.2.3	Correlation and Cross-Correlation {15}
41.2.4	Mask Matching Techniques {13}

- 41.2.5 Diverse Matching Techniques {19}
- 41.3 Image Registration {48}
 - 41.3.1 Registration {17}
 - 41.3.2 Image Registration Methods {13}
 - 41.3.3 Image Alignment {8}
 - 41.3.4 Image Warping {10}
- 41.4 Graph Isomorphism and Line Drawing {35}
 - 41.4.1 Graph Matching {9}
 - 41.4.2 Line Drawing {18}
 - 41.4.3 Contour Labeling {8}
- 42 Scene Analysis and Interpretation {123}
 - 42.1 Scene Interpretation {56}
 - 42.1.1 Image Scene {13}
 - 42.1.2 Scene Analysis {14}
 - 42.1.3 Scene Understanding {14}
 - 42.1.4 Scene Knowledge {15}
 - 42.2 Interpretation Techniques {67}
 - 42.2.1 Soft Computing {13}
 - 42.2.2 Labeling {8}
 - 42.2.3 Fuzzy Set {10}
 - 42.2.4 Fuzzy Calculation {16}
 - 42.2.5 Classification Models {20}
- 43 Image Information Fusion {88}
 - 43.1 Information Fusion {33}
 - 43.1.1 Multi-sensor Fusion {19}
 - 43.1.2 Mosaic Fusion Techniques {14}
 - 43.2 Evaluation of Fusion Result {19}
 - 43.3 Layered Fusion Techniques {36}
 - 43.3.1 Three Layers {8}
 - 43.3.2 Method for Pixel Layer Fusion {10}
 - 43.3.3 Method for Feature Layer Fusion {8}
 - 43.3.4 Method for Decision Layer Fusion {10}
- 44 Content-Based Retrieval {194}
 - 44.1 Visual Information Retrieval {66}
 - 44.1.1 Information Content Retrieval {11}
 - 44.1.2 Image Retrieval {14}
 - 44.1.3 Image Querying {12}
 - 44.1.4 Database Indexing {14}
 - 44.1.5 Image Indexing {15}
 - 44.2 Feature-Based Retrieval {28}
 - 44.2.1 Features and Retrieval {17}
 - 44.2.2 Color-Based Retrieval {11}
 - 44.3 Video Organization and Retrieval {51}
 - 44.3.1 Video Organization {15}
 - 44.3.2 Abrupt and Gradual Changes {17}
 - 44.3.3 Video Structuring {9}
 - 44.3.4 News Program Organization {10}
 - 44.4 Semantic Retrieval {49}
 - 44.4.1 Semantic-Based Retrieval {10}
 - 44.4.2 Multilayer Image Description {12}
 - 44.4.3 Higher Level Semantics {12}
 - 44.4.4 Video Understanding {15}
- 45 Spatial-Temporal Behavior Understanding {177}
 - 45.1 Spatial-Temporal Techniques {32}
 - 45.1.1 Techniques and Layers {13}
 - 45.1.2 Spatio-Temporal Analysis {12}
 - 45.1.3 Action Behavior Understanding {7}
 - 45.2 Action and Pose {45}
 - 45.2.1 Action Models {14}
 - 45.2.2 Action Recognition {5}

45.2.3	Pose Estimation {13}
45.2.4	Posture Analysis {13}
45.3	Activity and Analysis {28}
45.3.1	Activity {15}
45.3.2	Activity Analysis {13}
45.4	Events {23}
45.4.1	Event Detection {13}
45.4.2	Event Understanding {10}
45.5	Behavior and Understanding {49}
45.5.1	Behavior {10}
45.5.2	Behavior Analysis {14}
45.5.3	Behavior Interpretation {15}
45.5.4	Petri Net {10}

Part V Related References

46	Related Theories and Techniques {440}
46.1	Random Field {103}
46.1.1	Random Variables {17}
46.1.2	Random Process {18}
46.1.3	Random Fields {18}
46.1.4	Markov Random Field {10}
46.1.5	Markov Models {20}
46.1.6	Markov Process {20}
46.2	Bayesian Statistics {38}
46.2.1	Bayesian Model {13}
46.2.2	Bayesian Laws and Rules {15}
46.2.3	Belief Networks {10}
46.3	Graph Theory {109}
46.3.1	Tree {19}
46.3.2	Graph {20}
46.3.3	Graph Representation {17}
46.3.4	Graph Geometric Representation {10}
46.3.5	Directed Graph {11}
46.3.6	Graph Model {14}
46.3.7	Graph Classification {18}
46.4	Compressive Sensing {41}
46.4.1	Introduction {7}
46.4.2	Sparse Representation {16}
46.4.3	Measurement Coding and Decoding Reconstruction {18}
46.5	Neural Networks {64}
46.5.1	Neural Networks {13}
46.5.2	Special Neural Networks {16}
46.5.3	Training and Fitting {12}
46.5.4	Network Operations {12}
46.5.5	Activation Functions {11}
46.6	Various Theories and Techniques {85}
46.6.1	Optimization {15}
46.6.2	Kernels {19}
46.6.3	Stereology {9}
46.6.4	Relaxation and Expectation Maximization {14}
46.6.5	Context and RANSAC {16}
46.6.6	Miscellaneous {12}
47	Optics {280}
47.1	Optics and Instruments {33}
47.1.1	Classifications {15}
47.1.2	Instruments {18}
47.2	Photometry {41}
47.2.1	Intensity {11}
47.2.2	Emission and Transmission {14}
47.2.3	Optical Properties of the Surface {16}

- 47.3 Ray Radiation {55}
 - 47.3.1 Radiation {12}
 - 47.3.2 Radiometry {20}
 - 47.3.3 Radiometry Standards {12}
 - 47.3.4 Special Lights {11}
- 47.4 Spectroscopy {63}
 - 47.4.1 Spectrum {14}
 - 47.4.2 Spectroscopy {14}
 - 47.4.3 Spectral Analysis {16}
 - 47.4.4 Interaction of Light and Matter {19}
- 47.5 Geometric Optics {58}
 - 47.5.1 Ray {16}
 - 47.5.2 Reflection {18}
 - 47.5.3 Various Reflections {11}
 - 47.5.4 Refraction {13}
- 47.6 Wave Optics {30}
 - 47.6.1 Light Wave {12}
 - 47.6.2 Scattering and Diffraction {18}
- 48 Mathematical Morphology for Binary Images {81}
 - 48.1 Image Morphology {43}
 - 48.1.1 Morphology Fundamentals {14}
 - 48.1.2 Morphological Operations {16}
 - 48.1.3 Morphological Image Processing {13}
 - 48.2 Binary Morphology {38}
 - 48.2.1 Basic Operations {19}
 - 48.2.2 Combined Operations and Practical Algorithms {19}
- 49 Mathematical Morphology for Gray-Level Images {53}
 - 49.1 Gray-Level Morphology {43}
 - 49.1.1 Ordering Relations {13}
 - 49.1.2 Basic Operations {14}
 - 49.1.3 Combined Operations and Practical Algorithms {16}
 - 49.2 Soft Morphology {10}
- 50 Visual Sensation and Perception {308}
 - 50.1 Human Visual System {40}
 - 50.1.1 Human Vision {11}
 - 50.1.2 Organ of Vision {11}
 - 50.1.3 Visual Process {18}
 - 50.2 Eye Structure and Function {37}
 - 50.2.1 Eye Structure {9}
 - 50.2.2 Retina {16}
 - 50.2.3 Photoreceptor {12}
 - 50.3 Visual Sensation {88}
 - 50.3.1 Sensation {18}
 - 50.3.2 Brightness {14}
 - 50.3.3 Photopic and Scotopia Vision {11}
 - 50.3.4 Subjective Brightness {15}
 - 50.3.5 Vision Characteristics {20}
 - 50.3.6 Virtual Vision {10}
 - 50.4 Visual Perception {102}
 - 50.4.1 Perceptions {20}
 - 50.4.2 Perceptual Constancy {12}
 - 50.4.3 Theory of Color Vision {14}
 - 50.4.4 Color Vision Effect {17}
 - 50.4.5 Color Science {20}
 - 50.4.6 Visual Attention {19}
 - 50.5 Visual Psychology {41}
 - 50.5.1 Laws of Visual Psychology {17}
 - 50.5.2 Illusion {13}
 - 50.5.3 Illusion of Geometric Figure and Reason Theory {11}
- 51 Application of Image Technology {118}

- 51.1 Television {22}
 - 51.1.1 Digital Television {13}
 - 51.1.2 Color Television {9}
- 51.2 Visual Surveillance {40}
 - 51.2.1 Surveillance {8}
 - 51.2.2 Visual Inspection {9}
 - 51.2.3 Visual Navigation {14}
 - 51.2.4 Traffic {9}
- 51.3 Other Applications {56}
 - 51.3.1 Document and OCR {20}
 - 51.3.2 Medical Images {13}
 - 51.3.3 Remote Sensing {12}
 - 51.3.4 Various Applications {11}
- 52 International Organizations and Standards {172}
 - 52.1 Organizations {22}
 - 52.1.1 International Organizations {15}
 - 52.1.2 National Organizations {7}
 - 52.2 Image and Video Coding Standards {62}
 - 52.2.1 Binary Image Coding Standards {6}
 - 52.2.2 Grayscale Image Coding Standards {12}
 - 52.2.3 Video Coding Standards: MPEG {17}
 - 52.2.4 Video Coding Standards: H.26x {19}
 - 52.2.5 Other Standards {8}
 - 52.3 Public Systems and Databases {40}
 - 52.3.1 Public Systems {16}
 - 52.3.2 Public Databases {12}
 - 52.3.3 Face Databases {12}
 - 52.4 Other Standards {48}
 - 52.4.1 International System of Units {9}
 - 52.4.2 CIE Standards {13}
 - 52.4.3 MPEG Standards {12}
 - 52.4.4 Various Standards {14}

Bibliography

Index