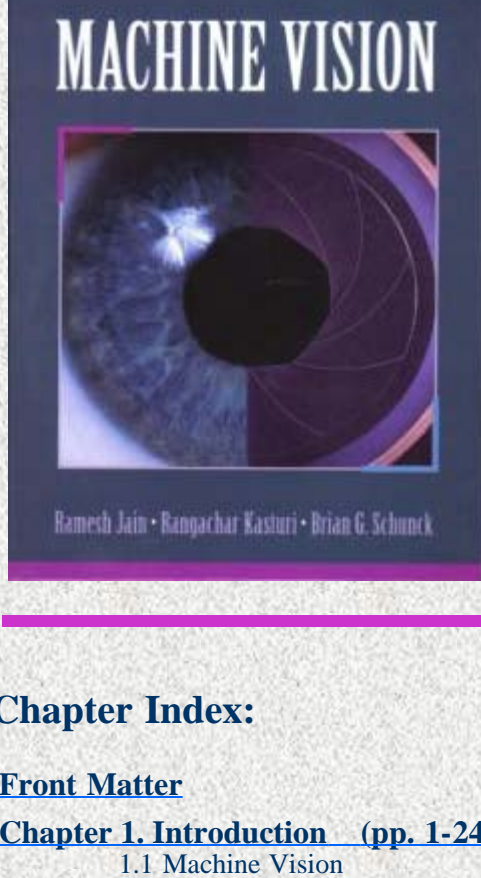


# MACHINE VISION

Ramesh Jain, Rangachar Kasturi, Brian G. Schunck  
Published by McGraw-Hill, Inc., ISBN 0-07-032018-7, 1995



*The field of machine vision, or computer vision, has been growing at a fast pace. As in most fast-developing fields, not all aspects of machine vision that are of interest to active researchers are useful to the designers and users of a vision system for a specific application.*

*This text is intended to provide a balanced introduction to machine vision. Basic concepts are introduced with only essential mathematical elements. The details to allow implementation and use of vision algorithm in practical application are provided, and engineering aspects of techniques are emphasized. This text intentionally omits theories of machine vision that do not have sufficient practical applications at the time.*

*This book is designed for people who want to apply machine vision to solve problems.*

## Chapter Index:

### Front Matter

#### Chapter 1. Introduction (pp. 1-24)

- 1.1 Machine Vision
- 1.2 Relationships to Other Fields
  - 1.3 Role of Knowledge
- 1.4 Image Geometry
  - 1.4.1 Perspective Projection
  - 1.4.2 Coordinate Systems
- 1.5 Sampling and Quantization
- 1.6 Image Definitions
- 1.7 Levels of Computation
  - 1.7.1 Point Level
  - 1.7.2 Local Level
  - 1.7.3 Global Level
  - 1.7.4 Object Level
- 1.8 Road Map

#### Chapter 2. Binary Image Processing (pp. 25-72)

- 2.1 Thresholding
- 2.2 Geometric Properties
  - 2.2.1 Size
  - 2.2.2 Position
  - 2.2.3 Orientation
- 2.3 Projections
- 2.4 Run-Length Encoding
- 2.5 Binary Algorithms
  - 2.5.1 Definitions
  - 2.5.2 Component Labeling
  - 2.5.3 Size Filter
  - 2.5.4 Euler Number
  - 2.5.5 Region Boundary
  - 2.5.6 Area and Perimeter
  - 2.5.7 Compactness
  - 2.5.8 Distance Measures
  - 2.5.9 Distance Transforms
  - 2.5.10 Medial Axis
  - 2.5.11 Thinning
  - 2.5.12 Expanding and Shrinking
- 2.6 Morphological Operators
- 2.7 Optical Character Recognition

#### Chapter 3. Regions (pp. 73-111)

- 3.1 Regions and Edges
- 3.2 Region Segmentation
  - 3.2.1 Automatic Thresholding
  - 3.2.2 Limitations of Histogram Methods
- 3.3 Region Representation
  - 3.3.1 Array Representation
  - 3.3.2 Hierarchical Representations
  - 3.3.3 Symbolic Representations
  - 3.3.4 Data Structures for Segmentation
- 3.4 Split and Merge
  - 3.4.1 Region Merging
  - 3.4.2 Removing Weak Edges
  - 3.4.3 Region Splitting
  - 3.4.4 Split and Merge
- 3.5 Region Growing

#### Chapter 4. Image Filtering (pp. 112-139)

- 4.1 Image Filtering
- 4.2 Histogram Modification
- 4.3 Linear Systems
- 4.4 Linear Filters
- 4.5 Median Filter
- 4.6 Gaussian Smoothing
  - 4.5.1 Rotational Symmetry
  - 4.5.2 Fourier Transform Property
  - 4.5.3 Gaussian Separability
  - 4.5.4 Cascading Gaussians
  - 4.5.5 Designing Gaussian Filters
  - 4.5.6 Discrete Gaussian Filters

#### Chapter 5. Edge Detection (pp. 140-185)

- 5.1 Gradient
- 5.2 Steps in Edge Detection
  - 5.2.1 Roberts Operator
  - 5.2.2 Sobel Operator
  - 5.2.3 Prewitt Operator
  - 5.2.4 Comparison
- 5.3 Second Derivative Operators
  - 5.3.1 Laplacian Operator
  - 5.3.2 Second Directional Derivative
- 5.4 Laplacian of Gaussian
- 5.5 Image Approximation
- 5.6 Gaussian Edge Detection
  - 5.6.1 Canny Edge Detector
  - 5.6.2 Subpixel Location Estimation
- 5.8 Edge Detector Performance
  - 5.8.1 Methods for Evaluating Performance
  - 5.8.2 Figure of Merit
- 5.9 Sequential Methods
- 5.10 Line Detection

#### Chapter 6. Contours (pp. 186-233)

- 6.1 Geometry of Curves
- 6.2 Digital Curves
  - 6.2.1 Chain Codes
  - 6.2.2 Slope Representation
  - 6.2.3 Slope Density Function
- 6.3 Curve Fitting
- 6.4 Polyline Representation
  - 6.4.1 Polyline Splitting
  - 6.4.2 Segment Merging
  - 6.4.3 Split and Merge
  - 6.4.4 Hop-Along Algorithm
- 6.5 Circular Arcs
- 6.6 Conic Sections
- 6.7 Spline Curves
- 6.8 Curve Approximation
  - 6.8.1 Total Regression
  - 6.8.2 Estimating Corners
  - 6.8.3 Robust Regression
  - 6.8.4 Hough Transform
- 6.9 Fourier Descriptors

#### Chapter 7. Texture (pp. 234-248)

- 7.1 Introduction
- 7.2 Statistical Methods of Texture Analysis
- 7.3 Structural Analysis of Ordered Texture
- 7.4 Model-Based Methods for Texture Analysis
- 7.5 Shape from Texture

#### Chapter 8. Optics (pp. 249-256)

- 8.1 Lens Equation
- 8.2 Image Resolution
- 8.3 Depth of Field
- 8.4 View Volume
- 8.5 Exposure

#### Chapter 9. Shading (pp. 257-275)

- 9.1 Image Irradiance
  - 9.1.1 Illumination
  - 9.1.2 Reflectance
- 9.2 Surface Orientation
- 9.3 The Reflectance Map
  - 9.3.1 Diffuse Reflectance
  - 9.3.2 Scanning Electron Microscopy
- 9.4 Shape from Shading
- 9.5 Photometric Stereo

#### Chapter 10. Color (pp. 276-288)

- 10.1 Color Physics
- 10.2 Color Terminology
- 10.3 Color Perception
- 10.4 Color Processing
- 10.5 Color Constancy
- 10.6 Discussion

#### Chapter 11. Depth (pp. 289-308)

- 11.1 Stereo Imaging
  - 11.1.1 Cameras in Arbitrary Position and Orientation
- 11.2 Stereo Matching
  - 11.2.1 Edge Matching
  - 11.2.2 Region Correlation
- 11.3 Shape from X
- 11.4 Range Imaging
  - 11.4.1 Structured Lighting
  - 11.4.2 Imaging Radar
- 11.5 Active Vision

#### Chapter 12. Calibration (pp. 309-364)

- 12.1 Coordinate Systems
- 12.2 Rigid Body Transformations
  - 12.2.1 Rotation Matrices
  - 12.2.2 Axis of Rotation
  - 12.2.3 Unit Quaternions
- 12.3 Absolute Orientation
- 12.4 Relative Orientation
- 12.5 Rectification
- 12.6 Depth from Binocular Stereo
- 12.7 Absolute Orientation with Scale
- 12.8 Exterior Orientation
  - 12.8.1 Calibration Example
- 12.9 Interior Orientation
- 12.10 Camera Calibration
  - 12.10.1 Simple Method for Camera Calibration
  - 12.10.2 Affine Method for Camera Calibration
  - 12.10.3 Nonlinear Method for Camera Calibration
- 12.11 Binocular Stereo Calibration
- 12.12 Active Triangulation
- 12.13 Robust Methods
- 12.14 Conclusions

#### Chapter 13. Curves and Surfaces (pp. 365-405)

- 13.1 Fields
- 13.2 Geometry of Curves
- 13.3 Geometry of Surfaces
  - 13.3.1 Planes
  - 13.3.2 Differential Geometry
  - 13.3.1 Cubic Spline Curves
- 13.4 Curve Representations
- 13.5 Surface Representations
  - 13.5.1 Polygonal Meshes
  - 13.5.2 Tensor Patches
  - 13.5.3 Tensor-Product Surfaces
- 13.6 Surface Interpolation
  - 13.6.1 Triangular Mesh Interpolation
  - 13.6.2 Bilinear Interpolation
  - 13.6.3 Robust Interpolation
- 13.7 Surface Approximation
  - 13.7.1 Regression Splines
  - 13.7.2 Variational Methods
  - 13.7.3 Weighted Spline Approximation
- 13.8 Surface Segmentation
  - 13.8.1 Initial Segmentation
  - 13.8.2 Extending Surface Patches
- 13.9 Surface Registration

#### Chapter 14. Dynamic Vision (pp. 406-458)

- 14.1 Change Detection
  - 14.1.1 Difference Pictures
  - 14.1.2 Static Segmentation and Matching
- 14.2 Segmentation Using Motion
  - 14.2.1 Time-Varying Edge Detection
  - 14.2.2 Stationary Camera
- 14.3 Motion Correspondence
- 14.4 Image Flow
  - 14.4.1 Computing Image Flow
  - 14.4.2 Feature-Based Methods
  - 14.4.3 Gradient-Based Methods
  - 14.4.4 Variational Methods for Image Flow
  - 14.4.5 Robust Computation of Image Flow
  - 14.4.6 Information in Image Flow
- 14.5 Segmentation Using a Moving Camera
  - 14.5.1 Ego-Motion Complex Log Mapping
  - 14.5.2 Depth Determination
- 14.6 Tracking
  - 14.6.1 Deviation Function for Path Coherence
  - 14.6.2 Path Coherence Function
  - 14.6.3 Path Coherence in the Presence of Occlusion
  - 14.6.4 Modified Greedy Exchange Algorithm
- 14.7 Shape from Motion

#### Chapter 15. Object Recognition (pp. 459-491)

- 15.1 System Components
- 15.2 Complexity of Object Recognition
- 15.3 Object Representation
  - 15.3.1 Observer-Centered Representations
  - 15.3.2 Object-Centered Representations
- 15.4 Feature Detection
- 15.5 Recognition Strategies
  - 15.5.1 Classification
  - 15.5.2 Matching
  - 15.5.3 Feature Indexing
- 15.6 Verification
  - 15.6.1 Template Matching
  - 15.6.2 Morphological Approach
  - 15.6.3 Symbolic
  - 15.6.4 Analogical Methods

#### Appendix A. Mathematical Concepts (pp. 492-501)

- A.1 Analytic Geometry
- A.2 Linear Algebra
- A.3 Variational Calculus
- A.4 Numerical Methods

#### Appendix B. Statistical Methods (pp. 502-510)

- B.1 Measurement Errors
- B.2 Error Distributions
- B.3 Linear Regression
- B.4 Nonlinear Regression

#### Appendix C. Programming Techniques (pp. 511-518)

- C.1 Image Descriptors
- C.2 Mapping operations
- C.3 Image File Formats

#### Bibliography (pp. 519-541)

#### Index (pp. 542-549)

Machine Vision in Mobile Devices Market 2020 SWOT Analysis by Players: Motorola Inc, CEVA Inc, Samsung, Apple Inc, MediaTek Inc, Huawei The Haitian-Caribbean News Network "machine vision" " Google News. Read More. News. Machine Vision Market Report 2020, Size, Share, SWOT Analysis and Forecast " Murphy's Hockey Law. Machine Vision Market Report 2020, Size, Share, SWOT Analysis and Forecast Murphy's Hockey Law "machine vision" " Google News. Read More. News. Machine vision, a combination of hardware and software that work together to help machines "see" something and then act, is prevalent in business today. With the support of artificial intelligence algorithms along with vision, machines automatically do many things only humans were able to do. " What is Machine Vision " Machine vision is the substitution of the human visual sense and judgment capabilities with a video camera and computer to perform an inspection task. It is the automatic acquisition and analysis of images to obtain desired data for controlling or evaluating a specific part or activity. " Key Points: " Automated/Non-Contact " Acquisition " Analysis " Data. Introduction and Overview. " What is Machine Vision. Image Acquisition. " Sensors " Optics " Lighting. Machine vision is the application of computer vision to factory automation. Just as human inspectors working on assembly lines visually inspect parts to judge the quality of workmanship, so machine vision systems use digital cameras and image processing software to perform similar inspections. A machine vision system is a computer that makes decisions based on the analysis of digital images.