

Rajeevan Amirtharajah

Dept. of Electrical and Computer Engineering
2064 Kemper Hall
University of California
One Shields Avenue
Davis, CA 95616-5294
(W) (530) 754-6562
(M) (617) 320-7588
amirtharajah@ece.ucdavis.edu

Objective To contribute directly to solving challenging problems in digital and mixed signal circuit design, electromagnetics, communications, signal processing, and system architecture.

Education **Massachusetts Institute of Technology**
Doctor of Philosophy, Electrical Engineering and Computer Science, June 1999
Thesis: Design of Low Power VLSI Systems Powered by Ambient Mechanical Vibration
Master of Engineering, Electrical Engineering and Computer Science, May 1994
Thesis: High Bandwidth Interchip Communication for Regular Networks
Bachelor of Science, Electrical Science and Engineering, May 1994

Experience **University of California, Davis, ECE Dept.** July 2003—Present
Assistant Professor
Teaching and research in digital circuit design and VLSI. Research interests include micropower embedded systems, power electronics which convert ambient energy sources to electrical power for batteryless device operation, circuits and architectures for energy scalable signal processing of sensor data, and innovative I/O circuit and interconnect design.

Independent Consulting Oct 2002—June 2003
Consulted on low power design, hardware feasibility studies, high performance I/O design, and digital ASIC and mixed-signal circuit design for several small companies and startups including SiCortex, BlueD Technologies, OcuNET Devices, and SMaL Camera Technologies.

High Speed Solutions, an Intel Company June 1999—Oct 2002
Senior Member of Technical Staff
One of two principal contributors on an engineering staff of six who brought an early venture startup company from initiating engineering development to successful acquisition by Intel in thirteen months. Half of a two designer team responsible for innovative signaling and circuit design and implementation of a chip set for a prototype high performance memory system. Also responsible for initial electromagnetic simulation of a novel connector concept. The prototype achieved 1.6 Gbps/pair bandwidth across an 8 load multidrop bus while dissipating peak power of 40 mW/transceiver. Performed initial work to extend performance to 3.2 Gbps for 8 loads and 5 Gbps for point-to-point links. Also developed two new interconnect concepts to enable multidrop peer-to-peer communication.

Primary responsibilities included signaling theory, analysis, and design, circuit design, simulation, and custom layout, initial interconnect design and simulation, and post fabrication silicon testing. Further responsibilities involved intellectual property development, interaction with RF, mechanical, verification, and CAD engineers, test methodology development, documentation, support for technical marketing and product intercept planning, definition of R&D directions, and interviewing and training new hires.

MIT Microsystems Technology Laboratory

Jan 1995—June 1999

Research Assistant

Investigated techniques for top to bottom implementation of signal processing systems which scavenge energy from vibration sources in their environment. Developed, modeled, and tested an electromagnetic vibration-to-electric energy converter based on a moving-coil transducer. Designed, implemented, and tested a custom low power DC-DC converter IC for regulating transducer output voltage based on desired load performance. Developed a detection/classification algorithm for estimating heart rate from a novel acoustic sensor's output. Designed, implemented, and tested a full custom 250K transistor low power DSP with innovative features for sensor signal processing as part of a system incorporating a MEMS vibration-to-electric energy converter and voltage regulator for energy scavenging operation of the heartbeat detection algorithm. Also designed and implemented a low power dynamic comparator incorporated in several group test chips.

MIT Department of EECS

Fall 1998

Teaching Assistant, 6.374 Analysis and Design of Digital Integrated Circuits

Developed and graded problem sets, exams, labs, and design projects in addition to running one-on-one and small group tutorials.

Lockheed Sanders Corp.

Summer 1997

Summer Intern

Developed and tested algorithms for detection and classification of signals for cardiac monitoring from a novel acoustic sensor.

MIT Artificial Intelligence Laboratory, Abacus Project

Oct 1992—Jan 1995

Research Assistant

Designed circuits for high bandwidth interchip communication for a SIMD array.

Undergraduate Researcher

Designed and simulated the architecture of a microsequencing unit, memory controller, and i/o system for a large-scale SIMD multiprocessor. Contributed to architectural and VLSI circuit design and layout of a high performance processor chip.

**IBM Thomas J. Watson Research Center,
Communication Circuits Group**

Summer 1992

Summer Intern

Designed a low-latency phase recovery circuit that uses transition detection to accelerate initial tracking.

Skills

Programming Languages: HSPICE, MATLAB, C, Verilog HDL, Skill, Scheme/Lisp
CAD: Cadence, Mentor Graphics, LINPAR

Grants

National Science Foundation CAREER Award #0547113, "Energy Scalable Signal Processing for Energy Harvesting Microsystems," \$400,000, 2006-2011, **PI: R. Amirtharajah**

Microelectronic Advanced Research Corporation (MARCO) Interconnect Focus Center, "Circuits and Architectures for Exploiting Silicon Nanowire Interconnect," \$278,001, 2006-2009, **PI: R. Amirtharajah**

Microelectronic Advanced Research Corporation (MARCO) Interconnect Focus Center, "Modulated Low Power Interconnect for Energy Harvesting Sensors," \$120,936, 2005-2006, **PI: R. Amirtharajah**

Xilinx University Program, "Energy Scalable Distributed Arithmetic on FPGAs," \$10,000 (software + equipment), 2004, **PI: R. Amirtharajah**

University of California, Davis - New Faculty Research Grant, "Energy Scalable Reconfigurable Logic for Energy Scavenging Microsystems," \$2,500, 2004-2005, **PI: R. Amirtharajah**

Journal Publications

- R. Amirtharajah, A. Chen, J. Loo and N. Guilar, "Nanomaterial Resistive Sensors: Noise, Power, and Circuit Interfaces," *International Journal of Nanotechnology*, to appear.
- N. Guilar, A. Chen, T. Kleeburg, A. Knoesen, D. Yankelevich, and R. Amirtharajah, "Integrated Solar Energy Harvesting and Storage," submitted to *IEEE Transactions on VLSI Systems*.
- R. Amirtharajah, T. Simon, J.R. Benham, J. Critchlow, and T.F. Knight, Jr., "A 1.6 Gb/s/pair Electromagnetically Coupled Multidrop Bus Using Modulated Signaling," *IEEE Journal of Solid-State Circuits*, in preparation.
- R. Rao, J. Wenck, D. Franklin, R. Amirtharajah, and V. Akella, "Exploiting Non-Uniform Memory Access Patterns Through Bitline Segmentation," *ACM SIGMICRO Newsletter*, Vol. 24, No. 1, 2006, [online], available: http://sigmicro-online.org/papers24_1/6.pdf.
- R. Amirtharajah, J. Collier, J. Siebert, B. Zhou and, A. Chandrakasan, "DSPs for Energy Harvesting Sensors: Applications and Architectures," *IEEE Pervasive Computing Magazine*, Vol. 4, Issue 3, July-Sep. 2005, pp. 72-9.
- D. D. Thaker, R. Amirtharajah, F. Impens, I. L. Chuang and, F. T. Chong, "Recursive TMR: Scaling Fault Tolerance in the Nanoscale Era," *IEEE Design & Test of Computers*, Vol. 22, Issue 4, July-Aug. 2005, pp. 298-305.
- R. Amirtharajah and A. Chandrakasan, "A Micropower Programmable DSP Using Approximate Signal Processing Based on Distributed Arithmetic," *IEEE Journal of Solid-State Circuits*, Vol. 39, No. 2, Feb. 2004, pp. 337-47.
- J. R. Benham, R. Amirtharajah, J. Critchlow, T. Simon, and T. F. Knight, Jr., "An Alignment Insensitive Separable Electromagnetic Coupler for High Speed Digital Multidrop Bus Applications," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 51, No. 12, Dec. 2003, pp. 2597-2603.
- S. Meninger, J.-O. Mur-Miranda, R. Amirtharajah, A. Chandrakasan, and J. Lang, "Vibration-to-Electric Energy Conversion," *IEEE Transactions on VLSI Systems*, Vol. 9, No. 1, Feb. 2001, pp. 64-76.
- A. Dancy, R. Amirtharajah, and A. Chandrakasan, "High-Efficiency Multiple-Output DC-DC Conversion for Low-Voltage Systems," *IEEE Transactions on VLSI Systems*, Vol. 8, No. 3, June 2000, pp. 252-63.
- R. Amirtharajah and A. Chandrakasan, "Self-Powered Signal Processing Using Vibration-Based Power Generation," *IEEE Journal of Solid-State Circuits*, Vol. 33, No. 5, May 1998, pp. 687-695.

Conferences

- R. Geyer, J. Oliver, R. Amirtharajah, V. Akella, and F. T. Chong, "Microchip Reuse: Environmental Rationale and Design Implications," *3rd International Conference on Life Cycle Management (LCM 2007)*, 27-29 August 2007, to appear.
- N. Guilar, P. Hurst, and R. Amirtharajah, "Interface Circuits for Multiphase Piezoelectric Energy Harvesters," submitted to *23rd Annual IEEE Applied Power Electronics Conference and Exposition (APEC 08)*.
- J. Wenck, J. Collier, J. Siebert, and R. Amirtharajah, "AC Power Supply Circuits for Energy Harvesting," *2007 Symposium on VLSI Circuits (VLSI 2007)*, 14-16 June 2007, pp. 92-3.
- N. Guilar, P. Hurst, and R. Amirtharajah, "Analysis of DC-DC Conversion for Energy Harvesting Systems Using a Mixed-Signal Sliding-Mode Controller," *38th IEEE Power Electronics Specialists Conference (PESC 07)*, 17-21 June 2007, pp. 2620-5.
- L. Guo, M. Scott, and R. Amirtharajah, "An Energy Scalable Functional Unit for Sensor Signal Processing," *IEEE 2007 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 15-20 April 2007, Vol. II, pp. 73-6.
- R. Rao, J. Wenck, D. Franklin, R. Amirtharajah, and V. Akella, "Segmented Bitline Cache: Exploiting Non-Uniform Memory Access Patterns," *13th IEEE International Conference on High Performance Computing (HiPC 2006)*, 18-21 December 2006, pp. 123-34.

- J. Oliver, R. Amirtharajah, R. Geyer and F. T. Chong, "Life-Cycle Aware Computer Architecture: Reusing Silicon in the Technology Food Chain," *ACM 12th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2006) Wild and Crazy Ideas (WACI-4)*, 24-26 October 2006.
- N. Guilar, A. Chen, T. Kleeburg, and R. Amirtharajah, "Integrated Solar Energy Harvesting and Storage," *2006 International Symposium on Low Power Electronics and Design*, 4-6 October 2006, pp. 20-4.
- L. Guo, M. Scott, and R. Amirtharajah, "An Energy Scalable Computational Array for Sensor Signal Processing," *IEEE 2006 Custom Integrated Circuits Conference (CICC)*, 10-13 September 2006, pp. 317-20.
- R. Amirtharajah, J. Collier, J. Siebert, J. Wenck, and B. Zhou, "Circuits for Energy Harvesting Sensor Signal Processing" (invited) *2006 43rd ACM/IEEE Design Automation Conference*, 24-28 July 2006, pp. 639-44.
- R. Amirtharajah, "An Energy Scalable Computational Array for Sensor Signal Processing" (invited) *2006 ISSCC Special Topic Session on Power-Aware Signal Processing*, 5 February 2006.
- R. Rao, J. Wenck, D. Franklin, R. Amirtharajah, and V. Akella, "Exploiting Non-Uniform Memory Access Patterns Through Bitline Segmentation," *4th Workshop on Memory Performance Issues (WMPI-2006)*, 11 February, 2006.
- R. Amirtharajah, A. Chen, D. Thaker, and F. T. Chong, "Circuit Interfaces and Optimization for Resistive Nanosensors," (invited) *Proc. of SPIE, Vol. 6008: Nanosensing: Materials and Devices II*, 23-26 October 2005, pp. 60080J1-15.
- J. Siebert, J. Collier, and R. Amirtharajah, "Self-Timed Circuits for Energy Harvesting AC Power Supplies," *2005 International Symposium on Low Power Electronics and Design*, August 2005, pp. 315-8.
- R. Amirtharajah, "Micropower ICs for Energy Scavenging and Sensor Signal Processing," (invited) *IEEE 2005 Vail Computer Elements Workshop*, 26-29 June 2005.
- D. D. Thaker, A. Chen, R. Amirtharajah, and F. T. Chong, "On Designing Self-Calibrating Nanoscale Sensors that Adaptively Invest Power for Accuracy," *Proc. of IEEE International Workshop on Design and Test of Defect-Tolerant Nanoscale Architectures (NANOARCH'05)*, May 2005, pp. 4.9-4.17.
- D. D. Thaker, F. Impens, I. L. Chuang, R. Amirtharajah, and F. T. Chong, "On Using Recursive TMR as a Soft Error Mitigation Technique," *2005 Workshop on the System Effects of Logic Soft Errors (SELSE-1)*, 5-6 April 2005.
- J. R. Benham, R. Amirtharajah, J. Critchlow, T. Simon, and T. F. Knight, Jr., "An Alignment Insensitive Separable Electromagnetic Coupler for High Speed Digital Multidrop Bus Applications," *2003 International Microwave Symposium*, 8-13 June 2003, vol. 2, pp. 1163-6.
- T. Simon, R. Amirtharajah, J.R. Benham, J. Critchlow, and T.F. Knight, Jr., "A 1.6 Gb/s/pair Electromagnetically Coupled Multidrop Bus Using Modulated Signaling," *2003 ISSCC Digest of Technical Papers*, Feb. 2003, pp. 184-5, 487.
- R. Amirtharajah, S. Meninger, J.-O. Mur-Miranda, A. Chandrakasan, and J. Lang, "A Micropower Programmable DSP Powered Using a MEMS-Based Vibration-to-Electric Energy Converter," *2000 ISSCC Digest of Technical Papers*, 2000, pp. 362-3, 469.
- R. Amirtharajah, T. Xanthopoulos, and A. Chandrakasan, "Power Scalable Processing Using Distributed Arithmetic," *1999 International Symposium on Low Power Electronics and Design*, 1999, pp. 170-5.
- S. Meninger, J.-O. Mur-Miranda, R. Amirtharajah, A. Chandrakasan, and J. Lang, "Vibration-to-Electric Energy Conversion," *1999 International Symposium on Low Power Electronics and Design*, 1999, pp. 48-53.
- A. Chandrakasan, R. Amirtharajah, S.-H. Cho, J. Goodman, G. Konduri, J. Kulik, W.

Rabiner, and A. Wang, "Design Considerations for Distributed Microsensor Systems," *1999 Proceedings of the IEEE Custom Integrated Circuits Conference*, 1999, pp. 279-86.

A. Chandrakasan, R. Amirtharajah, J. Goodman, and W. Rabiner, "Trends in Low Power Digital Signal Processing," *1998 International Symposium on Circuits and Systems*, Vol. 4, 1998, pp. 604-7.

R. Amirtharajah and A. Chandrakasan, "Self-Powered Low Power Signal Processing," *1997 Symposium on VLSI Circuits Digest of Technical Papers*, June 1997, pp. 25-26.

M. Bolotski, T. Simon, C. Vieri, R. Amirtharajah, and T.F. Knight, Jr., "Abacus: A 1024 Processor 8 ns SIMD Array," *Proc. Sixteenth Conference on Advanced Research in VLSI*, March 1995, pp. 28-40.

M. Bolotski, et al., "Abacus: A High-Performance Architecture for Vision," *Proc. of ICPR*, 1994.

Book Chapters

R. Amirtharajah, "Distributed Arithmetic," in *Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation*, S. Hauck and A. DeHon, eds., to appear.

A. Chandrakasan, R. Amirtharajah, A. Dancy, J. Goodman, W. Rabiner, and T. Xanthopoulos, "Future Directions in Energy Efficient Computing," in *Low-Power, High-Speed ULSI Circuits and Technology*, Realize, Inc., Japan, 1998.

Patents

R. Amirtharajah, T. Simon, J. R. Benham, J. Critchlow, and M. Naylor, "Interconnecting of Digital Devices," U.S. Patent No. 7,199,681, (2007).

T. Simon, R. Amirtharajah, and J. R. Benham, "Bus Signaling Through Electromagnetic Couplers Having Different Coupling Strengths at Different Locations," U.S. Patent No. 7,126,437, (2006).

T. Simon, R. Amirtharajah, and J. R. Benham, "Controlling Coupling Strength in Electromagnetic Bus Coupling," U.S. Patent No. 7,088,198, (2006).

T. Simon, R. Amirtharajah, T. F. Knight, Jr., N. Marketkar, and J. R. Benham, "Electromagnetically Coupled Bus System," U.S. Patent No. 7,080,186 (2006).

T. Simon, R. Amirtharajah, N. Marketkar, and T. F. Knight, Jr., "Symbol-Based Signaling Device for an Electromagnetically-Coupled Bus System," U.S. Patent No. 7,075,996, (2006).

T. Simon and R. Amirtharajah, "Calibrating Return Time With Cross-Coupled Arbiter/Delay Circuits to Compare Clock Signals," U.S. Patent No. 7,039,824, (2006).

N. Marketkar, T. F. Knight, Jr., J. R. Benham and R. Amirtharajah, "Electromagnetic Coupler Flexible Circuit With a Curved Coupling Portion," U.S. Patent No. 6,987,428, (2006).

T. Simon, R. Amirtharajah, J. R. Benham, and J. Critchlow, "Electromagnetic Coupler Registration and Mating," U.S. Patent No. 6,887,095 (2005).

T. Simon and R. Amirtharajah, "Selectively Combining Signals to Produce Desired Output Signal," U.S. Patent No. 6,812,761 (2004).

J. R. Benham and R. Amirtharajah, "Digital Network," U.S. Patent No. 6,788,163, (2004).

T. Simon and R. Amirtharajah, "Calibrating Return Time for Resynchronizing Data Demodulated From a Master Slave Bus," U.S. Patent No. 6,779,123, (2004).

T. Simon, R. Amirtharajah, N. Marketkar, T. F. Knight, Jr., and J. R. Benham, "Symbol-Based Signaling for an Electromagnetically-Coupled Bus System," U.S. Patent No. 6,697,420, (2004).

T. Simon and R. Amirtharajah, "Generating and Using Calibration Information," U.S. Patent No. 6,665,624, (2003).

T. Simon and R. Amirtharajah, "Selectively Combining Signals to Produce Desired Output Signal," U.S. Patent No. 6,661,269 (2003).

T. Simon, R. Amirtharajah, T. F. Knight, Jr., N. Marketkar, and J. R. Benham, "Electromagnetically Coupled Bus System," U.S. Patent No. 6,625,682 (2003).

N. Marketkar, J. R. Benham, T. F. Knight, Jr., and R. Amirtharajah, "An Electromagnetic Coupler Circuit Board Having at Least One Angled Conductive Trace," U.S. Patent No. 6,611,181 (2003).

J. R. Benham, N. Marketkar, and R. Amirtharajah, "An Electromagnetic Coupler," U.S. Patent No. 6,573,801 (2003).

T. Simon and R. Amirtharajah, "Clock Reshaping," U.S. Patent No. 6,498,512 (2002).

Talks

R. Amirtharajah, "Energy Harvesting for Wireless Sensors," Stanford EE Computer Systems Colloquium (EE 380), Stanford University, May 30, 2007 (Palo Alto, CA).

R. Amirtharajah, "Energy Harvesting for Wireless Sensors," Spring Quarter 2007 Seminar Series (MAE 297), Dept. of Mechanical and Aeronautical Engineering, Univ. of California, Davis, April 26, 2007 (Davis, CA).

R. Amirtharajah, "Microwatt Sensor Interfaces for Energy Harvesting Systems," Invited Seminar, S3C Corp., May 2, 2006 (Santa Clara, CA).

R. Amirtharajah, "Power Supplies for Energy Harvesting Sensors," Invited Seminar, National Semiconductor, August 16, 2005 (Grass Valley, CA).

R. Amirtharajah, "Micropower ICs for Energy Scavenging and Sensor Signal Processing," Invited Talk, Berkeley Manufacturing Institute, June 13, 2005 (Berkeley, CA).

R. Amirtharajah, "Energy Scalable Low Power DSP for Energy Harvesting Sensor Applications," Electrical Engineering Seminar, University of California, Los Angeles, September 9, 2004 (Los Angeles, CA).

R. Amirtharajah, "Energy Scalable Low Power DSP for Energy Harvesting Sensor Applications," Computer Science Seminar, California Institute of Technology, September 7, 2004 (Pasadena, CA).

R. Amirtharajah, "Energy Scalable Signal Processing for Energy Harvesting Sensors," Invited Seminar, Xilinx, Inc., June 22, 2004 (San Jose, CA).

R. Amirtharajah, "Energy Scalable Signal Processing for Energy Harvesting Sensors," BWRC Seminar, Berkeley Wireless Research Center, University of California, Berkeley, May 7, 2004 (Berkeley, CA).

R. Amirtharajah, "Energy Scalable Signal Processing for Energy Harvesting Sensors," Pico-Radio Meeting Talk, Berkeley Wireless Research Center, University of California, Berkeley, April 9, 2004 (Berkeley, CA).

R. Amirtharajah, "Ultra Low Power DSP for Energy Harvesting Applications," Invited Seminar, Dust, Inc., March 11, 2004 (Berkeley, CA).

R. Amirtharajah, "A 1.6 Gb/s/pair Electromagnetically Coupled Multidrop Bus Using Pulse-Based Modulated Signaling," 6.976 Invited Guest Lecture, Massachusetts Institute of Technology, May 9, 2003 (Cambridge, MA).

R. Amirtharajah, "Micropower Energy Scalable DSP Systems Powered From Vibration-to-Electric Energy Conversion," Invited Seminar, Brown University, Nov. 20, 2002 (Providence, RI).

Professional

IEEE Solid-State Circuits Society

IEEE Computer Society

IEEE Microwave Theory and Techniques Society

Sigma Xi, The Scientific Research Society

American Association for the Advancement of Science

Book Proposal Reviewer for Cambridge University Press

Paper Reviewer for IEEE *Journal of Solid-State Circuits*

Paper Reviewer for IEEE *Communications Magazine*
Paper Reviewer for IEEE *Transactions on Computer-Aided Design*
Paper Reviewer for IEEE *Transactions on Power Electronics*
Paper Reviewer for IEEE *Sensors Journal*
Paper Reviewer for IEEE *Transactions on Very Large Scale Integration (VLSI) Systems*
Paper Reviewer for ACM *Transactions on Architecture and Code Optimization*
Paper Reviewer for ACM *Journal on Emerging Technologies in Computing Systems*
Reviewer for 12th IEEE International Symposium on High-Performance Computer Architecture (HPCA-12), 2006
Reviewer for 17th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA 2005)
Technical Program Committee for 2004 Great Lakes Symposium on VLSI
Technical Program Committee for International Solid-State Circuits Conference, 2005-2007
Technical Program Committee for Hot Chips Conference, 2006 (Member) and 2007 (Co-Chair)

Awards & Honors National Science Foundation Graduate Fellowship 1994-1997
National Science Foundation CAREER Award 2006-2011

References Available upon request.