

VASANTHAN RAGHAVAN

Address

56 1/2 East Green St., # 205
Champaign, Illinois, 61820

Phone/E-Mail

(608) 239-4040
vasanth@illinois.edu
<http://www.ifp.uiuc.edu/~vasanth>

EDUCATION

Ph. D. in Electrical and Computer Engineering

University of Wisconsin-Madison, August 2006

Dissertation: Spatially Correlated Multi-Antenna Wireless Channels: Capacity and Limited Feedback Performance

Advisor: Prof. Akbar Sayeed

M. A. in Mathematics

University of Wisconsin-Madison, May 2005

M. S. in Electrical and Computer Engineering

University of Wisconsin-Madison, May 2004

Thesis: Capacity of Correlated MIMO Channels Using the Virtual Channel Representation

B. Tech in Electrical Engineering

Indian Institute of Technology (Madras), Chennai, India, August 2001

Thesis: Reduction of Computational Complexity of Frequency Domain Adaptive Algorithms

ACADEMIC EXPERIENCE

- **Postdoctoral Research Associate**, Coordinated Science Laboratory and the Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Aug. 2006 - present
Mentors: Prof. Venu Veeravalli and Prof. Nitin Vaidya
- **Graduate Research Assistant**, Wireless Communications Laboratory, University of Wisconsin-Madison, Sept. 2002 - Aug. 2006
Mentor: Prof. Akbar Sayeed
- **Graduate Fellow**, Electrical and Computer Engineering, University of Wisconsin-Madison, Sept. 2001 - Aug. 2002

GRANT WRITING EXPERIENCE

- Played a major role in putting together the **successful** NSF grant application “NEDG - MIMO Links in Wireless Edge Networks: Cross-Layer Protocol Design,” with PIs Prof. Nitin Vaidya (at University of Illinois) and Prof. Venu Veeravalli, Mar. 2008.
- Helped PIs Prof. Venu Veeravalli and Prof. Alexander Tartakovsky (at University of Southern California) put together a **successful** NSF grant “Optimal Change-point Detection and Identification Algorithms with Applications,” Mar. 2008.

TEACHING AND MENTORING EXPERIENCE

- Jointly conducting a short course on “Multiple-Input Multiple-Output Wireless Systems: Signaling, Design, and Fundamental Limits,” at IEEE Radio and Wireless Symposium (RAWCON), San Diego, CA, Jan. 22, 2009.
- **Mentoring** graduate students in the research groups of Prof. Venu Veeravalli, Prof. Nitin Vaidya and Prof. Ada Poon (currently at Stanford U.) at the University of Illinois. Collaboration with students has resulted in many conference and journal publications, and works in progress.
- **Guest Lecturer** for a lecture in the graduate course on detection and estimation theory (ECE 561), University of Illinois at Urbana-Champaign, Spring 2007.

- **Mentor** for Mr. Eric Meraz, a participant in the University of Wisconsin-Madison's initiative on providing research experience for under-represented minority students in the undergraduate population: Summer Undergraduate Research Experience (SURE) program, June 2006 - Aug. 2006.
- **Teaching Assistant**, Electrical and Computer Engineering, University of Wisconsin-Madison, Sep. 2004 - Dec. 2004, Junior level course on Signals and Systems (ECE 330).
- **Teaching Assistant**, Electrical and Computer Engineering, University of Wisconsin-Madison, Jan. 2004 - May 2004, Junior level course in Control Theory (ECE 334).
- **Teaching Assistant**, Electrical and Computer Engineering, University of Wisconsin-Madison, Sept. 2003 - Dec. 2003, Graduate level course on Image Processing (ECE 533).

INDUSTRIAL WORK EXPERIENCE

- **Summer Research Intern**, Mobile Wireless Branch, Communication Systems Lab, DSP R&D Center, Texas Instruments Inc., Dallas, TX, June 2005 - Aug. 2005
- **Summer Research Intern**, Mobile Wireless Branch, Communication Systems Lab, DSP R&D Center, Texas Instruments Inc., Dallas, TX, June 2004 - Aug. 2004

AWARDS AND HONORS

- **IEEE Student Travel Grant**, Information Theory Society, 2005 and 2006.
- **Vilas Travel Grant**, The Graduate School, University of Wisconsin-Madison, Nov. 2005.
- **Donald and Esther E. Procknow Fellowship**, Department of Electrical and Computer Engineering, University of Wisconsin-Madison, Sept. 2001 - Aug. 2002.
- **Institute Merit Cum Means Scholarship**, Indian Institute of Technology (Madras), Chennai, India, 1997 - 2001.

PROFESSIONAL ACTIVITIES

- Jointly conducting a short course on "Multiple-Input Multiple-Output Wireless Systems: Signaling, Design, and Fundamental Limits," at IEEE Radio and Wireless Symposium (RAWCON), San Diego, CA, Jan. 22, 2009.
- Technical Program Committee (TPC) Member, IEEE Fall Vehicular Technology Conference 2009, Anchorage, AK.
- Co-organized an invited session titled "Limited Feedback in MIMO Systems" at the Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, 2008.
- Session chair for three sessions on "MIMO, Space-time codes and Coding techniques" at the Allerton Conference on Communications, Control and Computing, Allerton, IL, 2008.
- Was one of three male participants invited to attend the "AdvanceVT: Transforming the Professoriate - Preparing Women for Academic Careers in Science and Engineering" conference at Virginia Polytechnic Institute, July 20-22, 2006. Attending this conference helped me learn about many of the current issues on diversity in the academe with particular emphasis on STEM fields.
- Organized a workshop on effective communication skills as a part of the Teaching Improvement Program (TIP) for continuing Teaching Assistants, College of Engineering, University of Wisconsin-Madison, Aug. 26, 2004.
- Member of IEEE, Information Theory, Communication Theory and Signal Processing Societies.
- Reviewed papers for *IEEE Transactions on Information Theory*, *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Signal Processing*, *IEEE Transactions on Communications*, *IEEE Transactions on Vehicular Technology*, *IEEE Journal on Selected Areas in Communication*, *IEEE Journal of Selected Topics in Signal Processing*, *IEEE Transactions on Aerospace and Electronic Systems*, *IEEE Communications Letters*, *EURASIP Journal on Wireless Communications and Networking*, *Wireless Communications and Mobile Computing*, *Wireless Personal Communications*, *Journal of Communication Networks*, *IEEE Infocom*, and many other conferences.

INVITED TALKS

SEMINARS

- “Limited Feedback Techniques for Spatially Correlated MIMO Channels,” Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, Sept. 11, 2006.
- “Limited Feedback Techniques for Spatially Correlated MIMO Channels,” Department of Electrical and Computer Engineering, Northwestern University, Evanston, IL, Nov. 20, 2006.
- “Exploiting Channel Information via Limited-Feedback in Next Generation MIMO Systems,” NEC Labs, Princeton, NJ, May 7, 2008.
- “Correlated MIMO Channels: Modeling and Low-Complexity Signaling,” Department of Electrical Engineering, University of Notre Dame, West Bend, IN, Aug. 28, 2008.
- “Correlated MIMO Channels: Modeling and Low-Complexity Signaling,” Department of Electrical Engineering, Colorado State University, Fort Collins, CO, Oct. 20, 2008.

INVITED CONFERENCE TALKS

- “Limited Feedback Techniques for Spatially Correlated Multi-Antenna Channels,” Invited to be presented at the session on MIMO, Information Theory and Applications Workshop, San Diego, CA, Jan. 27 - Feb. 1, 2008.
- “Towards Efficient “Limited” Feedback Codebook Designs: Exploiting Channel State Information Systematically,” Presented at the Workshop on Random Matrix Theory and Wireless Communications, Chautauqua Park, Boulder, CO, July 16, 2008.
- “Towards a Systematic Limited Feedback Design for the Spatially Correlated Downlink,” Invited to be presented at the session on Feedback in MIMO Systems, Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, Oct. 26-29, 2008.
- “Angular Domain Processing for MIMO Wireless Systems with Non-uniform Antenna Arrays,” Invited to be presented at the session on New Directions in MIMO, Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, Oct. 26-29, 2008.
- “Low-Complexity Signaling for Correlated Broadcast Channels,” Invited to present a talk at the Information Theory and Applications Workshop, San Diego, CA, Feb. 2009.

PUBLICATIONS

Journals

1. K. Liu, V. Raghavan, A. M. Sayeed, “Capacity Scaling and Spectral Efficiency in Wideband Correlated MIMO Channels,” *IEEE Transactions on Information Theory, Special Issue on MIMO systems*, vol. 49, no. 10, pp. 2504-2526, Oct. 2003.
2. V. Raghavan, K. M. M. Prabhu, P. C. W. Sommen, “An Analysis of Real-Fourier Domain Based Adaptive Algorithms Implemented with the Hartley Transform Using Cosine-Sine Symmetries,” *IEEE Transactions on Signal Processing*, vol. 53, no. 2, pp. 622-629, Feb. 2005.
3. V. Raghavan, A. M. Sayeed, “Weak Convergence and Rate of Convergence of MIMO Capacity Random Variable,” *IEEE Transactions on Information Theory*, vol. 52, no. 8, pp. 3799-3809, Aug. 2006.
4. V. Raghavan, K. M. M. Prabhu, P. C. W. Sommen, “Complexity of Pruning Strategies for the Frequency Domain LMS Algorithm,” *Signal Processing*, vol. 86, no. 10, pp. 2836-2843, Oct. 2006.
5. A. M. Sayeed, V. Raghavan, “Maximizing MIMO Capacity in Sparse Multipath with Reconfigurable Antenna Arrays,” *IEEE Journal of Selected Topics in Signal Processing, Special Issue on Adaptive Waveform Design for Agile Sensing and Communication*, vol. 1, no. 1, pp. 156-166, June 2007.
6. V. Raghavan, R. W. Heath, Jr., A. M. Sayeed, “Systematic Codebook Designs for Quantized Beamforming in Correlated MIMO Channels,” *IEEE Journal on Selected Areas in Communications, Special Issue on Optimization of MIMO Transceivers for Realistic Communication Networks*, vol. 25, no. 7, pp. 1298-1310, Sept. 2007, **Acceptance Rate: 23/82.**

7. V. Raghavan, G. Hariharan, A. M. Sayeed, "Capacity of Sparse Multipath in the UltraWideband Regime," *IEEE Journal of Selected Topics in Signal Processing, Special Issue on Performance Limits of Ultra-Wideband Systems*, vol. 1, no. 3, pp. 357-371, Oct. 2007.
8. G. Hariharan, V. Raghavan, A. M. Sayeed, "Capacity of Sparse Wideband Channels with Partial Channel Feedback," *European Transactions on Telecommunications, Special Issue on New Directions in Information Theory*, vol. 19, no. 4, pp. 475-493, June 2008.
9. C. Lin, V. Raghavan, V. V. Veeravalli, "To Code or Not to Code Across Time: Space-Time Coding with Feedback," *IEEE Journal on Selected Areas in Communications, Special Issue on Exploiting Limited Feedback in Tomorrow's Wireless Communication Networks*, vol. 26, no. 8, pp. 1588-1598, Oct. 2008.
10. V. Raghavan, V. V. Veeravalli, A. M. Sayeed "Quantized Multimode Precoding in Spatially Correlated Multi-Antenna Channels," *IEEE Transactions on Signal Processing*, vol. 56, no. 12, pp. 6017-6030, Dec. 2008.

Submitted/In Preparation: Preprints available at <http://www.ifp.uiuc.edu/~vasanth>

11. V. Raghavan, B. R. Barmish, "A Random Matrix Theoretic Approach to Stability of Systems with Uncertain Parameters," *Submitted to the IEEE Transactions on Automatic Control*, Dec. 2008.
12. V. Raghavan, V. V. Veeravalli, "Quickest Change-Detection of a Markov Process Across a Sensor Array," *Submitted to the IEEE Transactions on Information Theory*, Dec. 2008, <http://arxiv.org/abs/0812.3742>.
13. V. Raghavan, J. H. Kotecha, A. M. Sayeed, "Why Does the Kronecker Model Result in Misleading Capacity Estimates?" *Submitted to the IEEE Transactions on Information Theory*, July 2008, <http://www.arxiv.org/abs/0808.0036>.
14. V. Raghavan, A. M. Sayeed, V. V. Veeravalli, "Low-Complexity Structured Precoding for Spatially Correlated MIMO Channels," *Submitted to the IEEE Transactions on Information Theory*, May 2008, <http://www.arxiv.org/abs/0805.4425>.
15. V. Raghavan, A. M. Sayeed, "Multi-Antenna Capacity of Sparse Multipath Channels," *Submitted to the IEEE Transactions on Information Theory*, Dec. 2007.
16. V. Raghavan, V. V. Veeravalli, R. W. Heath, Jr., "A Source-Channel Matching Paradigm for Low-Complexity Adaptive MIMO Design," *in preparation for submission to the IEEE Transactions on Signal Processing*.
17. V. Raghavan, A. S. Y. Poon, V. V. Veeravalli, "Angular Domain Processing for Multi-Antenna Channels," *in preparation for submission to the IEEE Transactions on Signal Processing*.

Conferences

1. R. Sarathi, V. S. Chakravarthy, R. Vasanthan, M. Ahamed Khan, C. Venkataseshaiyah, "Investigation of Tracking Phenomena in Polymeric Materials," in *Proc. of International Symposium on High Voltage Engineering, ISH 2001*, Bangalore, India, July 2001.
2. **(Invited)** A. M. Sayeed, V. Raghavan, "Power Laws in the Eigenvalue Distribution of MIMO Wireless Channels," in *Proc. of 40th Annual Allerton Conference on Communications, Control, and Computing*, Monticello, IL, Oct. 3-5, 2002.
3. V. Raghavan, A. M. Sayeed, "MIMO Capacity Scaling and Saturation in Correlated Environments," in *Proc. of IEEE International Conference on Communications*, Anchorage, AK, pp. 3006-3010, May 11-15, 2003.
4. K. Liu, V. Raghavan, A. M. Sayeed, "Capacity and Spectral Efficiency in Wideband Correlated MIMO Channels," in *Proc. of IEEE International Symposium on Information Theory*, Yokohoma, Japan, p. 322, June 29 - July 4, 2003.
5. K. Liu, V. Raghavan, A. M. Sayeed, "A D-Connected Model for Spatially Correlated MIMO Channels," in *Proc. of 41st Annual Allerton Conference on Communications, Control, and Computing*, Monticello, IL, Oct. 2-4, 2003.

6. V. Raghavan, K. Liu, A. M. Sayeed, "An Asymptotic Analysis of Capacity in Narrowband MIMO Channels," in *Proc. of IEEE Global Telecommunications Conference*, San Francisco, CA, vol. 2, pp. 611-615, Dec. 1-5, 2003.
7. V. Raghavan, A. M. Sayeed, "Role of Channel Power in Sub-Linear Capacity Scaling of MIMO Channels," in *Proc. of 42nd Annual Allerton Conference on Communications, Control, and Computing*, Monticello, IL, Sept. 29 - Oct. 1, 2004.
8. A. M. Sayeed, V. Raghavan, J. H. Kotecha, "Capacity of Space-time Wireless Channels: A Physical Perspective," in *Proc. of Information Theory Workshop*, San Antonio, TX, Oct. 24-29, 2004.
9. V. Raghavan, A. M. Sayeed, "Achieving Coherent Capacity of Correlated MIMO Channels in the Low-Power Regime with Non-Flashy Signaling Schemes," in *Proc. of IEEE International Symposium on Information Theory*, Adelaide, Australia, pp. 906-910, Sept. 4-9, 2005.
10. V. Raghavan, A. M. Sayeed, N. Boston, "When is Limited Feedback for Transmit Beamforming Beneficial?" in *Proc. of IEEE International Symposium on Information Theory*, Adelaide, Australia, pp. 1544-1548, Sept. 4-9, 2005.
11. V. Raghavan, E. N. Onggosanusi, A. G. Dabak, "Single Rate Communication is Advantageous Over Per-Tone Rate Control in a Multi-User OFDM System," in *Proc. of IEEE Fall Vehicular Technology Conference*, Dallas, TX, Sept. 25-28, 2005.
12. V. Raghavan, G. Hariharan, A. M. Sayeed, "Exploiting Time-Frequency Coherence to Achieve Coherent Capacity in Wideband Wireless Channels," in *Proc. of 43rd Annual Allerton Conference on Communications, Control, and Computing*, Monticello, IL, Sept. 28-30, 2005.
13. V. Raghavan, A. M. Sayeed, N. Boston, "Near-Optimal Codebook Constructions for Limited Feedback Beamforming in Correlated MIMO Channels with Few Antennas," in *Proc. of IEEE International Symposium on Information Theory*, Seattle, WA, July 9-14, 2006.
14. A. M. Sayeed, V. Raghavan, "The Ideal MIMO Channel: Maximizing Capacity in Sparse Multipath with Reconfigurable Arrays," in *Proc. of IEEE International Symposium on Information Theory*, Seattle, WA, July 9-14, 2006.
15. V. Raghavan, A. M. Sayeed, "Impact of Spatial Correlation on Statistical Precoding in MIMO Channels with Linear Receivers," in *Proc. of 44th Annual Allerton Conference on Communications, Control, and Computing*, Monticello, IL, Sept. 27-29, 2006.
16. V. Raghavan, B. R. Barmish, "Stability of Systems with Random Parameters," in *Proc. of 45th IEEE Conference on Decision and Control*, San Diego, CA, Dec. 13-15, 2006.
17. V. Raghavan, A. M. Sayeed, V. V. Veeravalli, "Limited Feedback Precoder Design for Spatially Correlated MIMO Channels," in *Proc. of 41st Annual IEEE Conference on Information Sciences and Systems*, Mar. 14-16, 2007.
18. **(Invited)** A. M. Sayeed, V. Raghavan, "On the Impact of Reconfigurable Antenna Arrays in Cognitive Radio," in *Proc. of IEEE International Conference on Acoustics, Speech and Signal Processing*, Honolulu, HI, Apr. 15-20, 2007.
19. V. Raghavan, V. V. Veeravalli, R. W. Heath, Jr., "Reduced Rank Signaling in Spatially Correlated MIMO Channels," in *Proc. of IEEE International Symposium on Information Theory*, Nice, France, June 24-29, 2007.
20. V. Raghavan, V. V. Veeravalli, "On Quantized Multi-user Beamforming in Spatially Correlated Broadcast Channels," in *Proc. of IEEE International Symposium on Information Theory*, Nice, France, June 24-29, 2007.
21. V. Raghavan, A. S. Y. Poon, V. V. Veeravalli, "MIMO Systems with Arbitrary Antenna Array Architectures: Channel Modeling, Capacity and Low-Complexity Signaling," in *Proc. of Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 4-7, 2007.
22. C. Lin, V. Raghavan, V. V. Veeravalli, "Optimal Power Allocation for Linear Dispersion Codes over Correlated MIMO Channels with Channel State Feedback," in *Proc. of IEEE Global Telecommunications Conference*, Washington, DC, Nov. 26-30, 2007.

23. **(Invited)** V. Raghavan, V. V. Veeravalli, C. Lin, “Limited Feedback Techniques for Spatially Correlated Multi-Antenna Channels,” *Presented at the Information Theory and Applications Workshop*, San Diego, CA, Jan. 27 - Feb. 1, 2008.
24. C. Lin, V. Raghavan, V. V. Veeravalli, “Limited Feedback Space-Time Coding in Correlated MIMO Channels,” in *Proc. of 42nd Annual IEEE Conference on Information Systems and Sciences*, Princeton, NJ, Mar. 19-21, 2008.
25. V. Raghavan, A. S. Y. Poon, V. V. Veeravalli, “Non-Robustness of Statistics-Based Beamformer Design in Correlated MIMO Channels,” in *Proc. of IEEE International Conference on Acoustics, Speech and Signal Processing*, Las Vegas, NV, Mar. 30 - Apr. 4, 2008.
26. V. Raghavan, A. M. Sayeed, J. H. Kotecha, “Impact of Mismatched Statistics on Correlated MIMO Capacity,” in *Proc. of IEEE International Conference on Acoustics, Speech and Signal Processing*, Las Vegas, NV, Mar. 30 - Apr. 4, 2008.
27. **(Invited)** V. Raghavan, V. V. Veeravalli, “Quickest Detection of a Change Process Across a Sensor Array,” in *Proc. of the 11th International Conference on Information Fusion*, Cologne, Germany, June 30 - July 3, 2008.
28. G. Hariharan, V. Raghavan, A. M. Sayeed, “Capacity of Sparse Wideband Channels with Limited Feedback,” in *Proc. of IEEE International Symposium on Information Theory*, Toronto, Canada, July 6-11, 2008.
29. V. Raghavan, A. M. Sayeed, V. V. Veeravalli, “Structured Statistical Precoding for Correlated MIMO Channels,” in *Proc. of IEEE International Symposium on Information Theory*, Toronto, Canada, July 6-11, 2008.
30. **(Invited)** D. Huang, V. Raghavan, A. S. Y. Poon, V. V. Veeravalli, “Angular Domain Processing for MIMO Wireless Systems with Non-Uniform Antenna Arrays,” in *Proc. of Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 26-29, 2008.
31. **(Invited)** V. Raghavan, V. V. Veeravalli, “Towards a Systematic Limited Feedback Design for the Spatially Correlated Downlink,” in *Proc. of Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 26-29, 2008.
32. V. Raghavan, V. V. Veeravalli, “Systematic Limited Feedback Codebook Design for the Correlated MISO Broadcast Channel,” *Submitted to International Symposium on Information Theory*, 2009.
33. V. Raghavan, V. V. Veeravalli, “Bayesian Quickest Change Process Detection,” *Submitted to International Symposium on Information Theory*, 2009.
34. **(Invited)** V. Raghavan, V. V. Veeravalli, “Limited Feedback for Spatially Correlated MISO Broadcast Channels,” to be presented at the *Information Theory and Applications Workshop*, San Diego, CA, Feb. 2009.

Patents

1. M. Z. Ikram, E. N. Onggosanusi, V. Raghavan, A. G. Dabak, S. Hosur, B. Varadarajan, “An Enhanced Closed-Loop MIMO Design for OFDM/OFDMA-PHY,” Texas Instruments Docket No. 38973, Filed with USPTO, 2004.
2. M. Z. Ikram, E. N. Onggosanusi, V. Raghavan, A. G. Dabak, S. Hosur, B. Varadarajan, “Method and Apparatus for Providing Closed-Loop Transmit Precoding,” Filed by Texas Instruments with the European Patent Office, 2005.
3. V. Raghavan, E. N. Onggosanusi, A. G. Dabak, “Feedback and Scheduling Schemes for a Communications System,” Texas Instruments Docket No. 39534, Filed with USPTO, 2006.
4. A. M. Sayeed, V. Raghavan, “Method for Maximizing the Information Rate and Reliability of Wireless Communication Devices using Reconfigurable Antenna Arrays,” University of Wisconsin-Madison (WARF), 2006.

Standards Contributions

1. Muhammad Ikram, Eko Onggosanusi, Vasanthan Raghavan, Anand Dabak, Srinath Hosur, “An enhanced closed-loop MIMO design for OFDM/OFDMA-PHY,” IEEE 802.16 Broadband Wireless Access Working Group, IEEE doc. C802.16e-04/267, Seoul, Korea, Aug. 30 - Sept. 2, 2004.
2. “Throughput Evaluations in EUTRA OFDMA Downlink,” 3GPP TSG RAN WG1 Ad Hoc Committee on LTE, 3GPP doc. R1-050779, London, UK, Aug. 29 - Sept. 2, 2005.