

Haris Vikalo

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RESEARCH INTERESTS

- My interests are in the general area of genomic signal processing, with the focus on biomolecular detection systems (design, modeling, estimation, and limits of performance) and biological networks.
- Other interests include stochastic signal processing (estimation, detection, filtering algorithms), optimization, communications, and algorithm complexity.

EDUCATION

- Ph.D. in Electrical Engineering, Stanford University, Stanford, CA, 2003.
- M.Sc. in Electrical Engineering, Lehigh University, Bethlehem, PA, 1997.
- B.Sc. in Electrical Engineering, University of Zagreb, Croatia, 1995.

EMPLOYMENT

- **Assistant Professor**, ECE Department, The University of Texas at Austin, 09/2007 - present.
 - Doing research at the interface between electrical engineering and genomics, advising students, and teaching graduate and undergraduate courses in Electrical and Computer Engineering.
- **Associate Scientist**, EE Department, California Institute of Technology, 07/2003 - 09/2007. (Previously, **Postdoctoral Researcher**, 01/2003 - 07/2003).
 - The focus of my research at Caltech was in the general area of genomic signal processing. I was particularly interested in the development and applications of new approaches to the modeling, data acquisition and information processing in biomolecular detection systems, and understanding fundamental limits of their performance. The ultimate technological goal of my research was the design of high performance biochips for biomedical applications such as molecular diagnostics, pathogen detection, and high-throughput screening. Specific projects that I had worked on include the development of the novel real-time microarray detection platform; probabilistic modeling of and optimal estimation in both conventional and real-time DNA microarrays; optimal estimation of DNA initial copy number in polymerase chain reaction (PCR) processes; and finding explicit analytical bounds on the mean-square errors of optimal estimators in both microarray- and PCR-based schemes.
- **Research Assistant**, EE Department, Stanford University, 09/1997 - 10/2002.
 - Conducted research in the general areas of stochastic signal processing and communications. Specific topics include the design and analysis of efficient algorithms for solving computationally hard problems encountered in communications (both point-to-point and broadcast network schemes); adaptation of iterative decoding techniques to multi-antenna systems; information-theoretic aspects of wireless communication schemes; robust H^∞ techniques for the design of multi-rate and multi-user systems; and the energy efficient design of portable wireless systems.
- **Member of Technical Staff**, Bell Labs, Murray Hill, NJ, 06/1999 - 09/1999.
- **Research Assistant**, EECS Department, Lehigh University, PA, 01/1996 - 09/1997.

TEACHING EXPERIENCE

- *EE 381V Genomic Signal Processing*, ECE Department, UT-Austin, Fall 2008 (graduate).
- *EE 351M Digital Signal Processing*, ECE Department, UT-Austin, Spring 2008 (undergraduate).
- *EE 381K-6 Estimation Theory*, ECE Department, UT-Austin, Fall 2007, Spring 2009 (graduate).

AWARDS

- NSF Career Award, 2009.
- University of Zagreb, Faculty of Electrical Engineering's Bronze Award (graduated ranked first in the class of 550 students).
- University of Zagreb, Faculty of Electrical Engineering's Awards in 1991, 1992, and 1993 (the highest GPA in the class each academic year).
- 3rd place at the Bosnian national math competition, 1990.

PROFESSIONAL SERVICE

- Tutorial Chair for the IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS), Minneapolis, MN, 2009.
- Co-organized and presented a full-day tutorial on *Bioinformatics and Computational Biology I, II* at the IEEE International Conference on Acoustic, Speech, and Signal Processing, Las Vegas, NV, April 2008.
- Served as a reviewer for the following journals and conferences:
 - IEEE Transactions on Signal Processing, IEEE Transactions on Information Theory, IEEE Transactions on Communications, IEEE Transactions on Wireless Communications, EURASIP Signal Processing
 - IEEE Workshop on Genomic Signal Processing and Statistics (GENSIPS), IEEE International Communication Conference, IEEE Globecom Conference, IEEE International Conference on Acoustic, Speech, and Signal Processing, IEEE International Symposium on Information Theory

PATENTS

1. "Method and apparatus for detection, identification, and quantification of single-and multi-analytes in affinity-based sensor arrays," with B. Hassibi and A. Hassibi, U.S. patent application.
2. "A method for analyzing multiplexed target amplification assays using real-time microarrays," with B. Hassibi and A. Hassibi, provisional patent application.
3. "Methods for real-time microarray technology," with A. Hassibi, J.-L. Reichmann, and B. Hassibi, provisional patent application.
4. "Methods for compressed microarray technology," with B. Hassibi and F. Parvaresh, provisional patent application.

PUBLICATIONS

Genomic signal processing

(Design, modeling, estimation, and limits of performance for biomolecular detection systems)

Journal papers

1. S. Das, H. Vikalo, and A. Hassibi, "Scaling laws of biosensors," *Journal of Applied Physics*, 2009 (to appear).
2. H. Vikalo, B. Hassibi, and A. Hassibi, "Modeling and estimation for real-time microarrays," *IEEE Journal of Selected Topics in Signal Processing, Special Issue on Genomic and Proteomic Signal Processing*, vol. 2, no. 3, June 2008, pp: 286-296.
3. F. Parvaresh, H. Vikalo, S. Misra, and B. Hassibi, "Recovering sparse signals using sparse measurement matrices in compressed DNA microarrays," *IEEE Journal of Sel. Topics in Signal Processing, Special Issue on Genomic and Proteomic Signal Processing*, vol. 2, no. 3, June 2008, pp: 275-285.
4. A. Hassibi, H. Vikalo, and A. Hajimiri, "On noise processes and limits of performance in biosensors," *Journal of Applied Physics*, vol. 102, no. 1, July 2007, pp. 014909-014909-12.
5. H. Vikalo, A. Hassibi, and B. Hassibi, "A statistical model for microarrays, optimal estimation algorithms, and limits of performance," *IEEE Transactions on Signal Processing, Special Issue on Genomic Signal Processing*, vol. 54, no. 6, June 2006, pp. 2444-2455.
6. A. Hassibi, H. Vikalo, J.-L. Reichmann, and B. Hassibi, "Real-time microarrays," submitted to *Proceedings of the National Academy of Sciences (PNAS)*.
7. H. Vikalo, B. Hassibi, and A. Hassibi, "Maximum-likelihood estimation of DNA initial copy number in polymerase chain reaction processes," submitted.
8. H. Vikalo and M. Gokdemir, "On estimation in stochastically modeled real-time biosensor arrays," submitted.

Conference papers

1. H. Vikalo, F. Parvaresh, S. Misra, and B. Hassibi, "Sparse measurements, compressed sampling, and DNA microarrays," in Proceedings of IEEE ICASSP, Las Vegas, NV, 2008.
2. H. Vikalo, B. Hassibi, and A. Hassibi, "On estimation in real-time microarrays," in Proceedings of IEEE ICASSP, Las Vegas, NV, 2008.
3. H. Vikalo, B. Hassibi, and A. Hassibi, "Signal processing aspects of real-time DNA microarrays," *Comput. Advances in Multi-Sensor Adaptive Proc.*, St. Thomas, U.S. Virgin Islands, 2007 (invited).
4. H. Vikalo, A. Hassibi, and B. Hassibi, "Signal processing for real-time microarrays," in Proc. of IEEE Asilomar Conf. on Signals, Systems and Computers, Pacific Grove, CA, November 2007 (invited).
5. H. Vikalo, F. Parvaresh, and B. Hassibi, "On recovery of sparse signals in compressed DNA microarrays," in Proc. of IEEE Asilomar Conf. on Signals, Systems and Computers, November 2007.
6. H. Vikalo, B. Hassibi, M. Stojnic, and A. Hassibi, "Modeling the kinetics of hybridization in microarrays," *IEEE Int. Workshop on Gen. Sig. Proc. and Stat. (GENSIPS)*, Tuusula, Finland, 2007.

7. H. Vikalo, B. Hassibi, and A. Hassibi, "ML estimation of DNA initial copy number in polymerase chain reaction processes," in Proceedings of IEEE ICASSP, Honolulu, HI, 2007.
8. H. Vikalo, B. Hassibi, and A. Hassibi, "Limits of performance of DNA microarrays," in Proceedings of IEEE ICASSP, Toulouse, France, May 2006.
9. H. Vikalo, A. Hassibi, and B. Hassibi, "On joint maximum-likelihood estimation of PCR efficiency and initial amount of target," in Proc. of IEEE GENSIPS, College Station, TX, May 28-30, 2006.
10. H. Vikalo, A. Hassibi, and B. Hassibi, "Optimal estimation of gene expression levels in microarrays," in Proc. of IEEE GENSIPS, Newport, RI, May 22-25, 2005.
11. A. Hassibi and H. Vikalo, "A probabilistic model for inherent noise and systematic errors of microarrays," in Proc. of IEEE GENSIPS, Newport, RI, May 22-25, 2005.
12. H. Vikalo, A. Hassibi, and B. Hassibi, "Nucleic acid detection using bioluminescence regenerative cycle and statistical signal processing," in Proc. IEEE GENSIPS, Baltimore, MD, May 26-27, 2004.

Signal processing, communications, and algorithms

Books and book chapters

1. H. Vikalo and B. Hassibi, *Sphere Decoding Algorithms for Communications*, Cambridge University Press, (to be published).
2. T. Kailath, H. Vikalo, and B. Hassibi, "MIMO receive algorithms," in *Space-Time Wireless Systems: From Array Processing to MIMO Communications*, Cambridge University Press, 2006.
3. B. Hassibi and H. Vikalo, "Maximum-likelihood decoding and integer least-squares: The expected complexity," in *Multiantenna Channels: Capacity, Coding and Signal Processing*, AMS 2003.

Journal papers

1. M. El-Khamy, H. Vikalo, B. Hassibi, and R. J. McEliece, "Bounds on the performance of sphere decoding of linear block codes," *IEEE Transactions on Communications*, 2009 (to appear).
2. M. Stojnic, H. Vikalo, and B. Hassibi, "An H-infinity design approach to improve the speed of the sphere decoding algorithm," *IEEE Trans. on Sig. Processing*, vol. 56, no. 2, Feb. 2008, pp. 712-726.
3. H. Vikalo and B. Hassibi, "On joint detection and decoding of linear block codes on Gaussian vector channels," *IEEE Transactions on Signal Processing*, vol. 54, no. 9, September 2006, pp. 3330-3342.
4. M. Stojnic, H. Vikalo, and B. Hassibi, "Maximizing the sum-rate of multi-antenna broadcast channels using linear preprocessing," *IEEE Trans. on Wireless Comm.*, vol. 5, no. 9, Sept. 2006, pp. 2338-42.
5. H. Vikalo, B. Hassibi, and P. Stoica, "Joint ML channel estimation and signal detection," *IEEE Transactions on Wireless Communications*, vol. 5, no. 7, July 2006, pp. 1838-1845.
6. H. Vikalo, B. Hassibi, and U. Mitra, "Sphere-constrained ML detection for frequency-selective channels," *IEEE Transactions on Communications*, vol. 54, no. 7, July 2006, pp. 1179-1183.
7. H. Vikalo and B. Hassibi, "On sphere decoding algorithm. II. Generalizations, second-order statistics, and applications to communications," *IEEE Trans. on Sig. Proc.*, vol. 53, no. 8, Aug. 2005, 2819-34.

8. B. Hassibi and H. Vikalo, "On sphere decoding algorithm. I. Expected complexity," *IEEE Transactions on Signal Processing*, vol. 53, no. 8, August 2005, pp. 2806-2818 .
9. H. Vikalo, B. Hassibi, A. Erdogan, and T. Kailath, "On H-infinity design techniques for robust signal reconstruction in noisy filter banks," *EURASIP Signal Processing*, vol. 85, no. 1, Jan. 2005, pp. 1-14.
10. H. Vikalo, B. Hassibi, and T. Kailath, "Iterative decoding for MIMO channels via modified sphere decoder," *IEEE Trans. on Wireless Communications*, vol.3, no. 6, November 2004, pp. 2299-2311.
11. H. Vikalo, B. Hassibi, B. Hochwald, and T. Kailath, "On the capacity of frequency-selective channels in training-based transmission schemes," *IEEE Trans. Sig. Proc.*, vol. 52, no. 9, Sept. 2004, 2572-83.
12. H. Vikalo and B. Hassibi, "On ML sequence detection for multiple antenna systems over dispersive channels," *EURASIP J. Appl. Sig. Proc., Special Issue on Space-Time Coding*, May 2002, pp. 525-31.
13. H. Vikalo and B. Hassibi, "Statistical approach to solving the nearest codeword problem," to be submitted.
14. M. Stojnic, H. Vikalo, and B. Hassibi, "Asymptotic analysis of the Gaussian broadcast channel with perturbation preprocessing," to be submitted.
15. M. Stojnic, B. Hassibi and H. Vikalo, "PEP analysis of the SDP-based noncoherent ML-detection," to be submitted.

Conference papers

1. M. Stojnic, B. Hassibi, and H. Vikalo, "PEP analysis of the SDP based joint channel estimation and signal detection ," in Proc. of IEEE Int. Conf. on Acoust., Speech, and Sig. Proc. (ICASSP), 2007.
2. M. Stojnic, H. Vikalo, and B. Hassibi, "Further results on speeding up the sphere decoder," in Proceedings of IEEE ICASSP, Toulouse, France, May 2006.
3. M. Stojnic, H. Vikalo, and B. Hassibi, "Asymptotic analysis of the Gaussian broadcast channel with perturbation preprocessing," in Proceedings of IEEE ICASSP, Toulouse, France, May 2006.
4. M. El-Khamy, H. Vikalo, B. Hassibi, and R. J. McEliece, "On the performance of sphere decoding of block codes," in Proc. of IEEE Intern. Symp. on Information Theory (ISIT), Seattle, WA, July 2006.
5. M. El-Khamy, H. Vikalo, and B. Hassibi, "Bounds on the performance of sphere decoding of linear block codes," in Proc. of IEEE-ITSOC Information Theory Workshop on Coding and Complexity (ITW), New Zealand, 2005.
6. M. Stojnic, H. Vikalo, and B. Hassibi, "An efficient H-infinity estimation approach to speed up the sphere decoder," in Proceedings of International Conference on Wireless Networks, Communications, and Mobile Computing (WirelessCom), Kaanapali Beach, Maui, Hawaii, June 13-16, 2005.
7. M. Stojnic, H. Vikalo, and B. Hassibi, "An H-infinity based lower bound to speed up sphere decoder," in Proceedings of the 6th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), New York, NY, June 2005.
8. M. Stojnic, H. Vikalo, and B. Hassibi, "A branch-and-bound approach to speed up the sphere decoder," in Proceedings of IEEE ICASSP, Philadelphia, PA, 2005.

9. M. Stojnic, H. Vikalo, and B. Hassibi, "Maximizing the sum rate of multi-antenna broadcast channels using linear preprocessing," in Proceedings of IEEE Globecom, Dallas, TX, December 2004.
10. H. Vikalo and B. Hassibi, "Statistical approach to ML decoding of linear block codes on symmetric channels," in Proceedings of IEEE ISIT, Chicago, IL, June 2004.
11. H. Vikalo, B. Hassibi, and U. Mitra, "Sphere-constrained ML detection for channels with memory," in Proc. of the 37th Asilomar Conf. on Sig., Systems and Comp., Pacific Grove, CA, November 2003.
12. H. Vikalo and B. Hassibi, "On joint ML detection and decoding," in Proceedings of IEEE ISIT, Yokohama, Japan, June 2003.
13. H. Vikalo, B. Hassibi, and U. Mitra, "Sphere-constrained ML detection for frequency-selective channels," in Proceedings of IEEE ICASSP, Hong Kong, April 2003.
14. H. Vikalo, B. Hassibi, and P. Stoica, "On joint ML channel estimation and signal detection for SIMO channels," in Proceedings of IEEE ICASSP, Hong Kong, April 2003.
15. H. Vikalo and B. Hassibi, "Low-complexity iterative detection and decoding of multi-antenna systems employing channel and space-time codes," in Proceedings of the 36th Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, November 2002.
16. H. Vikalo and B. Hassibi, "On the expected complexity of sphere decoding for frequency-selective channels," in Proc. of Allerton Conf. on Comm., Control, and Comput., Allerton, IL, October 2002.
17. H. Vikalo and B. Hassibi, "Modified Fincke-Pohst algorithm for low-complexity iterative decoding over multiple antenna channels," in Proceedings of IEEE ISIT, Lausanne, Switzerland, 2002.
18. H. Vikalo and B. Hassibi, "Towards closing the capacity gap on multiple antenna channels," in Proceedings of IEEE ICASSP, Orlando, FL, 2002.
19. B. Hassibi and H. Vikalo, "On the expected complexity of integer least-squares problems," in Proceedings of IEEE ICASSP, Orlando, FL, 2002.
20. H. Vikalo and B. Hassibi, "Low-complexity iterative decoding over multiple antenna channels via a modified sphere decoder," in Proceedings of Allerton Conference on Communications, Control, and Computing, Allerton, IL, October 2001.
21. B. Hassibi and H. Vikalo, "On the expected complexity of sphere decoding," in Proceedings of the 35th Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, November 2001.
22. H. Vikalo, B. Hassibi, B. Hochwald, and T. Kailath, "Optimal training for frequency-selective fading channels," in Proceedings of IEEE ICASSP, Salt Lake City, UT, 2001.
23. H. Vikalo, B. Hassibi, and T. Kailath, "On robust multiuser detection," in Proceedings of the 34th Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, November 2000.
24. S. Mudulodu, H. Vikalo, A. Paulraj, and T. Kailath, "CDMA multisuser detection based on state-space estimation techniques," in Proceedings of the 34th Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, November 2000.
25. H. Vikalo, A. T. Erdogan, B. Hassibi, and T. Kailath, "Exponential-quadratic optimal signal reconstruction in noisy filter banks," in Proceedings of SPIE International Symposium on Optical Science and Technology, San Diego, CA, August 2000.

26. T. Simunic, H. Vikalo, and G. De Micheli, "Energy efficient design of portable wireless systems", in Proc. of IEEE Intern. Symposium on Low Power Electronics and Design, Rapallo, Italy, June 2000.
27. H. Vikalo, B. Hassibi, and T. Kailath, "Mixed H₂/H-infinity optimal signal reconstruction in noisy filter banks," in Proceedings of IEEE ICASSP, Istanbul, Turkey, June 2000.
28. H. Vikalo, B. Hassibi, and T. Kailath, "On H-infinity optimal signal reconstruction in noisy filter banks," in Proceedings of IEEE ICASSP, Phoenix, AZ, March 1999.
29. H. Vikalo and R. S. Blum, "Distributed detection in dependent Gaussian mixture noise," in Proc. of US-Australia workshop on defense signal processing, Victor Harbor, Australia, June 1997, p. 29.
30. H. Vikalo and R. S. Blum, "Distributed detection in dependent non-Gaussian noise," in Proceedings of IEEE ISIT, Ulm, Germany, June 1997.
31. H. Vikalo and R. S. Blum, "Distributed detection of known signals in Gaussian mixture noise which is dependent from sensor to sensor," in Proceedings of International Conference on Telecommunications (ICT), Melbourne, Australia, April 1997.
32. Z. Kovacic, S. Bogdan, and H. Vikalo, "Design and parameter adaptation of a fuzzy servo controller," in Proc. of the 6th Intern. Fuzzy Systems Association World Congress, Sao Paulo, Brazil, July 1995.
33. Z. Kovacic, M. Stajdohar, and H. Vikalo, "Fuzzy emulation of a linear PI controller," in Proceedings of 40th Conference KoREMA, Zagreb, Croatia, May 1995.