PROCEEDINGS OF SPIE

Wavelets and Sparsity XVIII

Dimitri Van De Ville Manos Papadakis Yue M. Lu Editors

13–15 August 2019 San Diego, California, United States

Sponsored and Published by SPIE

Volume 11138

Proceedings of SPIE 0277-786X, V. 11138

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Wavelets and Sparsity XVIII, edited by Dimitri Van De Ville, Manos Papadakis, Yue M. Lu, Proc. of SPIE Vol. 11138, 1113801 · © 2019 SPIE · CCC code: 0277-786X/19/\$21 · doi: 10.1117/12.2552793

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigital Library.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Wavelets and Sparsity XVIII*, edited by Dimitri Van De Ville, Manos Papadakis, Yue M. Lu, Proceedings of SPIE Vol. 11138 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510629691

ISBN: 9781510629707 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445 SPIE.org

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$21.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.



Paper Numbering: Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

vii ix	Authors Conference Committee
	NEURAL NETWORKS AND SPARSE REPRESENTATIONS I
11138 04	Optimal translational-rotational invariant dictionaries for images [11138-3]
11138 05	Virtual multi-modal object detection and classification with deep convolutional neural networks [11138-4]
	APPLICATIONS OF FRAMES AND RELATED TRANSFORMS
11138 06	Discrete optimizations using graph convolutional networks [11138-6]
11138 07	Data adaptive multi-scale representations for image analysis [11138-7]
11138 08	Multiscale analysis for higher-order tensors [11138-8]
11138 09	Iterative and greedy algorithms for the sparsity in levels model in compressed sensing [11138-9]
11138 0A	Radio astronomical image restoration with shape constraint [11138-10]
	WAVELETS ON GRAPHS
11138 OB	Tight framelets on graphs for multiscale data analysis [11138-11]
11138 0C	The extended generalized Haar-Walsh transform and applications [11138-12]
11138 0D	Slepian guided filtering of graph signals [11138-13]
	NEURAL NETWORKS AND SPARSE REPRESENTATIONS II
11138 OF	The structure of spaces of neural network functions [11138-15]

11138 0G	Compactly supported frame wavelets and applications in convolutional neural networks [11138-16]
11138 OH	Wavelet/shearlet hybridized neural networks for biomedical image restoration [11138-17]
11138 01	Ultra-high-order ICA: an exploration of highly resolved data-driven representation of intrinsic connectivity networks (sparse ICNs) [11138-18]
-	TIME-DEPENDENT GRAPH SIGNALS AND DYNAMIC GRAPHS I
11138 OL	Diffusion source detection in a network using partial observations [11138-20]
11138 ON	Sparse tensor dimensionality reduction with application to clustering of functional connectivity [11138-22]
	APPLICATIONS OF FRAMES AND TRANSFORMS IN NEURAL NETWORKS
11138 00	Structured receptive field networks and applications to hyperspectral image classification [11138-23]
11138 0Q	Geometric wavelet scattering on graphs and manifolds [11138-25]
11138 OR	Compressed sensing and generative models [11138-26]
11138 OS	Experimental performance of graph neural networks on random instances of max-cut [11138-27]
	COMPUTATIONAL PHOTONIC IMAGING
11138 OT	On fast object detection using single-photon lidar data [11138-28]
11138 OU	Passive indirect diffuse imaging [11138-29]
11138 OW	Lifting the veil: enhancing images in turbid aqueous environments [11138-31]
11138 OX	Occlusion-based computational periscopy with consumer cameras [11138-32]
	TIME-DEPENDENT GRAPH SIGNALS AND DYNAMIC GRAPHS II
11138 OY	Estimation of time-series on graphs using Bayesian graph convolutional neural networks [11138-33]

11138 OZ	Comparing linear structure-based and data-driven latent spatial representations for sequence prediction [11138-34]
11138 10	Time-resolved analysis of dynamic graphs: an extended Slepian design [11138-35]
11138 11	Wavelet-based graph inference using multiple testing [11138-36]
	APPLICATIONS IN BIO-IMAGING
11138 16	Generalized temporal sampling with active illumination in optical microscopy [11138-41]
	INVERSE PROBLEMS IN MRI
11138 17	Learning-based computational MRI reconstruction without big data: from linear interpolation and structured low-rank matrices to recurrent neural networks [11138-42]
11138 18	Highly efficient MRI through multi-shot echo planar imaging [11138-43]
11138 19	Online MR image reconstruction for compressed sensing acquisition in T2* imaging [11138-44]
11138 1A	Inverse GANs for accelerated MRI reconstruction [11138-45]
11138 1B	sRAKI-RNN: accelerated MRI with scan-specific recurrent neural networks using densely connected blocks [11138-46]
11138 IC	Parallel magnetic resonance imaging reconstruction algorithm by three-dimension directional Haar tight framelet regularization $[11138-47]$
	OPTIMAL FRAMES AND SUBSPACE PACKINGS
11138 1D	An infinite family of two-distance tight frames [11138-48]
11138 1E	Game of Sloanes: best known packings in complex projective space [11138-49]
11138 1F	Connections between structured tight frames and sum-of-squares optimization [11138-50]
11138 1G	Biangular Gabor frames and Zauner's conjecture [11138-51]
11138 1H	Linear programming bounds for cliques in Paley graphs [11138-52]

SPECTRAL GRAPH ANALYSIS

11138 11	Parameter tuning using asynchronous parallel pattern search in sparse signal reconstruction [11138-54]
11138 1K	Metrics of graph Laplacian eigenvectors [11138-56]
11138 1L	The random component-wise power method [11138-57]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Achard, Sophie, 11 Adcock, Ben, 09 Akçakaya, Mehmet, 1B Alexandru, Roxana, OL Altmann, Yoann, OT Amini, Arezou, 0Y Ashok, Amit, 0U Aviyente, Selin, 08 Balan, Radu, 06

Bandeira, Afonso S., OS, 1F Barbieri, Davide, 04 Bilgic, Berkin, 18 Bontonou, Myriam, OZ Borgnat, Pierre, ON, 11 Brown, Nicholas P., 1D Brugiapaglia, Simone, 09 Cabrelli, Carlos, 04 Calhoun, Vince, 01 Cao, Xiaozhi, 18

Cho, Jaeiin, 18 Chouzenoux, Emilie, 19 Ciuciu, Philippe, 19 Coates, Mark, 0Y DeGuchy, Omar, 11 DeRamus, Thomas, 01 Dobrosotskaya, Julia, 07 Dragotti, Pier Luigi, OL

Du, Yuhui, 01 El Gueddari, Loubna, 19

Faghiri, Ashkan, Ol Farrugia, Nicolas, OZ Frusque, Gaëtan, 0N Fu, Zening, 01 Gannaz, Irène, 11 Gao, Feng, 0Q Girard, Julien N., 0A Gonçalves, Paulo, 0N Goossens, Bart, OH Goyal, Vivek K., 0X

Gripon, Vincent, 0Z Guo, Weihong, 07 Haghani, Naveed, 06 Haldar, Justin P., 17 Hammernik, Kerstin, 1A Haque, Mozahid, 0G Hernández, Eugenio, 04

Hirn, Matthew, 0Q Hosseini, Seyed Amir Hossein, 1B

Iraji, Armin, 01

Iwen, Mark A., 08 Jaques, Christian, 16 Jasper, John, 1D, 1E Jung, Julien, 0N

Karantzas, Nikolaos, 0G, 0O

Kim, Tae Hvuna, 17 King, Emily J., 1E

King-Roskamp, Matthew, 09

Knoll, Florian, 1A Kunisky, Dmitriy, 1F Labate, Demetrio, 00 Lassance, Carlos, 0Z Lee, Kwan Kit, OU Lewis, Noah, 01 Li, Haotian, 1K Li, Yan-Ran, 1C Liao, Congyu, 18 Liebling, Michael, 16 Liégeois, Raphaël, 10 Luona, Hiệp, 0H Magsino, Mark, 1G, 1H Marcia, Roummel F., 11 McLaughlin, Stephen, OT Merad, Ibrahim, 10 Mitsakos, Nikolaos, 05 Mixon, Dustin G., 1E, 1G, 1H

Moeller, Steen, 1B Molter, Ursula, 04 Murray-Bruce, John, 0X Nammour, Fadi, 0A Narnhofer, Dominik, 1A Ngolè, Fred, 0A

Ozdemir, Alp, 08 Pal, Soumyasundar, 0Y Papadakis, Manos, 05, 0G, 0W

Parshall, Hans, 1H

Perlmutter, Michael, 0Q Pesquet, Jean-Christophe, 19 Petersen, Philipp, OF

Petrović, Miljan, 0D Philips, Wilfried, 0H Pock, Thomas, 1A Prasad, Saurabh, 00 Price, Eric, OR Qi, Shile, 01

Rachakonda, Srinivas, Ol Raslan, Mones, OF Roux, Marine, 11 Safari, Kazem, OG, OO

Saito, Naoki, OC, 1K Sarmadi, Saeed, OG Saunders, Charles, 0X Schmitz, Morgan A., 0A Setsompop, Kawin, 18 Shahraki, Farideh Foroozandeh, 00 Shao, Yiqun, 0C Starck, Jean-Luc, 0A Tachella, Julian, OT Teimury, Fatemeh, 0Y Teke, Oguzhan, 1L Tourneret, Jean-Yves, 0T Uğurbil, Kâmil, 1B Upadhyay, Sanat, OW Vaidyanathan, Palghat P., 1L Van De Ville, Dimitri, 0D, 10 Vignaud, Alexandre, 19 Villar, Soledad, OS Voigtlaender, Felix, OF Wang, Yu Guang, 0B Wolf, Guy, 0Q Yang, Shu, OU Yao, Weichi, OS Zare, Ali, 08 Zhang, Chi, 1B Zhang, Zijing, 18 Zhuang, Xiaosheng, OB, 1C

Conference Committee

Program Track Chair

Khan M. Iftekharuddin, Old Dominion University (United States)

Conference Chairs

Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Université de Genève (Switzerland) Manos Papadakis, University of Houston (United States) Yue M. Lu, Harvard University (United States)

Conference Program Committee

Sophie Achard, Grenoble Images Parole Signal Automatique (France)

Mehmet Akçakaya, University of Minnesota, Twin Cities (United States)

Pierre Borgnat, Laboratoire de Physique de l'ens de Lyon (France) **Benjamin Girault**, The University of Southern California (United States)

Vivek K. Goyal, Boston University (United States)

Emily J. King, Universität Bremen (Germany)

Demetrio Labate, University of Houston (United States)

Michael Liebling, Idiap Research Institute (Switzerland)

Dustin G. Mixon, The Ohio State University (United States)

Jean-Christophe Olivo-Marin, Institut Pasteur (France)

Michael Unser, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

Session Chairs

Signal, Image, and Data Processing Plenary Session **Khan M. Iftekharuddin**, Old Dominion University (United States)

1 Keynote Session I

Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Université de Genève (Switzerland)

- Neural Networks and Sparse Representations | Demetrio Labate, University of Houston (United States) Manos Papadakis, University of Houston (United States)
- Applications of Frames and Related Transforms
 Emily J. King, Universität Bremen (Germany)
 Dustin G. Mixon, The Ohio State University (United States)

- Wavelets on GraphsYue M. Lu, Harvard University (United States)
- Neural Networks and Sparse Representations II
 Demetrio Labate, University of Houston (United States)
 Manos Papadakis, University of Houston (United States)
- Keynote Session II
 Manos Papadakis, University of Houston (United States)
- 7 Time-Dependent Graph Signals and Dynamic Graphs I Sophie Achard, Grenoble Images Parole Signal Automatique (France)

Pierre Borgnat, Laboratoire de Physique de l'ens de Lyon (France) **Benjamin Girault**, The University of Southern California (United States)

- 8 Applications of Frames and Transforms in Neural Networks **Emily J. King**, Universität Bremen (Germany) **Dustin G. Mixon**, The Ohio State University (United States)
- 9 Computational Photonic ImagingVivek K. Goyal, Boston University (United States)
- Time-Dependent Graph Signals and Dynamic Graphs II
 Sophie Achard, Grenoble Images Parole Signal Automatique (France)

Pierre Borgnat, Laboratoire de Physique de l'ens de Lyon (France) **Benjamin Girault**, The University of Southern California (United States)

11 Keynote Session III

Yue M. Lu, Harvard University (United States)

12 Applications in Bio-Imaging

Jean-Christophe Olivo-Marin, Institut Pasteur (France) **Michael Liebling**, Idiap Research Institute (Switzerland)

13 Inverse Problems in MRI

Mehmet Akçakaya, University of Minnesota, Twin Cities (United States)

- Optimal Frames and Subspace Packings
 Emily J. King, Universität Bremen (Germany)
 Dustin G. Mixon, The Ohio State University (United States)
- 15 Spectral Graph Analysis

Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Université de Genève (Switzerland)