

Nickvash Kani

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PARTICULARS

PROFILE

A Research Assistant Professor at the University of Illinois at Urbana-Champaign specializing in information retrieval of mathematical documents. Research interests include parsing, retrieval and data-mining of STEM documents by analyzing their mathematical content. Skilled in applying natural language processing techniques to other data modalities.

EDUCATION

Ph. D. in Electrical and Computer Engineering Georgia Institute of Technology – Atlanta, GA	<i>Sep. 2013 - Dec. 2017</i> GPA - 3.82/4.0
M. S. in Electrical and Computer Engineering Georgia Institute of Technology – Atlanta, GA	<i>Sep. 2010 - May 2013</i> GPA - 4.0/4.0
B. S. in Computer Engineering Boston University – Boston, MA	<i>Sep. 2006 - May 2010</i> GPA - 3.80/4.0

WORK EXPERIENCE

- **Research Assistant Professor, University of Illinois at Urbana-Champaign**, Oct 2019 - Present. Am an assistant research professor in the electrical and computer engineering department at the University of Illinois at Urbana-Champaign. My research is focused on novel AI architectures and specialized algorithms for the retrieval and manipulation of mathematical expressions.
- **Senior Software Engineer, Reservoir Labs**, Mar 2018 - October 2019. The company was contracted to develop a LLVM-based C-compiler for a single-instruction, multiple-data (SIMD) processor. Furthermore, I have and continue to develop an operating environment (OE). Similar to OpenCL or CUDA, the operating environment handles kernel- scheduling/execution/synchronization and device memory allocation.
- **IC Design Intern, Broadcom Corporation**, May 2013 - Aug 2013. Developed script that automatically ran necessary programs to layout and formally verify chip designs. Performed power-threaded analysis on compiled designs and verified operation of scripted design.
- **Financial Management Systems Intern, Save the Children USA**, Jun 2007 - Aug 2007 and Mar 2008 - Apr 2008. Maintained existing accounting infrastructure and synced distributed air-gapped financial database system. Designed new database system for rapid reporting of financial metrics. Assisted in research and acquisition of alternate financial software.

RESEARCH EXPERIENCE

- **Graduate Research Assistant, Georgia Institute of Technology**

Design and Evaluation Spin-based Switching Technologies, (Prof Azad Naeemi | Jan. 2013 - March 2018)

Several next-generation technologies are being explored for low-power memory, logic, and beyond-CMOS applications. Of particular interest are spin-based technologies in which electron spins serve as the information token, while the moment of a magnetic body stores the digital spin information. The goal of this research is to theoretically model and analyze various spin-dependent effects, including spin-transfer torque, dipolar coupling, and thermally induced stochasticity, in ferromagnetic thin films. By implementing an end-to-end modeling framework for spin devices, the work provides guidelines on material, device, and circuit requirements to achieve application-specific performance targets.

Physical Design of Network-on-Chip Architectures (Prof Azad Naeemi | Jan 2011 - Dec 2012)

In current many-core microprocessors, the cost of energy dissipation related to information communication is quickly outpacing the cost of Boolean operations. The desired performance-per-energy in multi-core systems can be achieved by implementing a complex network-on-chip (NoC) architecture. In this research, we investigated the physical cost associated with NoC interconnection fabric and developed design solutions to mitigate the overhead and achieve the best-case performance at advanced CMOS technology nodes.

- **Undergraduate Research Assistant, Boston University.**

CIRIS Label-Free Detection System (Prof. Selim Unlu | Jun 2010 - Aug 2010)

The goal of this project was to develop a compact version of the IRIS label-free optical biosensing platform that senses the presence of an organic material on a silicon substrate through phase shift in light. The essential device platform was designed and implemented by me. The work laid the foundation to finalize a prototype for a compact version of the device, designed by another research group at Boston University.

MEMS Optical Communication Project (Prof. Mark Horenstein | May 2009 - Dec 2009)

The goal of this project was secure, long-range laser-communication through the use of a micro-mechanical deformable-mirror. When a high-voltage pulse is passed to the mirror, it is deformed and scatters the laser bouncing off of it and into a photo-receptor diode. The deformation of the mirror created the ability to transmit binary information. I assisted in the finalized version of the circuitry required to control the deformable-mirror and created the one-way communication encoding required to operate the system.

ESPART Optical Particle Sizing Systems (Prof. Malay Mazumder | Aug 2009 - Dec 2009)

The ESPART particle sizing system was a device pioneered by Prof. Malay Mazumder. This system could simultaneously measure the size and charge of a particle in extra-terrestrial environments. I assisted in operating the second generation of these devices and further developed LabView scripts to run the device.

TEACHING EXPERIENCE

- **Instructor** CS/ECE-374: Computational Complexity and Algorithms, [Fall 2020, Spring 2021, Fall 2021, Spring 2022, Fall 2022], University of Illinois at Urbana-Champaign.
- **Instructor** ECE342: Analog Circuit Theory, Spring 2020, University of Illinois at Urbana-Champaign.
- **Laboratory Assistant.** EE3042: Electronics Lab, Prof. Thomas Brewer and Prof. Robert Allen Robinson, Fall 2010, Georgia Institute of Technology.
- **Teaching Assistant.** EC450: Microcontroller Programming, Prof. Roscoe Giles, Spring 2010, Boston University.
- **Teaching Assistant.** EC311: Introduction to Logic Design, Prof. Alexander Taubin and Prof. Mark Karpovsky, Spring 2009, Fall 2009 and Spring 2010, Boston University.
- **Laboratory Assistant.** EC410: Introduction to Electronics, Prof. Min-Chang Lee, Prof. Alexander Sergienko and Prof. Selim Unlu, Fall 2008, Georgia Institute of Technology.

PUBLICATIONS

JOURNAL PAPERS

1. **Nickvash Kani**, Shaloo Rakheja, Azad Naeemi, "A generative design approach to benchmarking Spin-Switch devices", *In preparation*.

2. **Nickvash Kani**, Shaloo Rakheja, Azad Naeemi, “Analytic modeling of dipolar field requirements for robust coupling in a non-identical biaxial two-magnet system”, *Journal of Applied Physics*, July 2018, vol. 124, no. 2, p. 023901. [Article featured on cover page of the journal issue.] <https://doi.org/10.1063/1.5024821>
3. Rouhollah Mousavi Iraei, **Nickvash Kani**, Sourav Dutta, Dmitri E. Nikonov, Sasikanth Manipatruni, Ian A. Young, John T. Heron, Azad Naeemi, “Clocked magnetostriction-assisted spintronic device design and simulation”, *IEEE Transactions on Electron Devices*, May 2017, vol. 65, no. 5, pp. 2040-2046. <https://doi.org/10.1109/TED.2018.2817556>
4. **Nickvash Kani**, Azad Naeemi, “Analytical models for coupling reliability in identical two-magnet systems during slow reversals”, *Journal of Applied Physics*, December 2017, vol. 122, no. 22, p. 223902. <https://doi.org/10.1063/1.4996934>
5. **Nickvash Kani**, John T. Heron, Azad Naeemi, “Strain-mediated magnetization reversal through spin-transfer torque”, *IEEE Transactions on Magnetics*, May 2017, vol. 53, no. 11, pp. 1-8. <https://doi.org/10.1109/TMAG.2017.2703898>
6. Shaloo Rakheja, **Nickvash Kani**, “Spin pumping driven auto-oscillator for phase-encoded logic—device design and material requirements”, *AIP Advances*, May 2017, vol. 7, no. 5, p.055905. <https://doi.org/10.1063/1.4973390>
7. **Nickvash Kani**, Shaloo Rakheja, Azad Naeemi, “Non-monotonic probability of thermal reversal in thin-film biaxial nanomagnets with small energy barriers”, *AIP Advances*, May 2017, vol. 7, no. 5, p. 056006. <https://doi.org/10.1063/1.4974017>
8. Nikhil Rangarajan, Arun Parthasarathy, **Nickvash Kani**, Shaloo Rakheja, “Energy-efficient computing with probabilistic magnetic bits—performance modeling and comparison against probabilistic CMOS logic”, *IEEE Transactions on Magnetics*, April 2017, vol. 53, no. 11, pp. 1-10. <https://doi.org/10.1109/TMAG.2017.2696041>
9. **Nickvash Kani**, Shaloo Rakheja, Azad Naeemi, “A probability-density function approach to capture the stochastic dynamics of the nanomagnet and impact on circuit performance”, *IEEE Transactions on Electron Devices*, October 2016, vol. 63, no. 10, pp. 4119-4126. <https://doi.org/10.1109/TED.2016.2594170>
10. Sou-Chi Chang, **Nickvash Kani**, Sasikanth Manipatruni, Dmitri E Nikonov, Ian A Young, Azad Naeemi, “Scaling limits on all-spin logic”, *IEEE Transactions on Magnetics*, July 2016, vol. 52, no. 7, pp. 1-4. <https://doi.org/10.1109/TMAG.2016.2518702>
11. **Nickvash Kani**, Sou-Chi Chang, Sourav Dutta, Azad Naeemi, “A model study of an error-free magnetization reversal through dipolar coupling in a two-magnet system”, *IEEE Transactions on Magnetics*, February 2016, vol. 52, no. 2, pp. 1-12. [Article featured on cover page of the journal issue.] <https://doi.org/10.1109/TMAG.2015.2475426>
12. Sourav Dutta, Sou-Chi Chang, **Nickvash Kani**, Dmitri E Nikonov, Sasikanth Manipatruni, Ian A Young, Azad Naeemi, “Non-volatile clocked spin wave interconnect for beyond-CMOS nanomagnet pipelines”, *Scientific reports*, May 2015, pp. 9861. <https://www.nature.com/articles/srep09861>

CONFERENCE PAPERS

13. Shaloo Rakheja, **Nickvash Kani**, “Polymorphic spintronic logic gates for hardware security primitives — Device design and performance benchmarking”, *IEEE/ACM International Symposium on Nanoscale Architectures*, Boston, MA, July 2017. <https://doi.org/10.1109/NANOARCH.2017.8053726>
14. **Nickvash Kani**, Sourav Dutta, Azad Naeemi, “Analysis of coupling strength in multi-domain magnetosystems”, *2015 73rd Annual Device Research Conference (DRC)*, Columbus, OH, August 2015, pp.111-112. <https://doi.org/10.1109/DRC.2015.7175580>
15. **Nickvash Kani**, Azad Naeemi, “Wiring resource minimization for physically-complex Network-on-Chip architectures”, *2014 27th IEEE International System-on-Chip Conference (SOCC)*, Las Vegas, NV, September 2014, pp.110-115. <https://doi.org/10.1109/SOCC.2014.6948938>
16. **Nickvash Kani**, Azad Naeemi, “Pipeline design in spintronic circuits”, *IEEE/ACM International Symposium on Nanoscale Architectures*, Paris, France, July 2014, pp.110-115. <https://doi.org/10.1109/NANOARCH.2014.6880496>
17. Rouhollah Mousavi Iraei, Phillip Bonhomme, **Nickvash Kani**, Sasikanth Manipatruni, Dmitri E Nikonov, Ian A Young, Azad Naeemi “Impact of dimensional scaling and size effects on beyond CMOS All-Spin Logic interconnects”, *Interconnect Technology Conference (IITC)*, San Jose, CA, June 2014, pp.353-356. <https://doi.org/10.1109/IITC.2014.6831833>

18. **Nickvash Kani**, Azad Naeemi, "Circuit-technology co-optimization of heterogeneous hierarchical network-on-chips", *Interconnect Technology Conference (IITC)*, San Jose, CA, June 2012, pp.1-3. <https://doi.org/10.1109/IITC.2012.6251645>

PRESENTATIONS and POSTERS ¹

Note: *OP* stands for oral presentation and *PP* stands for poster presentation.

19. Shaloo Rakheja, **Nickvash Kani**, "Spin-Torque Nano-Oscillator Driven by Spin Pumping for Phase-Based Neuromorphic Computing", (*OP*) at *Materials Research Society (MRS)* Boston, MA, Nov 2017.
20. **Nickvash Kani**, Shaloo Rakheja, "Analytical Reliability Models for Two-Magnet Systems", (*OP*) at *5th Italian Conference on Magnetism (MAGNET)* Assisi, Italy, Sep 2017.
21. **Nickvash Kani**, Azad Naeemi, "Modeling of Reversal Dynamics in Mono-Domain Magnetic Bodies", (*PP*) at *SRC INDEX 5th Annual Review* New York City, NY, Jul 2017.
22. Nikhil Rangarajan, Arun Parthasarathy, **Nickvash Kani**, Shaloo Rakheja, "Voltage-tunable probabilistic computing with magnetic bits", (*PP*) at *IEEE International Magnetic Conference (INTERMAG)* Dublin, Ireland, Apr 2017.
23. **Nickvash Kani**, John T. Heron, Azad Naeemi, "A theoretical approach to strain-mediated nanomagnet reversal through spin-transfer torque", (*PP*) at *IEEE International Magnetic Conference (INTERMAG)* Dublin, Ireland, Apr 2017.
24. **Nickvash Kani**, John T. Heron, Azad Naeemi, "Enhanced nanomagnet spin-transfer-toque reversal through strain-induced meta-stable magnetization initialization", (*OP*) at *American Physical Society - March Meeting* New Orleans, LA, Mar 2017.
25. Shaloo Rakheja, **Nickvash Kani**, "Spin pumping driven auto-oscillator for phase-encoded logic", (*OP*) at *61st Annual Conference on Magnetism and Magnetic Materials* New Orleans, LA, Nov 2016.
26. **Nickvash Kani**, Shaloo Rakheja, Azad Naeemi, "Non-monotonic probability of thermal reversal in thin-film biaxial nanomagnets with small energy barriers", (*OP*) at *61st Annual Conference on Magnetism and Magnetic Materials* New Orleans, LA, Nov 2016.
27. **Nickvash Kani**, Azad Naeemi, "Characterization and Evaluation of Concatenable Spin Switch Devices III", (*PP*) at *SRC INDEX 4th Annual Review* Albany, NY, Jul 2016.
28. **Nickvash Kani**, Azad Naeemi, "An Analysis of Nanomagnet Relaxation under Sub-critical Longitudinal Fields in the Presence of Thermal Noise", (*OP*) at *13th Joint MMM-Intermag Conference* San Diego, CA, Jan 2016.
29. **Nickvash Kani**, Sou-Chi Chang, Sourav Dutta, Azad Naeemi, "Modeling and Analysis of Dipolar Coupling in Complex Magneto-systems", (Paper in *TECHCON* digest available to SRC members, *OP*, and *PP*) at *SRC TECHCON 2015*, Austin, TX, September 2015.
30. **Nickvash Kani**, Azad Naeemi, "Characterization and Evaluation of Concatenable Spin Switch Devices II", (*PP*) at *SRC INDEX 3rd Annual Review* Albany, NY, Jul 2015.
31. **Nickvash Kani**, Azad Naeemi, "Pipeline Design in Spintronic Circuits", (Paper in *TECHCON* digest available to SRC members, *OP*, and *PP*) at *SRC TECHCON 2014*, Austin, TX, September 2014.
32. **Nickvash Kani**, Azad Naeemi, "Characterization and Evaluation of Concatenable Spin Switch Devices I", (*PP*) at *SRC INDEX 2nd Annual Review* Albany, NY, Aug 2014. **Won best poster.**
33. **Nickvash Kani**, Azad Naeemi, "Compact Modeling and Circuit Design for Concatenable Spin Switch Devices", (*PP*) at *SRC INDEX 1st Annual Review* Albany, NY, Aug 2013.
34. **Nickvash Kani**, Azad Naeemi, "Physical Resource Minimization and Optimization for Networks-on-Chip", (*PP*) at *SRC IFC Annual Review* Atlanta, GA, Aug 2012.

ACADEMIC HONORS

- Cover of *AIP - Journal of Applied Physics* July 2018 Issue.
- Cover of "IEEE Transactions on Magnetics" Feb 2016 Issue.
- Best Poster at *SRC-INDEX Annual Review*, 2014.
- P. T. Hsu Memorial Award for Outstanding Senior Design Project, Boston University, 2010.
- Graduated *Magna Cum Laude* from Boston University

¹Includes all papers presented at academic conferences, workshops, and review meetings that are not assigned an online DOI. Conference abstracts were peer-reviewed but not published.