

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/220695437>

Algorithms for Image Processing and Computer Vision

Book · January 1997

Source: DBLP

CITATIONS

1,225

READS

29,782

1 author:



James R. Parker

The University of Calgary

157 PUBLICATIONS 2,295 CITATIONS

[SEE PROFILE](#)

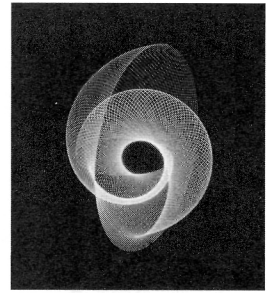
Some of the authors of this publication are also working on these related projects:



Python - An Introduction to Programming [View project](#)



NEW Edition of The Guide to Computer Simulations and Games [View project](#)



Algorithms for Image Processing and Computer Vision

Second Edition

J.R. Parker



WILEY

Wiley Publishing, Inc.



Contents

| | |
|--|------------|
| Preface | xxi |
| Chapter 1 Practical Aspects of a Vision System – Image Display, Input/Output, and Library Calls | 1 |
| OpenCV | 2 |
| The Basic OpenCV Code | 2 |
| The IplImage Data Structure | 3 |
| Reading and Writing Images | 6 |
| Image Display | 7 |
| An Example | 7 |
| Image Capture | 10 |
| Interfacing with the AIPCV Library | 14 |
| Website Files | 18 |
| References | 18 |
| Chapter 2 Edge-Detection Techniques | 21 |
| The Purpose of Edge Detection | 21 |
| Traditional Approaches and Theory | 23 |
| Models of Edges | 24 |
| Noise | 26 |
| Derivative Operators | 30 |
| Template-Based Edge Detection | 36 |
| Edge Models: The Marr-Hildreth Edge Detector | 39 |
| The Canny Edge Detector | 42 |
| The Shen-Castan (ISEF) Edge Detector | 48 |
| A Comparison of Two Optimal Edge Detectors | 51 |

| | | |
|------------------|--|------------|
| | Color Edges | 53 |
| | Source Code for the Marr-Hildreth Edge Detector | 58 |
| | Source Code for the Canny Edge Detector | 62 |
| | Source Code for the Shen-Castan Edge Detector | 70 |
| | Website Files | 80 |
| | References | 82 |
| Chapter 3 | Digital Morphology | 85 |
| | Morphology Defined | 85 |
| | Connectedness | 86 |
| | Elements of Digital Morphology — Binary Operations | 87 |
| | Binary Dilation | 88 |
| | Implementing Binary Dilation | 92 |
| | Binary Erosion | 94 |
| | Implementation of Binary Erosion | 100 |
| | Opening and Closing | 101 |
| | MAX — A High-Level Programming Language for Morphology | 107 |
| | The “Hit-and-Miss” Transform | 113 |
| | Identifying Region Boundaries | 116 |
| | Conditional Dilation | 116 |
| | Counting Regions | 119 |
| | Grey-Level Morphology | 121 |
| | Opening and Closing | 123 |
| | Smoothing | 126 |
| | Gradient | 128 |
| | Segmentation of Textures | 129 |
| | Size Distribution of Objects | 130 |
| | Color Morphology | 131 |
| | Website Files | 132 |
| | References | 135 |
| Chapter 4 | Grey-Level Segmentation | 137 |
| | Basics of Grey-Level Segmentation | 137 |
| | Using Edge Pixels | 139 |
| | Iterative Selection | 140 |
| | The Method of Grey-Level Histograms | 141 |
| | Using Entropy | 142 |
| | Fuzzy Sets | 146 |
| | Minimum Error Thresholding | 148 |
| | Sample Results From Single Threshold Selection | 149 |

| | |
|---|------------|
| The Use of Regional Thresholds | 151 |
| Chow and Kaneko | 152 |
| Modeling Illumination Using Edges | 156 |
| Implementation and Results | 159 |
| Comparisons | 160 |
| Relaxation Methods | 161 |
| Moving Averages | 167 |
| Cluster-Based Thresholds | 170 |
| Multiple Thresholds | 171 |
| Website Files | 172 |
| References | 173 |
| Chapter 5 Texture and Color | 177 |
| Texture and Segmentation | 177 |
| A Simple Analysis of Texture in Grey-Level Images | 179 |
| Grey-Level Co-Occurrence | 182 |
| Maximum Probability | 185 |
| Moments | 185 |
| Contrast | 185 |
| Homogeneity | 185 |
| Entropy | 186 |
| Results from the GLCM Descriptors | 186 |
| Speeding Up the Texture Operators | 186 |
| Edges and Texture | 188 |
| Energy and Texture | 191 |
| Surfaces and Texture | 193 |
| Vector Dispersion | 193 |
| Surface Curvature | 195 |
| Fractal Dimension | 198 |
| Color Segmentation | 201 |
| Color Textures | 205 |
| Website Files | 205 |
| References | 206 |
| Chapter 6 Thinning | 209 |
| What Is a Skeleton? | 209 |
| The Medial Axis Transform | 210 |
| Iterative Morphological Methods | 212 |
| The Use of Contours | 221 |
| Choi/Lam/Siu Algorithm | 224 |
| Treating the Object as a Polygon | 226 |
| Triangulation Methods | 227 |

| | |
|---|------------|
| Force-Based Thinning | 228 |
| Definitions | 229 |
| Use of a Force Field | 230 |
| Subpixel Skeletons | 234 |
| Source Code for Zhang-Suen/Stentiford/Holt Combined Algorithm | 235 |
| Website Files | 246 |
| References | 247 |
| Chapter 7 Image Restoration | 251 |
| Image Degradations — The Real World | 251 |
| The Frequency Domain | 253 |
| The Fourier Transform | 254 |
| The Fast Fourier Transform | 256 |
| The Inverse Fourier Transform | 260 |
| Two-Dimensional Fourier Transforms | 260 |
| Fourier Transforms in OpenCV | 262 |
| Creating Artificial Blur | 264 |
| The Inverse Filter | 270 |
| The Wiener Filter | 271 |
| Structured Noise | 273 |
| Motion Blur — A Special Case | 276 |
| The Homomorphic Filter — Illumination | 277 |
| Frequency Filters in General | 278 |
| Isolating Illumination Effects | 280 |
| Website Files | 281 |
| References | 283 |
| Chapter 8 Classification | 285 |
| Objects, Patterns, and Statistics | 285 |
| Features and Regions | 288 |
| Training and Testing | 292 |
| Variation: In-Class and Out-Class | 295 |
| Minimum Distance Classifiers | 299 |
| Distance Metrics | 300 |
| Distances Between Features | 302 |
| Cross Validation | 304 |
| Support Vector Machines | 306 |
| Multiple Classifiers — Ensembles | 309 |
| Merging Multiple Methods | 309 |
| Merging Type 1 Responses | 310 |
| Evaluation | 311 |
| Converting Between Response Types | 312 |

| | |
|---|----------------|
| Merging Type 2 Responses | 313 |
| Merging Type 3 Responses | 315 |
| Bagging and Boosting | 315 |
| Bagging | 315 |
| Boosting | 316 |
| Website Files | 317 |
| References | 318 |
| Chapter 9 Symbol Recognition | 321 |
| The Problem | 321 |
| OCR on Simple Perfect Images | 322 |
| OCR on Scanned Images — Segmentation | 326 |
| Noise | 327 |
| Isolating Individual Glyphs | 329 |
| Matching Templates | 333 |
| Statistical Recognition | 337 |
| OCR on Fax Images — Printed Characters | 339 |
| Orientation — Skew Detection | 340 |
| The Use of Edges | 345 |
| Handprinted Characters | 348 |
| Properties of the Character Outline | 349 |
| Convex Deficiencies | 353 |
| Vector Templates | 357 |
| Neural Nets | 363 |
| A Simple Neural Net | 364 |
| A Backpropagation Net for Digit Recognition | 368 |
| The Use of Multiple Classifiers | 372 |
| Merging Multiple Methods | 372 |
| Results From the Multiple Classifier | 375 |
| Printed Music Recognition — A Study | 375 |
| Staff Lines | 376 |
| Segmentation | 378 |
| Music Symbol Recognition | 381 |
| Source Code for Neural Net Recognition System | 383 |
| Website Files | 390 |
| References | 392 |
| Chapter 10 Content-Based Search — Finding Images by Example | 395 |
| Searching Images | 395 |
| Maintaining Collections of Images | 396 |
| Features for Query by Example | 399 |
| Color Image Features | 399 |
| Mean Color | 400 |
| Color Quad Tree | 400 |

| | |
|---|-----|
| Hue and Intensity Histograms | 401 |
| Comparing Histograms | 402 |
| Requantization | 403 |
| Results from Simple Color Features | 404 |
| Other Color-Based Methods | 407 |
| Grey-Level Image Features | 408 |
| Grey Histograms | 409 |
| Grey Sigma — Moments | 409 |
| Edge Density — Boundaries Between Objects | 409 |
| Edge Direction | 410 |
| Boolean Edge Density | 410 |
| Spatial Considerations | 411 |
| Overall Regions | 411 |
| Rectangular Regions | 412 |
| Angular Regions | 412 |
| Circular Regions | 414 |
| Hybrid Regions | 414 |
| Test of Spatial Sampling | 414 |
| Additional Considerations | 417 |
| Texture | 418 |
| Objects, Contours, Boundaries | 418 |
| Data Sets | 418 |
| Website Files | 419 |
| References | 420 |
| Systems | 424 |

Chapter 11 High-Performance Computing for Vision and Image Processing 425

| | |
|--|-----|
| Paradigms for Multiple-Processor Computation | 426 |
| Shared Memory | 426 |
| Message Passing | 427 |
| Execution Timing | 427 |
| Using <i>clock()</i> | 428 |
| Using <code>QueryPerformanceCounter</code> | 430 |
| The Message-Passing Interface System | 432 |
| Installing MPI | 432 |
| Using MPI | 433 |
| Inter-Process Communication | 434 |
| Running MPI Programs | 436 |
| Real Image Computations | 437 |
| Using a Computer Network — Cluster Computing | 440 |

| | |
|--|-----|
| A Shared Memory System — Using the PC Graphics Processor | 444 |
| GLSL | 444 |
| OpenGL Fundamentals | 445 |
| Practical Textures in OpenGL | 448 |
| Shader Programming Basics | 451 |
| Vertex and Fragment Shaders | 452 |
| Required GLSL Initializations | 453 |
| Reading and Converting the Image | 454 |
| Passing Parameters to Shader Programs | 456 |
| Putting It All Together | 457 |
| Speedup Using the GPU | 459 |
| Developing and Testing Shader Code | 459 |
| Finding the Needed Software | 460 |
| Website Files | 461 |
| References | 461 |

| | |
|--------------|------------|
| Index | 465 |
|--------------|------------|