

# RECOGNITION — AND — PERCEPTION — OF — IMAGES

FUNDAMENTALS AND APPLICATIONS

Edited by  
**IFTIKHAR B. ABBASOV**

 Scrivener  
Publishing

**WILEY**

# **Recognition and Perception of Images**

**Fundamentals and Applications**

Edited by  
**Iftikhar B. Abbasov**



**WILEY**

This edition first published 2021 by John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA and Scrivener Publishing LLC, 100 Cummings Center, Suite 541J, Beverly, MA 01915, USA

© 2021 Scrivener Publishing LLC

For more information about Scrivener publications please visit [www.scrivenerpublishing.com](http://www.scrivenerpublishing.com).

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, except as permitted by law. Advice on how to obtain permission to reuse material from this title is available at <http://www.wiley.com/go/permissions>.

#### **Wiley Global Headquarters**

111 River Street, Hoboken, NJ 07030, USA

For details of our global editorial offices, customer services, and more information about Wiley products visit us at [www.wiley.com](http://www.wiley.com).

#### **Limit of Liability/Disclaimer of Warranty**

While the publisher and authors have used their best efforts in preparing this work, they make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives, written sales materials, or promotional statements for this work. The fact that an organization, website, or product is referred to in this work as a citation and/or potential source of further information does not mean that the publisher and authors endorse the information or services the organization, website, or product may provide or recommendations it may make. This work is sold with the understanding that the publisher is not engaged in rendering professional services. The advice and strategies contained herein may not be suitable for your situation. You should consult with a specialist where appropriate. Neither the publisher nor authors shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages. Further, readers should be aware that websites listed in this work may have changed or disappeared between when this work was written and when it is read.

#### **Library of Congress Cataloging-in-Publication Data**

ISBN 9781119750550

Cover image: Face Recognition (Scharfsinn86 | Dreamstime.com)

Cover design by Kris Hackerott

11 72690

Set in size of 11pt and Minion Pro by Manila Typesetting Company, Makati, Philippines

Printed in the USA

1.4.3	Binocular Signs	48
1.4.4	Binocular Disparity and Stereopsis	49
1.5	Visual Illusions	49
1.5.1	Constancy Perception	51
1.5.2	The Development of the Process of Perception	52
1.5.3	Perception after Surgery Insight	53
1.5.4	Illusion of the Moon	54
1.5.5	Illusions of Muller-Lyer, Ponzo, Poggendorf, Zolner	55
1.5.6	Horizontal – Vertical Illusion	57
1.5.7	Illusions of Contrast	57
1.6	Conclusion	60
	References	60
<b>2</b>	<b>Image Recognition Based on Compositional Schemes</b>	<b>63</b>
	<i>Victoria I. Barvenko and Natalia V. Krasnovskaya</i>	
2.1	Artistic Image	63
2.2	Classification of Features	69
2.3	Compositional Analysis of an Art Work	71
2.4	Classification by Shape, Position, Color	73
2.5	Classification According to the Content of the Scenes	76
2.6	Compositional Analysis in Iconography	80
2.7	Associative Mechanism of Analysis	83
2.8	Conclusions	86
	References	86
<b>3</b>	<b>Sensory and Project Images in the Design Practice</b>	<b>89</b>
	<i>Anna A. Kuleshova</i>	
3.1	Sensory Image Nature	89
3.2	Language and Images Symbolics	96
3.3	Methods of Images Production in Ideas	102
3.4	Personality Image Projecting	106
3.5	Project Image	108
3.6	Conclusion	120
	References	121
<b>4</b>	<b>Associative Perception of Conceptual Models of Exhibition Spaces</b>	<b>125</b>
	<i>Olga P. Medvedeva</i>	
4.1	Associative Modeling of the Exhibition Space Environment	125
4.1.1	Introduction	125
4.1.2	Conceptual and Terminological Apparatus of Conceptual Modeling and Shaping	127

4.1.3	Compositional and Planning Basis for Creating the Environment of Exhibition Spaces	128
4.1.4	Scenario Approach in the Figurative Solution of Environmental Spaces	128
4.1.5	Conceptual Approach to Creating Exhibition Spaces	129
4.1.6	Perception of the Figurative Solution of the Environment	129
4.2	Associative Modeling of Environmental Objects in Exhibition Spaces	134
4.2.1	Conceptual and Figurative Basis for the Formation of Environmental Objects	134
4.2.2	Associative and Imaginative Modeling of the Environmental Objects	134
4.2.3	Cognitive Bases of Perception of Associative-Figurative Models of Objects in Environmental Spaces	135
4.2.4	Perception of the Figurative Solution of an Environmental Object	136
4.2.5	Options of Conceptual and Figurative Modeling of Objects in Environmental Spaces	136
4.3	Conclusion	141
	References	141
<b>5</b>	<b>Disentanglement For Discriminative Visual Recognition</b>	<b>143</b>
	<i>Xiaofeng Liu</i>	
5.1	Introduction	144
5.2	Problem Statement. Deep Metric Learning Based Disentanglement for FER	149
5.3	Adversarial Training Based Disentanglement	152
5.4	Methodology. Deep Metric Learning Based Disentanglement for FER	154
5.5	Adversarial Training Based Disentanglement	159
5.5.1	The Structure of Representations	159
5.5.2	Framework Architecture	160
5.5.3	Informative to Main-Recognition Task	160
5.5.4	Eliminating Semantic Variations	161
5.5.5	Eliminating Latent Variation	162
5.5.6	Complementary Constraint	162
5.6	Experiments and Analysis	162
5.6.1	Deep Metric Learning Based Disentanglement for FER	162
5.6.2	Adversarial Training-Based Disentanglement	169

5.7	Discussion	176
5.7.1	Independent Analysis	176
5.7.2	Equilibrium Condition	176
5.8	Conclusion	178
	References	179
<b>6</b>	<b>Development of the Toolkit to Process the Internet Memes Meant for the Modeling, Analysis, Monitoring and Management of Social Processes</b>	<b>189</b>
	<i>Margarita G. Kozlova, Vladimir A. Lukianenko and Mariia S. Germanchuk</i>	
6.1	Introduction	190
6.2	Modeling of Internet Memes Distribution	193
6.3	Intellectualization of System for Processing the Internet Meme Data Flow	197
6.4	Implementation of Intellectual System for Recognition of Internet Meme Data Flow	207
6.5	Conclusion	216
	References	217
<b>7</b>	<b>The Use of the Mathematical Apparatus of Spatial Granulation in The Problems of Perception and Image Recognition</b>	<b>221</b>
	<i>Sergey A. Butenkov, Vitaly V. Krivsha and Nataly S. Krivsha</i>	
7.1	Introduction	221
7.2	The Image Processing and Analysis Base Conceptions	222
7.2.1	The Main Stages of Image Processing	222
7.2.2	The Fundamentals of a New Hybrid Approach to Image Processing	223
7.2.3	How is this New Approach Different?	223
7.3	Human Visual Perception Modeling	224
7.3.1	Perceptual Classification of Digital Images	224
7.3.2	The Vague Models of Digital Images	226
7.4	Mathematic Modeling of Different Kinds of Digital Images	227
7.4.1	Images as the Special Kind of Spatial Data	228
7.4.2	Fundamentals of Topology and Digital Topology	230
7.4.3	Regularity and the Digital Topology of Regular Regions	230
7.5	Zadeh's Information Granulation Theory	232
7.6	Fundamentals of Spatial Granulation	235
7.6.1	Basic Ideas of Spatial Granulation	235
7.6.2	Abstract Vector Space	236

7.6.3	Abstract Affine Space	237
7.6.4	Cartesian Granules in an Affine Space	237
7.6.5	Granule-Based Measures in Affine Space	240
7.6.6	Fuzzy Spatial Relation Over the Granular Models	240
7.7	Entropy-Preserved Granulation of Spatial Data	241
7.8	Digital Images Granulation Algorithms	243
7.8.1	Matroids and Optimal Algorithms	244
7.8.2	Greedy Image Granulation Algorithms	244
7.9	Spatial Granulation Technique Applications	247
7.9.1	Granulation of Graphical DataBases	247
7.9.2	Automated Target Detection (ATD) Problem	250
7.9.3	Character Recognition Problem	251
7.9.4	Color Images Granulation in the Color Space	252
7.9.5	Spatial Granules Models for the Curvilinear Coordinates	253
7.9.6	Color Histogram for Color Images Segmentation	255
7.10	Conclusions	257
	References	257
<b>8</b>	<b>Inverse Synthetic Aperture Radars: Geometry, Signal Models and Image Reconstruction Methods</b>	<b>261</b>
	<i>Andon D. Lazarov and Chavdar N. Minchev</i>	
8.1	Introduction	261
8.2	ISAR Geometry and Coordinate Transformations	263
8.2.1	3-D Geometry of ISAR Scenario	263
8.2.2	3-D to 2-D ISAR Geometry Transformation	266
8.3	2-D ISAR Signal Models and Reconstruction Algorithms	274
8.3.1	Linear Frequency Modulation Waveform	274
8.3.2	2-D LFM ISAR Signal Model - Geometric Interpretation of Signal Formation	275
8.3.3	ISAR Image Reconstruction Algorithm	277
8.3.4	Correlation - Spectral ISAR Image Reconstruction	279
8.3.5	Phase Correction Algorithm and Autofocusing	280
8.3.6	Barker Phase Code Modulation Waveform	289
8.3.7	Barker ISAR Image Reconstruction	290
8.3.8	Image Quality Criterion and Autofocusing	291
8.4	3-D ISAR Signal Models and Image Reconstruction Algorithms	296
8.4.1	Stepped Frequency Modulated ISAR Signal Model	296
8.4.2	ISAR Image Reconstruction Algorithm	298
8.4.3	Complementary Codes and Phase Code Modulated Pulse Waveforms	306

8.4.4	ISAR Complementary Phase Code Modulated Signal Modeling	309
8.4.5	ISAR Image Reconstruction Procedure	311
8.4.6	Parametric ISAR Image Reconstruction	317
8.5	Conclusions	323
	Acknowledgment	324
	References	324
<b>9</b>	<b>Remote Sensing Imagery Spatial Resolution Enhancement</b> <i>Sergey A. Stankevich, Iryna O. Piestova and Mykola S. Lubskyi</i>	<b>327</b>
9.1	Introduction	328
9.2	Multiband Aerospace Imagery Informativeness	328
9.3	Equivalent Spatial Resolution of Multiband Aerospace Imagery	330
9.4	Multispectral Imagery Resolution Enhancement Based on Spectral Signatures' Identification	336
9.5	Multispectral Imagery Resolution Enhancement Using Subpixels Values Reallocation According to Land Cover Classes' Topology	341
9.6	Remote Sensing Longwave Infrared Data Spatial Resolution Enhancement	346
9.7	Issues of Objective Evaluation of Remote Sensing Imagery Actual Spatial Resolution	359
9.8	Conclusion	360
	References	361
<b>10</b>	<b>The Theoretical and Technological Peculiarities of Aerospace Imagery Processing and Interpretation By Means of Artificial Neural Networks</b> <i>Oleg G. Gvozdev</i>	<b>369</b>
10.1	Introduction	371
10.2	Peculiarities of Aerospace Imagery, Ways of its Digital Representation and Tasks Solved on It	373
10.2.1	Peculiarities of Technological Aerospace Imaging Process	375
10.2.2	Aerospace Imagery Defects	378
10.2.3	Aerospace Imagery Channel/Spectral Structure	378
10.2.4	Aerospace Imagery Spatial Resolution	380
10.2.5	Radiometric Resolution of Aerospace Imagery	381
10.2.6	Aerospace Imagery Data Volumes	382
10.2.7	Aerospace Imagery Labeling	385



10.2.8	Limited Availability of Aerospace Imagery	386
10.2.9	Semantic Features of Aerospace Imagery	386
10.2.10	The Tasks Solved by Means of Aerospace Imagery	387
10.2.11	Conclusion	388
10.3	Aerospace Imagery Preprocessing	390
10.3.1	Technological Stack of Aerospace Imagery Processing	391
10.3.2	Structuring and Accessing to Aerospace Datasets	392
10.3.3	Standardization of Measurements Representation	394
10.3.4	Handling of Random Channel/Spectral Image Structure	397
10.3.5	Ensuring of Image Sizes Necessary for Processing	398
10.3.6	Tile-Based Image Processing	399
10.3.7	Design of Training Samples from the Aerospace Imagery Sets	402
10.4	Interpretation of Aerospace Imagery by Means of Artificial Neural Networks	406
10.4.1	ANN Topologies Building Framework Used for Aerospace Imagery Processing	407
10.4.2	Object Non-Locality and Different Scales	413
10.4.3	Topology Customizing to the Different Channel/Spectral Structures of Aerospace Imagery	418
10.4.4	Integration of Aerospace Imagery with the Different Spatial Resolution	421
10.4.5	Instance Segmentation	421
10.4.6	Learning Rate Strategy	423
10.4.7	Program Interfaces Organization	424
10.4.8	Recommendations on the Framework Application	435
10.5	Conclusion	436
	References	438
	<b>Index</b>	<b>445</b>

# **This book is dedicated to the unique interdisciplinary research of imagery processing, recognition and perception.**

The contents of this book are based on the concepts of mathematical processing, compositional analysis applied in art and design, and psychological factors of the information perception process. The conduction of compositional analysis carried out in the course of images processing and recognition, creation of the image project solution and modeling of the conceptual space structures are considered together with the mechanism of their perception.

Written and edited by a group of international experts, the practical applications for industry are covered, including the influence of internet memes on social networks and face recognition technology subject to interferences. The algorithms of perception and improving of accuracy necessary for satellite imagery recognition and complex reflection from the object are represented with the use of artificial neural networks.

Not just a study in how humans recognize and perceive images, this outstanding new volume delves into how these processes are used in technology for continuously evolving industrial applications. Whether for the veteran scientist or engineer, or for the student, this is a must-have for any library.

This outstanding new volume:

- Combines mathematics, arts, and psychology to cover the basic concepts and applications for the recognition and perception of images
- Is based on mathematical processing, compositional analysis in art and design, and psychological factors of the information perception process
- Presents algorithms for increasing recognition accuracy using artificial neural networks of satellite images
- Presents the technologies of face recognition

**Iftikhar B. Abbasov**, PhD, is a specialist in mathematical modeling, computer engineering and industrial design at the Southern Federal University in Russia. He has numerous publications to his credit, focusing on the use of mathematical modeling and high-level computer programming for practical applications such as ocean exploration, coastal and aircraft engineering, and perception of images.

Cover Design: Kris Hackerott

Cover Image: © Thermal Face Recognition -  
Scharfsinn86 | Dreamstime.com

# **WILEY**



Also available  
as an e-book

[www.wiley.com](http://www.wiley.com)

[www.scrivenerpublishing.com](http://www.scrivenerpublishing.com)

ISBN 978-1-119-75055-0



9 781119 750550