

PROCEEDINGS OF SPIE

Wavelets and Sparsity XV

Dimitri Van De Ville
Vivek K. Goyal
Manos Papadakis
Editors

26–29 August 2013
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 8858

Proceedings of SPIE 0277-786X, V. 8858

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

Wavelets and Sparsity XV, edited by Dimitri Van De Ville, Vivek K. Goyal, Manos Papadakis,
Proc. of SPIE Vol. 8858, 885801 · © 2013 SPIE · CCC code: 0277-786X/13/\$18
doi: 10.1117/12.2046361

Proc. of SPIE Vol. 8858 885801-1

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Wavelets and Sparsity XV*, edited by Dimitri Van De Ville, Vivek K. Goyal, Manos Papadakis, Proceedings of SPIE Vol. 8858 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X
ISBN: 9780819497086

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 © 2013, 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 \$18.00 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/13/\$18.00.

Printed in the United States of America.

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



SPIEDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID Number.

Contents

xi Conference Committee

SESSION 1 SPARSE REPRESENTATIONS

- 8858 02 **Image inpainting: theoretical analysis and comparison of algorithms** [8858-1]
E. J. King, G. Kutyniok, W.-Q. Lim, Technische Univ. Berlin (Germany)
- 8858 03 **Directional and non-directional representations for the characterization of neuronal morphology** [8858-2]
B. Ozcan, D. Labate, Univ. of Houston (United States) D. Jiménez, Univ. of Costa Rica (Central America) M. Papadakis, Univ. of Houston (United States)
- 8858 04 **Alpha molecules: curvelets, shearlets, ridgelets, and beyond** [8858-3]
P. Grohs, ETH Zürich (Switzerland); S. Keiper, G. Kutyniok, M. Schäfer, Technische Univ. Berlin (Germany)
- 8858 05 **A split-augmented Lagrangian algorithm for spectral factorization of a set of 2D directional filters and application to the design of compact shearlet frames** [8858-5]
B. Goossens, J. Aelterman, H. Luong, A. Pižurica, W. Philips, Ghent Univ. (Belgium)
- 8858 07 **Optimal restoration of noisy 3D x-ray data via shearlet decompositions** [8858-6]
D. Labate, Univ. of Houston (United States); G. R. Easley, The MITRE Corp. (United States); K. Guo, Missouri State Univ. (United States)

SESSION 2 KEYNOTE SESSION I

- 8858 08 **Interplay in various settings between shift invariant spaces, wavelets, and sampling (Keynote Paper)** [8858-7]
P. M. Luthy, G. L. Weiss, E. N. Wilson, Washington Univ. in St. Louis (United States)

SESSION 3 FRAME THEORY AND SPARSE APPROXIMATIONS I

- 8858 0C **Weighted and reweighted approximate message passing** [8858-11]
N. Ghadermarzy, Ö. Yilmaz, The Univ. of British Columbia (Canada)
- 8858 0D **Signal recovery from thresholded frame measurements** [8858-12]
H. Boche, Technische Univ. München (Germany); M. Guillemard, G. Kutyniok, F. Philipp, Technische Univ. Berlin (Germany)

SESSION 4		FRAME THEORY AND SPARSE APPROXIMATIONS II
8858 0F	Random fusion frames for loss-insensitive packet encoding [8858-14]	B. G. Bodmann, P. K. Singh, Univ. of Houston (United States)
8858 0G	Preconditioning of frames [8858-15]	G. Kutyniok, Technische Univ. Berlin (Germany); K. A. Okoudjou, Univ. of Maryland (United States); F. Philipp, Technische Univ. Berlin (Germany)
8858 0H	Stability of phase retrievable frames [8858-16]	R. Balan, Univ. of Maryland, College Park (United States)
SESSION 5		WAVELETS AND SPARSITY ON THE SPHERE
8858 0I	On the computation of directional scale-discretized wavelet transforms on the sphere [8858-17]	J. D. McEwen, Univ. College London (United Kingdom); P. Vandergheynst, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Y. Wiaux, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Univ. Hospital Ctr. (Switzerland) and Univ. Hospital Lausanne (Switzerland) and Univ. of Geneva (Switzerland)
8858 0J	Flaglets for studying the large-scale structure of the Universe [8858-18]	B. Leistedt, H. V. Peiris, J. D. McEwen, Univ. College London (United Kingdom)
8858 0K	3D sparse representations on the sphere and applications in astronomy [8858-19]	F. Lanusse, J.-L. Starck, Lab. AIM, URM CEA-CNRS (France)
8858 0L	Spatio-spectral formulation and design of spatially-varying filters for signal estimation on the 2-sphere [8858-20]	Z. Khalid, R. A. Kennedy, P. Sadeghi, S. Durrani, The Australian National Univ. (Australia)
8858 0M	Classification and construction of closed-form kernels for signal representation on the 2-sphere [8858-21]	R. A. Kennedy, P. Sadeghi, Z. Khalid, The Australian National Univ. (Australia); J. D. McEwen, Univ. College London (United Kingdom)
8858 0N	A spatirospectral localization approach for analyzing and representing vector-valued functions on spherical surfaces [8858-22]	A. Plattner, F. J. Simons, Princeton Univ. (United States)
SESSION 6		GROUP SPARSITY
8858 0O	Combining multiple observations of audio signals [8858-23]	I. Bayram, Istanbul Technical Univ. (Turkey)
8858 0P	Hybrid approximate message passing for generalized group sparsity [8858-24]	A. K. Fletcher, Univ. of California, Santa Cruz (United States); S. Rangan, Polytechnic Institute of New York Univ. (United States)

- 8858 0Q **On linear transform design with non-linear approximation** [8858-25]
O. G. Sezer, Texas Instruments Inc. (United States); O. G. Guleryuz, LG Electronics Mobile Research Lab. (United States)
- 8858 0R **Group sparse optimization by alternating direction method** [8858-26]
W. Deng, W. Yin, Y. Zhang, Rice Univ. (United States)

SESSION 8 SPARSITY AND FRI SAMPLING METHODS

- 8858 0T **A unified framework for 3rd generation LIDAR pulse processing based on finite rate of innovations** [8858-28]
C. D. Creusere, J. Castorena, New Mexico State Univ. (United States)
- 8858 0U **MAP recovery of polynomial splines from compressive samples and its application to vehicular signals** [8858-29]
A. Hirabayashi, Ritsumeikan Univ. (Japan); S. Makido, Toyota Central R&D Labs., Inc. (Japan); L. Condat, GIPSA-Lab. (France)
- 8858 0V **Sampling great circles at their rate of innovation** [8858-30]
S. Deslauriers-Gauthier, P. Marziliano, Nanyang Technological Univ. (Singapore)
- 8858 0Y **Approximate Strang-Fix: sampling infinite streams of Diracs with any kernel** [8858-33]
P. L. Dragotti, J. Oñativia, A. J. Urigüen, Imperial College London (United Kingdom); T. Blu, Chinese Univ. of Hong Kong (China)

SESSION 9 OPTIMIZATION FOR SPARSE RECOVERY PROBLEMS

- 8858 0Z **Joint image registration and reconstruction from compressed multi-view measurements** [8858-35]
G. Puy, P. Vandergheynst, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8858 11 **Sparsity and cosmology: inverse problems in cosmic microwave background experiments** [8858-37]
F. C. Sureau, J. Bobin, J.-L. Starck, Lab. AIM, UMR CEA-CNRS (France)

SESSION 10 COMPUTATIONAL BIO-IMAGING I

- 8858 13 **Coding and sampling for compressive x-ray diffraction tomography** [8858-40]
J. A. Greenberg, K. Krishnamurthy, M. Lakshmanan, K. MacCabe, Duke Univ. (United States); S. Wolter, Duke Univ. (United States) and Elon Univ. (United States); A. Kapadia, D. Brady, Duke Univ. (United States)
- 8858 14 **Theory of compressive sensing with quadratic phase systems and examples in optics** [8858-41]
Y. Rivenson, A. Stern, Ben-Gurion Univ. of the Negev (Israel)

SESSION 11 COMPUTATIONAL BIO-IMAGING II

- 8858 16 **Rotation-covariant visual concept detection using steerable Riesz wavelets and bags of visual words** [8858-43]
A. Depeursinge, Stanford Univ. (United States) and Univ. Hospital of Geneva (Switzerland) and Univ. of Applied Sciences Western Switzerland (Switzerland); A. Foncubierta, Univ. of Applied Sciences Western Switzerland (Switzerland); H. Müller, Univ. Hospital of Geneva (Switzerland) and Univ. of Applied Sciences Western Switzerland (Switzerland); D. Van de Ville, Univ. Hospital of Geneva (Switzerland) and Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8858 18 **Biological video reconstruction using linear or non-linear Fourier measurements** [8858-45]
Y. Le Montagner, Institut Pasteur (France) and Télécom ParisTech (France); E. Angelini, Télécom ParisTech (France); J.-C. Olivo-Marin, Institut Pasteur (France)
- 8858 19 **Fast thresholded multi-channel Landweber algorithm for wavelet-regularized multi-angle deconvolution** [8858-46]
N. Chacko, M. Liebling, Univ. of California, Santa Barbara (United States)

SESSION 12 EMERGING TRANSFORMS AND APPLICATIONS

- 8858 1B **Compressed gated range sensing** [8858-48]
G. Tsagkatakis, Foundation for Research and Technology-Hellas (Greece); A. Woiselle, Sagem Défense Sécurité (France); G. Tzagkarakis, Commissariat à l'Energie Atomique (France); M. Bousquet, Sagem Défense Sécurité (France); J.-L. Starck, Commissariat à l'Energie Atomique (France); P. Tsakalides, Foundation for Research and Technology-Hellas (Greece)
- 8858 1C **Angle-preserving quantized phase embeddings** [8858-49]
P. T. Boufounos, Mitsubishi Electric Research Labs. (United States)
- 8858 1D **Poisson noise removal with pyramidal multi-scale transforms** [8858-50]
A. Woiselle, Sagem Défense Sécurité (France); J.-L. Starck, Lab. AIM, CNRS, CEA (France); J. M. Fadili, Ecole Nationale Supérieure d'Ingenieurs de Caen et Ctr. de Recherche (France)
- 8858 1E **Compressed sensing image reconstruction for the LOFAR Radio Telescope** [8858-51]
H. Garsden, J.-L. Starck, S. Corbel, Commissariat à l'Énergie Atomique, CNRS, Univ. Paris Diderot (France); C. Tasse, SKA South Africa (South Africa) and GEPI, Observatoire de Paris, CNRS, Univ. Paris Diderot (France); A. Woiselle, Commissariat à l'Énergie Atomique, CNRS, Univ. Paris Diderot (France) and Sagem Défense Sécurité (France)
- 8858 1F **Spatio-temporal regularization for range imaging with high photon efficiency** [8858-52]
A. Kirmani, A. Colaço, D. Shin, V. K. Goyal, Massachusetts Institute of Technology (United States)

SESSION 13 SIGNAL REPRESENTATIONS AND SPARSITY ON GRAPHS

- 8858 1H **Local hub screening in sparse correlation graphs** [8858-54]
H. Firouzi, A. O. Hero III, Univ. of Michigan (United States)
- 8858 1K **On the interplay between topology and signals supported on graphs** [8858-57]
M. G. Rabbat, McGill Univ. (Canada)
- 8858 1L **On the sparsity of wavelet coefficients for signals on graphs** [8858-58]
B. Ricaud, D. I. Shuman, P. Vandergheynst, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8858 1N **A fast Monte Carlo algorithm for source localization on graphs** [8858-60]
A. Agaskar, Harvard School of Engineering and Applied Sciences (United States) and MIT Lincoln Lab. (United States); Y. M. Lu, Harvard School of Engineering and Applied Sciences (United States)

SESSION 14 FRAME THEORY AND APPLICATIONS I

- 8858 1O **Near-optimal phase retrieval of sparse vectors** [8858-61]
A. S. Bandeira, Princeton Univ. (United States); D. G. Mixon, Air Force Institute of Technology (United States)
- 8858 1P **Compressive parameter estimation with earth mover's distance via K-median clustering** [8858-62]
D. Mo, M. F. Duarte, Univ. of Massachusetts, Amherst (United States)
- 8858 1Q **A construction of unimodular equiangular tight frames from resolvable Steiner systems** [8858-63]
J. Jasper, Univ. of Missouri-Columbia (United States)
- 8858 1R **Frame theory for locally compact abelian groups** [8858-64]
E. J. King, Univ. Bremen (Germany)
- 8858 1S **Fast null space tuning algorithms with feedbacks for sparse signal recovery** [8858-65]
T. Mi, Renmin Univ. of China (China); S. Li, San Francisco State Univ. (United States) and Univ. of China (China)

SESSION 15 FRAME THEORY AND APPLICATIONS II

- 8858 1T **Multiscale dictionaries, transforms, and learning in high-dimensions** [8858-66]
S. Gerber, M. Maggioni, Duke Univ. (United States)
- 8858 1U **Random encoding of quantized finite frame expansions** [8858-67]
M. Iwen, Michigan State Univ. (United States); R. Saab, Univ. of California, San Diego (United States)

- 8858 1W **Using projections for phase retrieval** [8858-69]
J. Cahill, P. G. Casazza, Univ. of Missouri-Columbia (United States); J. Peterson, Air Force Institute of Technology (United States); L. M. Woodland, Univ. of Missouri-Columbia (United States)

SESSION 16 SPARSITY IN MRI

- 8858 1X **Reconstruction with diffeomorphic motion compensation for undersampled dynamic MRI** [8858-70]
G. Adluru, E. V. R. DiBella, The Univ. of Utah (United States)
- 8858 1Y **Motion estimation/compensated compressed sensing using patch-based low rank penalty** [8858-71]
H. Yoon, J. C. Ye, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 8858 1Z **Low-rank + sparse (L+S) reconstruction for accelerated dynamic MRI with separation of background and dynamic components** [8858-72]
R. Otazo, D. K. Sodickson, New York Univ. School of Medicine (United States); E. J. Candès, Stanford Univ. (United States)
- 8858 20 **Joint image reconstruction and motion parameter estimation for free-breathing navigator-gated cardiac MRI** [8858-73]
M. Akçakaya, T. A. Basha, S. Weingärtner, R. Nezafat, Beth Israel Deaconess Medical Ctr. (United States)
- 8858 21 **Exploiting local low-rank structure in higher-dimensional MRI applications** [8858-74]
J. D. Trzasko, Mayo Clinic College of Medicine (United States)
- 8858 22 **Accelerated dynamic MRI using sparse dictionary learning** [8858-75]
S. G. Lingala, M. Jacob, The Univ. of Iowa (United States)
- 8858 23 **Prospective motion correction for functional MRI using sparsity and Kalman filtering** [8858-76]
D. S. Weller, D. C. Noll, J. A. Fessler, Univ. of Michigan (United States)

POSTER SESSION

- 8858 24 **Imaging dark matter using sparsity** [8858-77]
F. Lanusse, A. Leonard, J.-L. Starck, Lab. AIM, UMR CEA-CNRS (France)
- 8858 25 **Curvelet-based method for orientation estimation of particles** [8858-78]
J. Sampo, Lappeenranta Univ. of Technology (Finland) and Univ. of Helsinki (Finland); J. J. Takalo, Univ. of Jyväskylä (Finland); S. Siltanen, Univ. of Helsinki (Finland); A. Miettinen, Univ. of Jyväskylä (Finland); M. Lassas, Univ. of Helsinki (Finland); J. Timonen, Univ. of Jyväskylä (Finland)

- 8858 26 **Optical coherence tomography noise reduction over learned dictionaries with introduction of complex wavelet for start dictionary** [8858-79]
R. Kafieh, H. Rabbani, Isfahan Univ. of Medical Sciences (Iran, Islamic Republic of)
- 8858 27 **Dense grid sibling frames with linear phase filters** [8858-80]
F. Abdelnour, Weill Cornell Medical College (United States)

Author Index

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)

Vivek K. Goyal, Massachusetts Institute of Technology (United States)
Manos Papadakis, University of Houston (United States)

Conference Program Committee

Sophie Achard, Gipsa-laboratory (France)

Akram Aldroubi, Vanderbilt University (United States)

Radu V. Balan, University of Maryland, College Park (United States)

Bernhard G. Bodmann, University of Houston (United States)

Peter G. Casazza, University of Missouri-Columbia (United States)

Emilie Chouzenoux, Université Paris-EST (France)

Pier Luigi Dragotti, Imperial College London (United Kingdom)

Jalal M. Fadili, ENSICAEN (France)

Alexandre Gramfort, Telecom Paris Tech (France)

Onur G. Guleryuz, FutureWei Technologies, Inc. (United States)

Mathews Jacob, The University of Iowa (United States)

Matthew Fickus, Air Force Institute of Technology (United States)

Ilya A. Krishtal, Northern Illinois University (United States)

Gitta Kutyniok, Technische Universität Berlin (Germany)

Demetrio Labate, University of Houston (United States)

Andrew F. Laine, Columbia University (United States)

Michael Liebling, University of California, Santa Barbara (United States)

Yue M. Lu, Harvard University (United States)

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

Jonas Richiardi, Stanford University (United States)

Ivan W. Selesnick, Polytechnic Institute of New York University
(United States)

Michael Unser, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

Yves Wiaux, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

Session Chairs

1 Sparse Representations

Demetrio Labate, University of Houston (United States)

Ilya A. Krishtal, Northern Illinois University (United States)

- 2 Keynote Session I
Manos Papadakis, University of Houston (United States)
- 3 Frame Theory and Sparse Approximations I
Bernhard G. Bodmann, University of Houston (United States)
Radu V. Balan, University of Maryland, College Park (United States)
Gitta Kutyniok, Technische Universität Berlin (Germany)
- 4 Frame Theory and Sparse Approximations II
Bernhard G. Bodmann, University of Houston (United States)
Radu V. Balan, University of Maryland, College Park (United States)
Gitta Kutyniok, Technische Universität Berlin (Germany)
- 5 Wavelets and Sparsity on the Sphere
Yves Wiaux, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
Frederik J. Simons, Princeton University (United States)
- 6 Group Sparsity
Onur G. Guleryuz, FutureWei Technologies, Inc. (United States)
Ivan W. Selesnick, Polytechnic Institute of New York University (United States)
- 7 Keynote Session II
Vivek K. Goyal, Massachusetts Institute of Technology (United States)
- 8 Sparsity and FRI Sampling Methods
Pier Luigi Dragotti, Imperial College London (United Kingdom)
- 9 Optimization for Sparse Recovery Problems
Jalal M. Fadili, ENSICAEN (France)
Florent Sureau, Commissariat à l'Énergie Atomique (France)
- 10 Computational Bio-Imaging I
Michael Liebling, University of California, Santa Barbara (United States)
- 11 Computational Bio-Imaging II
Michael Liebling, University of California, Santa Barbara (United States)
- 12 Emerging Transforms and Applications
Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 13 Signal Representations and Sparsity on Graphs
Yue M. Lu, Harvard University (United States)
- 14 Frame Theory and Applications I
Matthew Fickus, Air Force Institute of Technology (United States)
Peter G. Casazza, University of Missouri-Columbia (United States)

- 15 Frame Theory and Applications II
Matthew Fickus, Air Force Institute of Technology (United States)
Peter G. Casazza, University of Missouri-Columbia (United States)

- 16 Sparsity in MRI
Mathews Jacob, The University of Iowa (United States)

Panel Discussion on Twenty Years of Wavelets and the As(/Des)cent of Mount Sparsity

Guido Weiss, Washington University in St. Louis (United States)
Michael Unser, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
Felix J. Herrmann, The University of British Columbia (Canada)