

CONTENTS

CONTRIBUTORS ix
PREFACE xi
FUTURE CONTRIBUTIONS xiii

A Wavelet-Based Method for Multifractal Image Analysis: From
Theoretical Concepts to Experimental Applications
A. ARNÉODO, N. DECOSTER, P. KESTENER, AND S. G. ROUX

I. Introduction 2
II. Image Processing with the 2D Continuous Wavelet Transform 7
III. Test Applications of the WTMM Method to Monofractal
and Multifractal Rough Surfaces 23
IV. Multifractal Analysis of High-Resolution Satellite Images
of Cloud Structure 41
V. Multifractal Analysis of 3D Turbulence Simulation Data 53
VI. Multifractal Analysis of Digitized Mammograms 73
VII. Conclusion 80
References 82

An Analysis of the Geometric Distortions Produced by Median
and Related Image Processing Filters
E. R. DAVIES

I. Introduction 94
II. Image Filters 96
III. Shifts Produced by Median Filters in Continuous Images 105
IV. Shifts Produced by Median Filters in Digital Images 122
V. Shifts Produced by Mean Filters 146
VI. Shifts Produced by Mode Filters 150
VII. Shifts Produced by Rank-Order Filters 156
VIII. Rank-Order Filters—a Didactic Example 170
IX. A Problem with Closing 174
X. A Median-Based Corner Detector 178
XI. Boundary Length Measurement Problem 183
XII. Concluding Remarks 188
References 191

Two-Photon Excitation Microscopy

ALBERTO DIASPRO AND GIUSEPPE CHIRICO

I. Introduction	195
II. Historical Notes	198
III. Basic Principles of Two-Photon Excitation of Fluorescent Molecules	202
IV. Behavior of Fluorescent Molecules under TPE Regime	212
V. Optical Consequences and Resolution Aspects	219
VI. Architecture of Two-Photon Microscopy	225
VII. Application Gallery	257
VIII. Conclusions	273
References	276

Phase Closure Imaging

ANDRÉ LANNES

I. Introduction	288
II. Phase Space and Integer Lattices	293
III. Phase Closure Operator, Phase Closure Projection, and Related Properties	296
IV. Variance-Covariance Matrix of the Closure Phases	299
V. Spectral Phase Closure Projection	299
VI. Reference Algebraic Framework	305
VII. Statement of the Phase Calibration Problem	307
VIII. Phase Calibration Discrepancy and Related Results	309
IX. Optimal Model Phase Shift and Related Results	313
X. Special Cases	315
XI. Simulated Example	317
XII. Concluding Comments	319
Appendix 1	320
Appendix 2	321
Appendix 3	321
Appendix 4	323
References	327

**Three-Dimensional Image Processing and
Optical Scanning Holography**

TING-CHUNG POON

I. Introduction	329
II. Two-Pupil Optical Heterodyne Scanning	330
III. Three-Dimensional Imaging Properties	337
IV. Optical Scanning Holography	340

V. Concluding Remarks	347
References	348

Nonlinear Image Processing using Artificial Neural NetworksDICK DE RIDDER, ROBERT P. W. DUIN, MICHAEL EGMONT-
PETERSEN, LUCAS J. VAN VLIET, AND PIET W. VERBEEK

I. Introduction	352
II. Applications of ANNs in Image Processing	356
III. Shared Weight Networks for Object Recognition	366
IV. Feature Extraction in Shared Weight Networks	377
V. Regression Networks for Image Restoration	399
VI. Inspection and Improvement of Regression Networks	418
VII. Conclusions	442
References	447

INDEX	451
-----------------	-----