

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Alfred Kobsa

University of California, Irvine, CA, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

TU Dortmund University, Germany

Madhu Sudan

Microsoft Research, Cambridge, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Gerhard Weikum

Max Planck Institute for Informatics, Saarbruecken, Germany

Cris L. Luengo Hendriks
Gunilla Borgefors Robin Strand (Eds.)

Mathematical Morphology and Its Applications to Signal and Image Processing

11th International Symposium, ISMM 2013
Uppsala, Sweden, May 27-29, 2013
Proceedings

Volume Editors

Cris L. Luengo Hendriks
Gunilla Borgefors
Robin Strand

Swedish University of Agricultural Sciences and Uppsala University
Centre for Image Analysis
Box 337
751 05 Uppsala, Sweden

E-mails:

cris@cb.uu.se
gunilla@cb.uu.se
robin@cb.uu.se

ISSN 0302-9743 e-ISSN 1611-3349
ISBN 978-3-642-38293-2 e-ISBN 978-3-642-38294-9
DOI 10.1007/978-3-642-38294-9
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2013937542

CR Subject Classification (1998): I.4.10, I.5.4, C.3, G.2, J.3, I.2.8

LNCS Sublibrary: SL 6 – Image Processing, Computer Vision, Pattern Recognition,
and Graphics

© Springer-Verlag Berlin Heidelberg 2013

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

The volume you hold in your hand collects the papers accepted for presentation at the 11th International Symposium on Mathematical Morphology (ISMM 2013), held in Uppsala, Sweden, during May 27–29, 2013. ISMM has been held approximately every two years since 1993, when the series was initiated in Barcelona. The ten preceding editions of this conference were very successful, and the series has established itself as the main scientific event in the field.

We received 52 high-quality papers, each of which was sent to at least three Program Committee members for review. Based on 153 detailed reviews, we accepted 33 papers and conditionally accepted another eight. These eight papers were accepted after substantial revision by the authors in response to reviewer concerns. We decided to conditionally accept papers that needed important changes because each of us has listened to the presentation of a paper we reviewed, only to realize that the authors did nothing with our comments. In this case, however, and to our delight, even papers we accepted without conditions were in most cases extensively rewritten in response to reviewer comments.

In addition to the 41 reviewed papers, this volume contains three papers authored by our invited speakers:

- “Adaptive Morphologic Regularizations for Inverse Problems,” by Bhabatosh Chanda (Indian Statistical Institute) with P. Purkait
- “The Laplace-Beltrami Operator: A Ubiquitous Tool for Image and Shape Processing,” by Ron Kimmel (Technion–Israel Institute of Technology) with A. Wetzler, Y. Aflalo, and A. Dubrovina
- “Geography, Mathematics and Mathematical Morphology,” by Christine Voiron-Canicio (University of Nice–Sophia Antipolis).

We would like to thank everyone involved in putting together this volume and the conference: the authors for providing the scientific content; the Program Committee and the additional reviewers for thorough reviews and detailed comments; the Steering Committee for giving us the opportunity to organize this conference and supporting us throughout the process; Springer for doing most of the work involved in putting this volume together; our two universities for financial support; The Swedish Research Council for sponsoring two of our invited speakers; the International Association for Pattern Recognition and Centre for Interdisciplinary Mathematics (Uppsala University) for sponsoring the third invited speaker; and the City of Uppsala for sponsoring the conference dinner

at Östgöta nation. Finally, we would like to acknowledge EasyChair, the on-line conference management system we used free of charge to handle the paper submission and review process.

March 2013

C. Luengo
G. Borgfors
R. Strand
C. Kiselman
V. Čurić

Organization

ISM 2013 was organized by the Centre for Image Analysis, a collaboration between Uppsala University and the Swedish University of Agricultural Sciences.

Organizing Committee

Gunilla Borgefors	General Chair
Christer Kiselman	Invited Speakers' Chair and Adviser
Cris L. Luengo Hendriks	Program Chair
Robin Strand	Local Organization Chair
Vlada Ćurić	Assistant

Steering Committee

Jesús Angulo	Mines ParisTech, France
Junior Barrera	University of São Paulo, Brazil
Isabelle Bloch	Télécom ParisTech, France
Gunilla Borgefors	Uppsala University, Sweden
Renato Keshet	Hewlett Packard Laboratories, Israel
Ron Kimmel	Technion–Israel Institute of Technology, Israel
Petros Maragos	National Technical University of Athens, Greece
Christian Ronse	University of Strasbourg, France
Philippe Salembier	Technical University of Catalonia, Spain
Dan Schonfeld	University of Illinois at Chicago, USA
Pierre Soille	EC Joint Research Centre, Italy
Hugues Talbot	University of East Paris, France
Michael H.F. Wilkinson	University of Groningen, The Netherlands

Program Committee

Jesús Angulo	Jocelyn Chanussot	Allan Hanbury
Akira Asano	Jean Cousty	Marcin Iwanowski
Junior Barrera	José Crespo	Andrei Jalba
Jon Atli Benediktsson	Vladimir Ćurić	Dominique Jeulin
Isabelle Bloch	Johan Debayle	Renato Keshet
Gunilla Borgefors	Etienne Decencière	Ron Kimmel
Michael Buckley	Adrian Evans	Christer Kiselman
Bernhard Burgeth	Thierry Geraud	Ullrich Köthe
Bhabatosh Chanda	Lionel Gueguen	Sébastien Lefèvre

VIII Organization

Roberto Lotufo	Christian Ronse	Iván Ramon
Cris L. Luengo Hendriks	Philippe Salembier	Terol-Villalobos
Petros Maragos	Gabriella Sanniti Di Baja	Matthew Thurley
Beatriz Marcotegui	Jean Serra	Marc Van
Petr Matula	Behara Seshadri Daya	Droogenbroeck
Fernand Meyer	Sagar	Michel Westenberg
Laurent Najman	Ida-Maria Sintorn	Michael H.F. Wilkinson
Georgios Ouzounis	Pierre Soille	
Nicolas Passat	Robin Strand	
Jos Roerdink	Hugues Talbot	

Additional Reviewers

Mauro Dalla Mura	Bangalore Ravi Kiran	Benjamin Perret
Nicola Falco	Prashanth Marpu	

Table of Contents

Theory

Similarity between Hypergraphs Based on Mathematical Morphology . . . <i>Isabelle Bloch, Alain Bretto, and Aurélie Leborgne</i>	1
Simplification Operators on a Dimension-Independent Graph-Based Representation of Morse Complexes <i>Lidija Čomić, Leila De Floriani, and Federico Iuricich</i>	13
Random Tessellations and Boolean Random Functions <i>Dominique Jeulin</i>	25
Discrete Set-Valued Continuity and Interpolation <i>Laurent Najman and Thierry Géraud</i>	37
Solving Problems in Mathematical Morphology through Reductions to the U-Curve Problem <i>Marcelo S. Reis and Junior Barrera</i>	49
Analytical Solutions for the Minkowski Addition Equation <i>Joel Edu Sánchez Castro, Ronaldo Fumio Hashimoto, and Junior Barrera</i>	61

Trees and Hierarchies

A Comparison of Many Max-tree Computation Algorithms <i>Edwin Carlinet and Thierry Géraud</i>	73
Constructive Links between Some Morphological Hierarchies on Edge-Weighted Graphs <i>Jean Cousty, Laurent Najman, and Benjamin Perret</i>	86
A Quasi-linear Algorithm to Compute the Tree of Shapes of nD Images <i>Thierry Géraud, Edwin Carlinet, Sébastien Crozet, and Laurent Najman</i>	98
Efficient Schemes for Computing α -Tree Representations <i>Jiří Havel, François Merciol, and Sébastien Lefèvre</i>	111
Ground Truth Energies for Hierarchies of Segmentations <i>Bangalore Ravi Kiran and Jean Serra</i>	123

Playing with Kruskal: Algorithms for Morphological Trees in
Edge-Weighted Graphs 135
Laurent Najman, Jean Cousty, and Benjamin Perret

Optima on Hierarchies of Partitions 147
Jean Serra and Bangalore Ravi Kiran

Semi-connections and Hierarchies 159
Olena Tankyevych, Hugues Talbot, and Nicolas Passat

Adaptive Morphology

Stochastic Morphological Filtering and Bellman-Maslov Chains 171
Jesús Angulo and Santiago Velasco-Forero

Saliency-Based Parabolic Structuring Functions 183
Vladimir Čurić and Cris L. Luengo Hendriks

Adaptive Morphologic Regularizations for Inverse Problems 195
Pulak Purkait and Bhabatosh Chanda

Attribute Controlled Reconstruction and Adaptive Mathematical
Morphology 207
Andrés Serna and Beatriz Marcotegui

On Nonlocal Mathematical Morphology 219
Santiago Velasco-Forero and Jesús Angulo

Colour

Vectorial Quasi-flat Zones for Color Image Simplification 231
Erhan Aptoula, Jonathan Weber, and Sébastien Lefèvre

Morphology for Color Images via Loewner Order for Matrix Fields 243
Bernhard Burgeth and Andreas Kleefeld

A Multivariate Mathematical Morphology Based on Orthogonal
Transformation, Probabilistic Extrema Estimation and Distance
Optimization 255
*Alexandru Căliman, Mihai Ivanovici, Noël Richard, and
Gheorghe Toacșe*

Group-Invariant Frames for Colour Morphology 267
Jasper J. van de Gronde and Jos B.T.M. Roerdink

Manifolds and Metrics

Mathematical Morphology for Real-Valued Images on Riemannian Manifolds	279
<i>Jesús Angulo and Santiago Velasco-Forero</i>	
A Weight Sequence Distance Function	292
<i>Benedek Nagy, Robin Strand, and Nicolas Normand</i>	
The Laplace-Beltrami Operator: A Ubiquitous Tool for Image and Shape Processing	302
<i>Aaron Wetzler, Yonathan Aflalo, Anastasia Dubrovina, and Ron Kimmel</i>	

Filtering

Towards Morphological Image Regularization Using the Counter-Harmonic Mean	317
<i>Jorge Larrey-Ruiz, Rafael Verdú-Monedero, Juan Morales-Sánchez, and Jesús Angulo</i>	
A Learning Framework for Morphological Operators Using Counter-Harmonic Mean	329
<i>Jonathan Masci, Jesús Angulo, and Jürgen Schmidhuber</i>	
Flooding Edge or Node Weighted Graphs	341
<i>Fernand Meyer</i>	
Towards Connected Filtering Based on Component-Graphs	353
<i>Benoît Naegel and Nicolas Passat</i>	
Inf-structuring Functions and Self-dual Marked Flattenings in bi-Heyting Algebra	365
<i>Benjamin Perret</i>	
From Extrema Relationships to Image Simplification Using Non-flat Structuring Functions	377
<i>Guilherme Polo and Neucimar J. Leite</i>	
Two Applications of Shape-Based Morphology: Blood Vessels Segmentation and a Generalization of Constrained Connectivity	390
<i>Yongchao Xu, Thierry Géraud, and Laurent Najman</i>	

Detectors and Descriptors

Robust Keypoint Detection Using Dynamics	402
<i>Miguel Angel Cataño and Juan Climent</i>	

A Granulometry Based Descriptor for Object Categorization	413
<i>Arnaldo Câmara Lara and Roberto Hirata Jr.</i>	
Qualitative Comparison of Contraction-Based Curve Skeletonization Methods	425
<i>André Sobiecki, Haluk C. Yasan, Andrei C. Jalba, and Alexandru C. Telea</i>	
Detection of Texture and Isolated Features Using Alternating Morphological Filters	440
<i>Igor Zingman, Dietmar Saupe, and Karsten Lambers</i>	
Applications	
Estimation of Separating Planes between Touching 3D Objects Using Power Watershed	452
<i>Clara Jaquet, Edward Andò, Gioacchino Viggiani, and Hugues Talbot</i>	
Efficient 1D and 2D Barcode Detection Using Mathematical Morphology	464
<i>Melinda Katona and László G. Nyúl</i>	
Faster Fuzzy Connectedness via Precomputation	476
<i>Filip Malmberg and Robin Strand</i>	
Mask Connectivity by Viscous Closings: Linking Merging Galaxies without Merging Double Stars	484
<i>Ugo Moschini, Scott C. Trager, and Michael H.F. Wilkinson</i>	
Discrete Simulation of a Chladni Experiment	496
<i>Frédéric Rieux</i>	
Automated Quality Inspection of Microfluidic Chips Using Morphologic Techniques	508
<i>Thomas Schwarzbauer, Martin Welk, Chris Mayrhofer, and Rainer Schubert</i>	
Geography, Mathematics and Mathematical Morphology	520
<i>Christine Voiron-Canicio</i>	
Author Index	531