Marvasti et al. EURASIP Journal on Advances in Signal Processing 2012, **2012**:90
http://asp.eurasipjournals.com/content/2012/1/90

EURASIP Journal on Advances in Signal Processing
a SpringerOpen Journal

EDITORIAL Open Access

Editorial

Farokh Marvasti[1*], Ali Mohammad-Djafari[2] and Jonathon Chambers[3]

Over the last three decades, there has been increasing interest in exploiting sparseness constraints in signal processing, that is, searching for target signals with as few non-zero entries as possible. This approach was, perhaps, first exploited in the modelling of excitation signals in speech processing or reflectivity sequences in seismic deconvolution with only a small number of non-zero values. Some 30 years later, the associated mathematical methods and application domains, both for single- and multiple-dimensional signals, have evolved to a point where *sparse signal processing* has become an area of study in its own right.

This special issue on sparse signal processing, therefore, begins with a review article by Marvasti et al. [1], entitled *A unified approach to sparse signal processing* which provides a tutorial review of sparse signal recovery using various techniques with minimal sampling measurements, in effect, compressed sampling, and also describes applications of sparsity in a number of other challenging domains. Many of the articles in this special issue are related to applications of sparse signal processing.

The next set of articles provides examples of where sparsity can be exploited in parameter estimation problems. The article by Djafari [2] uses a Bayesian inference approach to address both signal and image inversion problems wherein sparsity is considered either in the original or transformed signal space. Taxonomy of prior models is provided for the related probabilistic frameworks, and associated estimation algorithms are developed.

Angelosante and Giannakis [3], in an invited article, consider the problem of estimating the parameters of time-varying autoregressive models. They overcome the lack of continuity and high computational complexity in working with high-dimensional datasets by casting their problem as a sparse regression with grouped variables. This is then solved with a group least-absolute shrinkage and selection operator, denoted *Lasso*. Numerical evaluations are employed to demonstrate the merits of the approach.

Zhu et al [4]. also examine a parameter estimation problem in the context of Synthetic Aperture Radar (SAR). They address a difficult nonlinear problem by employing linearization and an over-complete dictionary. This is motivated by the sparse distribution in the observation space of SAR micromotion targets. A variational approximation framework is also exploited for Bayesian computation, and numerical simulations confirm the higher resolution achievable by the proposed approach over conventional methods.

Xie et al. [5] provide a hybrid approach for 2D direction-of-arrival estimation in the presence of mutual coupling across the array. They employ a manifold decomposition approach for the case when the number of sensors is sparse, smaller than required in traditional beamspace-based algorithms. In particular, an algorithm to estimate azimuth angle without exact knowledge of the mutual coupling is provided.

Blanco and Nájar [6] propose an algorithm for estimating the angles of arrival of multiple uncorrelated sources impinging upon a uniform linear array. They use an over-complete dictionary representation of the spatial covariance matrix model. A sparsity penalty is applied and a least angle regression/homotopic approach is used to solve the resulting objective function. Their approach is shown to achieve high resolution with the advantage of low computational cost.

Li et al. [7] focus upon source localization with a single snapshot and improve the efficiency of an iterative adaptive approach by utilizing the optimal filter only on the spatial components corresponding to the impinging angles of the sources. Their evaluations confirm that this simplification attains comparable accuracy of source angle and power estimation with a substantial reduction in computational load.

Sahnoun et al. [8] address multi-dimensional modal estimation using sparse estimation techniques in combination with an efficient multigrid approach. To overcome huge size in the necessary dictionaries, they refine their dictionaries over several levels of resolution. Their sparse modal

* Correspondence: fmarvasti@gmail.com
[1]Advanced Communications Research Institute, Sharif University of Technology, Tehran, Iran
Full list of author information is available at the end of the article

method is shown to enhance greatly the estimation accuracy for noisy signals and to yield good robustness to the choice of the number of components.

The next set of articles includes works on dictionary learning and provides both practical approaches and new theoretical results. Huang et al. [9] consider adaptive matching pursuit to find atoms used in the context of dictionary learning. They apply a total least squares constraint in the learning and concentrate upon obtaining a better match between the grid, and the ensuing dictionary, and the available measurements.

Zheng et al. [10] provide an algorithm for sparse signal recovery based on exploiting the relationship between the noise subspace and an overcomplete basis matrix representation. Their approach has the advantage that not only it can enhance the sparseness of the solution, but also can reduce the number of required data snapshots and the signal-to-noise ratio for stable recovery.

Wang et al. [11] also study sparse signal reconstruction and propose the restricted isometry property for the orthogonal matching pursuit algorithm. Their bound is found to be close to that previously conjectured by researchers in the field.

The final set of articles includes works which show where sparsity can be exploited in various application domains: communications, image & video processing, and radar.

Pakrooh et al. [12] investigate the problem of deterministic pilot allocation in Orthogonal Frequency Division Multiplexing systems. They propose a method based on the minimization of a coherence measure of the submatrix of the unitary discrete Fourier transform matrix associated with the pilot subcarriers and propose strategies for carrier placement based on cyclic difference sets. They also consider orthogonal matching pursuit and an Iterative Method with Adaptive Thresholding for channel estimation.

Lagunas and Nájar [13] consider spectrum sensing for cognitive radio. They use a feature-based approach based on periodic non-uniform sampling. A correlation-matching procedure is proposed to detect predetermined spectral shapes in sparse wideband regimes.

Sermwuthisarn et al. [14] address sparse signal reconstruction from a compressed measurement image corrupted by impulsive noise. An octave-tree discrete wavelet transform is employed to induce sparsity within the image signal. The energy distribution of the reconstructed sparse signal is then used to perform noise removal, and the noise-corrupted coefficients are finally estimated to yield the reconstructed signal.

The article by Zamani et al. [15] is set in the context of magnetic resonance imaging and proposes the use of certain sampling strategies to increase the speed of cardiac cine visualization. Fuzzy c-means clustering is used to cluster statistical features extracted from the temporal-spatial data, and hidden Markov models are also used for modelling. The authors achieve a doubling in speed over current methods.

Liu et al. [16] undertake a study in sparse signal processing for ballistic missile warning radar, and assume the radar return is sparse. A sparse dictionary is developed which is parameterized by the unknown precession frequency used in modelling a conical missile during flight. The precession frequency and the scattering centres of the missile are then estimated through nonlinear least squares and an orthogonal matching pursuit algorithm.

We wish to acknowledge all the reviewers who have helped considerably to improve the quality of this special issue. Special thanks must also be expressed for the support from Dr Arash Amini and Professor Bulent Sankur; together with that provided by Christopher Sy at the Journal Editorial Office. Finally, the Lead Editor, Farokh Marvasti, wishes to thank Prof Izzat Dawazah for providing the opportunity for him to spend a period of sabbatical leave at University College London.

Author details
[1]Advanced Communications Research Institute, Sharif University of Technology, Tehran, Iran [2]Laboratoire des Signaux et Systemes (L2S), CNRS-SUPELEC UNIV PARIS SUD, Orsay, France [3]Communications Division, School of Electronic, Electrical and Systems Engineering, Loughborough University, Leicestershire, UK

Competing interests
The authors declare that they have no competing interests.

Received: 19 March 2012 Accepted: 26 April 2012
Published: 26 April 2012

References

1. Farokh Marvasti, Arash Amini, Farzan Haddadi, Mehdi Soltanolkotabi, Babak Khalaj, Akram Aldroubi, Saeid Sanei, Jonathon Chambers, A unified approach to sparse signal processing. *EURASIP Journal on Advances in Signal Processing* **2012**, 44 (2012). doi:10.1186/1687-6180-2012-44
2. Ali Mohammad-Djafari, Bayesian approach with prior models which enforce sparsity in signal and image processing. *EURASIP Journal on Advances in Signal Processing*, **2012**:52 (2012)
3. Daniele Angelosante, Georgios GiannakisB, Group lassoing change-points in piecewise-constant AR. *EURASIP Journal on Advances in Signal Processing*. **2012**, 70 (2012). doi:10.1186/1687-6180-2012-70
4. Sha Zhu, Ali Mohammad-Djafari, Hongqiang Wang, Bin Deng, Xiang Li, Junjie Mao, Parameter estimation for SAR micromotion target based on sparse signal representation. *EURASIP Journal on Advances in Signal Processing*. **2012**, 13 (2012). doi:10.1186/1687-6180-2012-13
5. Julan Xie, Zishu He, Huiyong Li, Jun Li, 2D DOA estimation with sparse uniform circular arrays in the presence of mutual coupling. *EURASIP Journal on Advances in Signal Processing*. **2011**, 127 (2011). doi:10.1186/1687-6180-2011-127
6. Luis Blanco, Montse Najar, Sparse covariance fitting for direction of arrival estimation. *EURASIP Journal on Advances in Signal Processing* (in press)
7. Gang Li, Hao Zhang, Xiqin Wang, Xiang-Gen Xia, An efficient implementation of iterative adaptive approach for source localization. *EURASIP Journal on Advances in Signal Processing*. **2012**, 7 (2012). doi:10.1186/1687-6180-2012-7
8. Souleymen Sahnoun, El-Hadi Djermoune, Charles Soussen, David Brie, Sparse multidimensional modal analysis using a multigrid dictionary

refinement. *EURASIP Journal on Advances in Signal Processing*. **2012**, 60 (2012)
9. Tianyao Huang, Yimin Liu, Huadong Meng, Xiqin Wang, Adaptive matching pursuit with constrained total least squares. EURASIP Journal on Advances in Signal Processing. **2012**, 76 (2012). doi:10.1186/1687-6180-2012-76
10. Chundi Zheng, Gang Li, Yimin Liu, Xiqin Wang, Subspace Weighted L2,1 Minimization for Sparse Signal Recovery. *EURASIP Journal on Advances in Signal Processing* (in press)
11. Jian Wang, Seokbeop Kwon, Byonghyo Shim, Near optimal bound of orthogonal matching pursuit using restricted isometric constant. *EURASIP Journal on Advances in Signal Processing*. **2012**, 8 (2012). doi:10.1186/1687-6180-2012-8
12. Pooria Pakrooh, Arash Amini, Farokh Marvasti, OFDM pilot allocation for sparse channel estimation. *EURASIP Journal on Advances in Signal Processing*. **2012**, 59 (2012). doi:10.1186/1687-6180-2012-59
13. Eva Lagunas, Montse Najar, Sparse correlation matching-based spectrum sensing for open spectrum communications. *EURASIP Journal on Advances in Signal Processing*. **2012**, 31 (2012). doi:10.1186/1687-6180-2012-31
14. Parichat Sermwuthisarn, Duangrat Gansawat, Vorapoj Patanavijit, Supatana Auethavekiat, Impulsive noise rejection method for compressed measurement signal in compressed sensing. *EURASIP Journal on Advances in Signal Processing*. **2012**, 68 (2012). doi:10.1186/1687-6180-2012-68
15. Pooria Zamani, Mohammad Kayvanrad, Hamid Soltanian-Zadeh, Using learned under-sampling pattern for increasing speed of cardiac cine MRI based on compressive sensing principles. *EURASIP Journal on Advances in Signal Processing*. **2012**, 82 (2012). doi:10.1186/1687-6180-2012-82
16. Lihua Liu, Xiaoyong Du, Mounir Ghogho, Weidong Hu, Des McLernon, Precession missile feature extraction using sparse component analysis of radar measurements. *EURASIP Journal on Advances in Signal Processing*. **2012**, 24 (2012). doi:10.1186/1687-6180-2012-24

doi:10.1186/1687-6180-2012-90
Cite this article as: Marvasti *et al.*: **Editorial.** *EURASIP Journal on Advances in Signal Processing* 2012 **2012**:90.