ZHIHUI ZHU

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RESEARCH INTERESTS

- Mathematical analysis of (nonsmooth) nonconvex optimization problems
- Efficient and reliable methods for high-dimensional and large-scale optimization problems
- Expressivity, trainability, and generalization of deep neural networks
- Data analysis, machine learning, and signal processing using low-complexity models
- Approximation theory and computational harmonic analysis

EDUCATION

2017	Ph.D. in Electrical Engineering (Dr. Michael Wakin, advisor)	Colorado School of Mines
2012	B.E. in Telecommunications Engineering (Dr. Gang Li, advisor), winner of Best Bachelor's Thesis Award (1/125)	Zhejiang University of Technology Jianxing Honors College

POSITIONS

2018-present	Postdoctoral Fellow (Dr. René Vidal, advisor)	Johns Hopkins University Center for Imaging Science Mathematical Institute for Data Science
2014-2017	Research Assistant (Dr. Michael Wakin, advisor)	Colorado School of Mines Dept. of Electrical Engineering
2013-2014	Teaching Assistant	Colorado School of Mines Dept. of Electrical Engineering
2010-2013	Research Assistant (Dr. Gang Li, advisor)	Zhejiang University of Technology Zhejiang Key Lab. for Signal Processing

HONORS

2018	Electrical Engineering Graduate Research Award	Colorado School of Mines
2016	Travel Grant for the February Fourier Talks	Norbert Wiener Center
2013	National Scholarship	Ministry of Education of PRC
2012	Best Bachelor's Thesis Award (1/125) for the Thesis "On The Sparse Representation of Signals in Compressive Sensing"	ZJUT
2011	Meritorious Winner of MCM/ICM	COMAP

PREPRINTS[1]

1. Z. Zhu*, Q. Li*, G. Tang, and M. B. Wakin, "Global Optimality in Distributed Low-rank Matrix Factorization," arXiv preprint arXiv: 1811.03129, 2018.

2. X. Li*, Z. Zhu*, A.M.-C. So, and R. Vidal, "Nonconvex Robust Low-rank Matrix Recovery," submitted to *SIAM Journal on Optimization*, arXiv preprint arXiv:1809.09237, 2018.

3. Z. Zhu, D. Soudry, Y. C. Eldar, and M. B. Wakin, "The Global Optimization Geometry of Shallow Linear Neural Networks," submitted to *Mathematical Foundations of Deep Learning in Imaging Science*, special issue of *Journal of Mathematical Imaging and Vision*, arXiv preprint arXiv:1805.04938, 2018.

4. Z. Zhu and X. Li, "Convergence Analysis of Alternating Nonconvex Projections," submitted to *SIAM Journal on Mathematics of Data Science*, arXiv preprint arXiv:1802.03889, 2018.

5. Z. Zhu and M. B. Wakin, "Time-Limited Toeplitz Operators on Abelian Groups: Applications in Information Theory and Subspace Approximation," submitted to *Information and Inference: A Journal of the IMA*, arXiv preprint arXiv:1711.07956, 2017.

6. Z. Zhu, Q. Li, G. Tang, and M. B. Wakin, "The Global Optimization Geometry of Low-Rank Matrix Optimization," submitted to *IEEE Transactions on Information Theory*, arXiv preprint arXiv:1703.01256, 2017.

JOURNAL PUBLICATIONS

1. Q. Li, Z. Zhu, and G. Tang, "The Non-convex Geometry of Low-rank Matrix Optimization," to appear in *Information and Inference: A Journal of the IMA*.

2. S. Karnik, Z. Zhu, M. B. Wakin, J. Romberg, and M. A. Davenport, "The Fast Slepian Transform," to appear in *Applied and Computational Harmonic Analysis*.

3. C. Wang, Z. Zhu, H. Gu, X. Wu, and S. Liu, "Hankel Low-Rank Approximation for Seismic Noise Attenuation," to appear in *IEEE Transactions on Geoscience and Remote Sensing*.

4. Z. Zhu, S. Karnik, M. Wakin, M. Davenport, and J. Romberg, "ROAST: Rapid Orthogonal Approximate Slepian Transform,", *IEEE Transactions on Signal Processing*, vol 66, no. 22, pp. 5887-5901, November 2018.

5. Z. Zhu, G. Li, J. Ding. Q. Li, and X. He, "On Collaborative Compressive Sensing Systems: The Framework, Design and Algorithm," *SIAM Journal on Imaging Sciences*, vol 11, no. 2, pp. 1717-1758, 2018.

6. Z. Zhu, Q. Li, G. Tang, and M. B. Wakin, "Global Optimality in Low-rank Matrix Optimization," *IEEE Transactions on Signal Processing*, vol 66, no. 13, pp. 3614-3628, July 2018.

7. T. Hong and Z. Zhu, "An Efficient Method for Robust Projection Matrix Design," *Signal Processing*, vol. 143, pp. 200-210, February 2018.

8. Z. Zhu, S. Karnik, M. A. Davenport, J. K. Romberg, and M. B. Wakin, "The Eigenvalue Distribution of Discrete Periodic Time-Frequency Limiting Operators," *IEEE Signal Processing Letters*, vol. 25, no. 1, pp. 95–99, January 2018.

9. Z. Zhu and M. B. Wakin, "Approximating Sampled Sinusoids and Multiband Signals Using Multiband Modulated DPSS Dictionaries," *Journal of Fourier Analysis and Applications*, vol. 23, no. 6, pp. 1263–1310, December 2017.

[1] *indicates equal contribution. Link to each paper can be found by clicking the title.

10. Z. Zhu and M. B. Wakin, "On the Asymptotic Equivalence of Circulant and Toeplitz Matrices," *IEEE Transactions on Information Theory*, vol. 63, no. 5, pp. 2975-2992, May 2017.

11. G. Li, Z. Zhu, D. Yang, L. Chang, and H. Bai, "On Projection Matrix Optimization for Compressive Sensing Systems," *IEEE Transactions on Signal Processing*, vol. 61, no. 11, pp. 2887-2898, June 2013.

CONFERENCE PUBLICATIONS

1. Z. Zhu, Y. Wang, D. P. Robinson, D. Naiman, R. Vidal, and M. C. Tsakiris, "Dual Principal Component Pursuit: Improved Analysis and Efficient Algorithms," to appear in *Neural Information Processing Systems (NIPS)*, December 2018. (acceptance rate = 20.8%)

2. Z. Zhu*, X. Li*, K. Liu, and Q. Li, "Dropping Symmetry for Fast Symmetric Nonnegative Matrix Factorization," to appear in *Neural Information Processing Systems (NIPS)*, December 2018. (acceptance rate = 20.8%)

3. Z. Zhu, M. Lopez-Santillana, and M. B. Wakin,"Super-Resolution of Complex Exponentials from Modulations with Known Waveforms," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, Curacao, Dutch Antilles, December 2017.

4. Z. Zhu, Q. Li, G. Tang, and M. B. Wakin, "Global Optimality in Low-rank Matrix Optimization," *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Montreal, Quebec, Canada, November 2017.

5. Z. Zhu, D. Yang, M. B. Wakin, and G. Tang, "A Super-Resolution Algorithm for Multiband Signal Identification," *51st Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, California, October 2017.

6. Z. Zhu, S. Karnik, M. B. Wakin, M. A. Davenport, and J. K. Romberg, "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

7. G. Li, Z. Zhu, H. Bai, and A. Yu, "A New Framework for Designing Incoherent Sparsifying Dictionaries," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

8. Q. Li, S. Li, H. Mansour, M. Wakin, D. Yang, and Z. Zhu, "JAZZ: A Companion to MUSIC for Frequency Estimation with Missing Data," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

9. S. Karnik, Z. Zhu, M. B. Wakin, J. K. Romberg, and M. A. Davenport, "Fast Computations for Approximation and Compression in Slepian Spaces," *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Greater Washington, D.C., December 2016.

10. Z. Zhu and M. B. Wakin, "On the Dimensionality of Wall and Target Return Subspaces in Through-the-Wall Radar Imaging," *4th International Workshop on Compressed Sensing Theory and its Applications to Radar, Sonar and Remote Sensing (CoSeRa)*, Aachen, Germany, September 2016.

11. Z. Zhu, G. Tang, P. Setlur, S. Gogineni, M. Wakin, and M. Rangaswamy, "Super-Resolution in SAR Imaging: Analysis With the Atomic Norm," *IEEE Sensor Array and Multichannel Signal Processing (SAM) Workshop*, Rio de Janeiro, Brazil, July 2016.

12. Z. Zhu and M. B. Wakin, "New Analysis of Multiband Modulated DPSS Dictionaries," *Workshop on Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Cambridge, England, July 2015.

13. Z. Zhu and M. B. Wakin, "Wall Clutter Mitigation and Target Detection Using Discrete Prolate Spheroidal Sequences," *3rd International Workshop on Compressed Sensing Theory and its Applications to Radar, Sonar and Remote Sensing (CoSeRa)*, Pisa, Italy, June 2015.

14. Z. Zhu and M. B. Wakin, "Detection of Stationary Targets Using Discrete Prolate Spheroidal Sequences," *International Review of Progress in Applied Computational Electromagnetics (ACES)*, Williamsburg, Virginia, March 2015.

15. H. Bai, Z. Zhu, G. Li, and S. Li, "Design of Optimal Measurement Matrix for Compressive Detection," *International Symposium on Wireless Communication Systems (ISWCS)*, Ilmenau, Germany, August 2013.

16. S. Li, Z. Zhu, G. Li, L. Chang, and Q. Li, "Projection Matrix Optimization for Block-sparse Compressive Sensing," *IEEE International Conference on Signal Processing, Communication and Computing (ICSPCC)*, KunMing, August 2013.

17. Q. Li, Z. Zhu, S. Tang, L. Chang, and G. Li, "Projection Matrix Optimization Based on SVD for Compressive Sensing Systems," *Chinese Control Conference (CCC)*, July 2013.

18. Z. Zhu, D. Yang, G. Li, and C. Huang, "Stable 2nd Order Adaptive IIR filter Structure for Blind Deconvolution," *International Congress on Image and Signal Processing (CISP)*, Shanghai, October 2011.

PRESENTATIONS

1. "A Super-resolution Algorithm for Multiband Signal Identification," *51st Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, October 2017.

2. "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, April 2017.

3. "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *Computing-Mines Affiliates Partnership Program (C-MAPP) Award Event*, January 2017.

4. "Wall Clutter Mitigation and Target Detection in Through-the-Wall Radar Imaging," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, March 2016.

5. "On the Asymptotic Equivalence of Circulant and Toeplitz Matrices", *2016 February Fourier Talks – FFT 2016, Norbert Wiener Center for Harmonic Analysis and Applications, Department of Mathematics, University of Maryland*, College Park, Maryland, February 2016.

6. "SAR Radar Imaging of Targets Through the Wall," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, January 2016.

7. "New Analysis of Multiband Modulated DPSS Dictionaries," *Zhejiang Key Laboratory for Signal Processing*, May 2015.

8. "SAR Radar Imaging of Targets Through the Wall", *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, April 2015.

TEACHING EXPERIENCE

May 2018	Johns Hopkins Teaching Institute offered by Johns Hopkins Teaching Academy
Sep. 2016	Substitute Lecturer for *Information Systems Science II* (EENG 311)
2013-2014	Lab Instructor for *Digital Logic* (EENG 284)
Fall 2012	Teaching Assistant for *Signals and Systems*

MENTORING EXPERIENCE

2018-present	co-mentor Tianyu Ding (a Ph.D. student at JHU) on the project "Discovering High-Dimensional Structures in Big and Corrupted Data"
2016-2017	co-mentor Manuel Lopez-Santillana (an undergraduate student at CSM) on the project "Through-the-Wall Radar Imaging"
2012-2013	co-mentor Qiuwei Li and Shuang Li (undergraduate students at ZJUT) on the project "Sensing Matrix Design for Compressive Sensing"

PROFESSIONAL ACTIVITIES

Professional Societies

IEEE, SIAM

Technical Program Committees

IEEE International Conference on Digital Signal Processing (DSP), 2017
IEEE International Conference on Communication Technology (ICCT), 2017 & 2018

Reviewer for the Following Journals

Applied Computational and Harmonic Analysis
Bikhause Springer Series on Harmnois Analysis
Digital Signal Processing
Frontiers in Applied Mathematics and Statistics
IEEE Geoscience and Remote Sensing Letters
IEEE Journal of Selected Topics in Signal Processing
IEEE Signal Processing Letters
IEEE Transactions on Information Theory
IEEE Transactions on Signal Processing
Information and Inference: A Journal of the IMA
International Journal of Computer Vision
Patter Recognition Letters
Signal Processing

Reviewer for the Following Conferences

IEEE Radar Conference (RadarConf)
IEEE Int. Conference on Digital Signal Processing (DSP)
IEEE Int. Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)
International Conference on Learning Representations (ICLR)
Neural Information Processing Systems (NIPS)

EDUCATION EXPERIENCE

We presented lessons and activities related to signal filtering, movie recommendation systems, Google PageRank, and signal and video enhancement at the Mines Tech Camp/Discover STEM summer outreach program for middle school students (2014-2016), the Creating Technology program for high school girls (2015), and the Rocky Mountain Camp summer camp for dyslexic kids (2015-2016).

SERVICES

2010-2012	President of Mathematical Modeling Association, ZJUT
2011-2012	Counselor Assistant, Jianxing Honors College, ZJUT
2010-2012	Class Monitor, ZJUT