Alireza Vahid, PhD

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Who I am

Wireless architectures and protocols have become too complicated to scale and meet the ever-increasing demands of future applications such as the Internet of Things, vehicular systems, mmWave and THz communications, WiFi6, 5G, 6G and beyond. It is time for a fundamental change in our approach. I jointly develop communication algorithms and antenna structures to harness the computational power of the analog forefront, and drastically improve network throughput, power consumption, and latency. Beyond communications, I collaborate with experts to develop new models and codes to overcome the challenges of emerging data storage technologies such as Racetrack and DNA archival storage. I seek to impact wireless networking, sensing, and data storage through my innovations.

Research Interests

- Theory of Wireless Networking with Programmable Computational Antennas
- Network Information Theory, Communication Theory, and Signal Processing
- Coding Theory and its Applications in Data Storage and High-Performance Computing

Education

- **Cornell University** — Ithaca, NY
  MSc & PhD in Electrical and Computer Engineering — 2015
  - PhD Thesis: The Impact of Imperfect Feedback on the Capacity of Wireless Networks
  - **2015 Cornell Best PhD Thesis Award**
  - Advisor: Salman Avestimehr, PhD
- **Sharif University of Technology** — Tehran, Iran
  BSc in Electrical Engineering — 2009

Positions Held

- **University of Colorado Denver** — Denver, CO
  Assistant Professor of Electrical Engineering — 2017 to present
- **Theia Technologies** — Denver, CO
  Founder and CEO — 2020 to present
- **Duke University** — Durham, NC
  Adjunct Assistant Professor of Electrical & Computer Engineering — 2018
- **Duke University** — Durham, NC
  Postdoctoral Research Scientist — 2014-2017
- **Qualcomm Inc.** — San Diego, CA
  Innovation Fellow — 2013
- **Bell Labs** — Holmdel, NJ
  Research Intern — 2012

Funding

Funding Agency	Year	Role	Total Budget	Share	Title
NSF	2020	PI	\$500k	50%	Cross-Layer Interference Management: Bringing Interference Alignment to Reality
Lab Venture Partners	2019	PI	\$125k	100%	Theia: A Low-Complexity Distributed Interference Management Solution
State of Colorado	2019	PI	\$90k	100%	Opportunistic Communication Protocols in Dynamic Wireless Systems
University of Colorado	2018	PI	\$30k	100%	Deceptive Solutions in Data Transmission
Qualcomm Inc.	2013	PI	\$100k	50%	Collaborative Interference Management

Selected Awards & Honors

- Best Paper Award at IEEE CCWC 2020
- Lab Venture Challenge Award for my invention "Theia" (\$125k) 2019
- Runner-up Best Paper Award at Dependable Systems and Networks (DSN) 2019
- New Faculty Research Award, CU Denver (\$30k) 2019
- Creative Research Collaborative (CRC) Fellowship, CU Denver 2018
- Young Upwardly Mobile Professor (YUMP) Award, CU Denver 2018, 2019
- Best PhD Thesis Award, School of ECE, Cornell University 2015
- Qualcomm Innovation Fellowship (\$100k) 2013
- Best PhD Teaching Award, School of ECE, Cornell University 2011
- Jacobs Scholar Fellowship, School of ECE, Cornell University 2009
- Ranked 2nd among over 360,000 in Iranian University Entrance Exam 2004
- Ranked 2nd in Azad University National Entrance Exam 2004
- Silver Medal in Iranian National Physics Olympiad 2003

Journal Publications

(J1) T. Levy, A. Vahid, R. Giryes, "Ranking Recovery from Limited Comparisons using Low-Rank Matrix Completion," *to appear in the journal of Applied and Computational Harmonic Analysis*, 2020.

(J2) S. Nassirpour, A. Vahid, "Embedded Codes for Reassembling Non-Overlapping Random DNA Fragments," *IEEE Transactions on Molecular, Biological, and Multi-Scale Communications*, 2020.

(J3) M. Johnny, A. Vahid, "Exploiting Coherence Time Variations for Opportunistic Blind Interference Alignment," *IEEE Transactions on Communication Theory*, 2020.

(J4) A. Vahid, "On the Degrees-of-Freedom of Two-Unicast Wireless Networks with Delayed CSIT," *IEEE Transactions on Information Theory*, vol. 65, no. 8, pp. 5176–5188, 2019.

(J5) A. Vahid, A. R. Calderbank, "Throughput Region of Spatially Correlated Interference Packet Networks," *IEEE Transactions on Information Theory*, vol. 65, no. 2, pp. 1220–1235, 2019.

(J6) G. Mappouras, A. Vahid, R. Calderbank, D. Sorin, "Extending Flash Lifetime in Embedded Processors by Expanding Analog Choice," *IEEE Transactions on Computer-Aided Design Integrated Circuits and Systems*, vol. 37, no. 11, pp. 2462–2473, 2018.

(J7) A. Vahid, V. Aggarwal, S. Avestimehr, A. Sabharwal, "Interference Management with Mismatched Partial Channel State Information," *EURASIP Journal on Wireless Communications and Networking*, 2017.

(J8) A. Vahid, M. Maddah-Ali, S. Avestimehr, and Y. Zhu, "Binary Fading Interference Channel with No CSIT," *IEEE Transactions on Information Theory*, vol. 63, no. 6, pp. 3565–3578, 2017.

(J9) A. Vahid, A. R. Calderbank, "Two-User Erasure Interference Channels with Local Delayed CSIT," *IEEE Transactions on Information Theory*, vol. 62, no. 9, pp. 4910–4923, 2016.

(J10) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Approximate Capacity Region of the MISO Broadcast Channels With Delayed CSIT," *IEEE Transactions on Communications*, vol. 64, no. 7, pp. 2913–2924, 2016.

(J11) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Capacity Results for Binary Fading Interference Channels with Delayed CSIT," *IEEE Transactions on Information Theory*, vol. 60, no. 10, pp. 6093–6130, 2014.

(J12) A. Vahid, C. Suh, and S. Avestimehr, "Interference Channels with Rate-Limited Feedback," *IEEE Transactions on Information Theory*, vol. 58, no. 5, pp. 2788–2812, 2012.

Conference Publications

(C1) M. A. Farahani, A. Vahid, A. E. Goodwell, "Evaluating Ecohydrological Model Sensitivity to Forcing Variability with an Information Theory-Based Approach," *Proceedings of American Geophysical Union (AGU* Fall Meeting), 2020. **Interdisciplinary work in environmental engineering.**

(C2) I. Shomorony A. Vahid, "Communicating over the Torn-Paper Channel," *to appear in IEEE Global Communications Conference (GLOBECOM)*, 2020.

(C3) S. C. Lin, I. H. Wang, A. Vahid, "Capacity of Erasure Broadcast Channels with Single-User Delayed CSI and Common Messages," *to appear in IEEE Global Communications Conference (GLOBECOM)*, 2020.

(C4) M. Johnny, A. Vahid, "Embedding Information in Radiation Pattern Fluctuations," *Proceedings of International Symposium on Information Theory (ISIT)*, 2020.

(C5) S. Nassirpour, A. Vahid, "Throughput, Delay, and Complexity Tradeoffs in Interference Channels," *Proceedings of 10th IEEE Annual Computing and Communication Workshop and Conference (CCWC)*, 2020. **Winner Best Paper Award**.

(C6) A. Vahid, I. H. Wang, S. C. Lin, "Capacity results for erasure broadcast channels with intermittent feedback," *Proceedings of IEEE Information Theory Workshop (ITW)*, 2019.

(C7) Mappouras, A. Vahid, R. Calderbank, D. Sorin, "GreenFlag: Protecting 3D-Racetrack Memory from Shift Errors," *Proceedings of 49th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN)*. **Runner-up Best Paper Award**.

(C8) S. C. Lin, I. H. Wang, A. Vahid, "No Feedback, No Problem: Capacity of Erasure Broadcast Channels with Single-User Delayed CSI," *Proceedings of International Symposium on Information Theory (ISIT)*, 2019.

(C9) A. Vahid, "Finite Field X-Channels with Delayed CSIT and Common Messages," *Proceedings of International Symposium on Information Theory (ISIT)*, 2018.

(C10) A. Vahid, R. Calderbank, "ARQ for interference packet networks," *Proceedings of International Symposium on Information Theory (ISIT)*, 2018.

(C11) G. Mappouras, A. Vahid, R. Calderbank, D. R. Hower, D. Sorin, "Jenga: Efficient Fault Tolerance for Stacked DRAM," *Proceedings of IEEE International Conference on Computer Design (ICCD)*, 2017.

(C12) A. Vahid, R. Calderbank, "When does spatial correlation add value to delayed channel state information?" *Proceedings of International Symposium on Information Theory (ISIT)*, 2016.

(C13) G. Mappouras, A. Vahid, R. Calderbank, D. Sorin, "Methuselah Flash: Rewriting Codes for Extra-Long Storage Lifetime," *Proceedings of 46th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN)*, 2016.

(C14) A. Eslami, A. Velasco, A. Vahid, G. Mappouras, R. Calderbank, D. Sorin, "Writing without Disturb on Phase Change Memories by Integrating Coding and Layout Design," *Proceedings of Memory Systems (MEMSYS)*, 2015.

(C15) A. Vahid, I. Shomorony, R. Calderbank, "Informational Bottlenecks in Two-Unicast Wireless Networks with Delayed CSIT," *Proceedings of Allerton conference*, 2015.

(C16) A. Vahid, R. Calderbank, "Impact of Local Delayed CSIT on the Capacity Region of the Two-User Interference Channel," *Proceedings of International Symposium on Information Theory (ISIT)*, 2015.

(C17) A. Vahid, G. Mappouras, A. Velasco, R. Calderbank, and D. J. Sorin, "Virtual Cells and Concatenated Codes for Flash Memory," *Proceedings of Fifth Non-Volatile Memories Workshop (NVMW).*

(C18) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Binary Fading Interference Channel with No CSIT," *Proceedings of International Symposium on Information Theory (ISIT)*, 2014.

(C19) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Communication Through Collisions: Opportunistic Utilization of Past Receptions," *Proceedings of IEEE Infocom*, 2014.

(C20) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Approximate Capacity of the Two-User MISO Broadcast Channel with Delayed CSIT," *Proceedings of Allerton conference*, 2013.

(C21) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Binary Fading Interference Channel with Delayed Feedback," *Proceedings of International Symposium on Information Theory (ISIT)*, 2012.

(C22) A. Vahid, M. Maddah-Ali, and S. Avestimehr, "Interference Channel with Binary Fading: Effect of Delayed Network State Information," *Proceedings of Allerton conference*, 2011.

(C23) A. Vahid, V. Aggarwal, S. Avestimehr, and A. Sabharwal, "On the Capacity of Multi-hop Wireless Networks with Partial Network Knowledge," *Proceedings of Allerton conference*, 2010.

(C24) A. Vahid and S. Avestimehr, "The Two-User Deterministic Interference Channel with Rate-Limited Feedback," *Proceedings of International Symposium on Information Theory (ISIT)*, 2010.

Preprints and Submitted Papers

(P1) I. Shomorony, A. Vahid, "Torn-Paper Coding," *submitted to IEEE Transactions on Information Theory*, 2020.

(P2) S. Nassirpour, A. Vahid, "On Duality of Stability and Capacity Regions in Interference Networks," *submitted to IEEE Transactions on Communications*, 2020.

(P3) A. Vahid, S. C. Lin, I. H. Wang, "Erasure Broadcast Channels with Intermittent Feedback," *submitted to IEEE Transactions on Information Theory*, 2020.

(P4) S. C. Lin, I. H. Wang, A. Vahid, "Capacity of Two-User Erasure Broadcast Channels with Single-User Delayed CSI," *submitted to IEEE Transactions on Information Theory*, 2020.

(P5) M. Johnny, A. Vahid, "Distributed Blind Interference Management with Computational Antennas," *submitted to IEEE Transactions on Communications*, 2020.

(P6) H. Jafarian, I. Shomorony, A. Vahid, "Design and Development of Deceptive and Agile Wireless Infrastructures against Adversarial Traffic Analysis Attacks," *under review.*

Patents

(Patent1) A. Vahid, "Embedding Information in Radiation Pattern Fluctuations," US Provisional Patent, 2020.

(Patent2) A. Vahid, "Low-Complexity Practical Implementation of Blind Interference Alignment using Reconfigurable Antennas," US Provisional Patent, 2019.

(Patent3) D. Sorin, G. Mappouras, R. Calderbank, A. Vahid,"Systems and Methods for Improving Memory Bandwidth," US Provisional Patent, 2019.

Graduate Students

- Sajjad Nassirpour — PhD Candidate
  - Started 2019. Best Paper Award at CCWC'20. One accepted journal paper.
- Yalda Nael — MSc Candidate
  - Female candidate working on Erasure Broadcast Channels
- John McFarlane — MSc Candidate
  - Working on data security and deceptive communications

Teaching Experience and Student Mentorship

- Instructor, University of Colorado Denver
  - Data and Information Inference Theory (G) — Fall 2019
  - Engineering Probability and Statistics (UG) — Spring 2019
  - Random Processes (G) — Fall 2018
  - Digital Communication Systems (G) — Spring 2018 & 2019
  - Information and Coding Theory (G) — Fall 2017 & 2019
- **Data+ Summer Program, Duke University** — Durham, NC
  Mentor for Water Reservoir Project — Jun. to Aug. 2015
  - Advised a team of undergraduates and two graduate students

  - Aligned the capabilities of the undergraduates with the demands of the external client
  - Managed communication with the external client
  - Conducted comprehensive study of water reservoirs across North America
  - Quantified the role of human operator in water level fluctuations

- **Teaching Assistant, Cornell University** Ithaca, NY
  Random Signals in Communication and Signal Processing Fall 2010
  - **2011 Cornell University Best PhD Teaching Award**

Professional Activities

- TPC member,
  - IEEE Annual Computing and Communication Workshop and Conference (CCWC) 2020
  - Non-Volatile Memories Workshop (NVMW) 2021
  - IEEE International Symposium on Information Theory (ISIT) 2021
- Reviewer:
  - IEEE Transactions on Information Theory
  - IEEE Transactions on Communications
  - IEEE Transactions on Wireless Communications
  - IEEE Transactions on Vehicular Technology
  - IEEE International Symposium on Information Theory
  - IEEE INFOCOM
  - IEEE GLOBECOM
  - IEEE Information Theory Workshop
  - IEEE Communication Letters
  - IEEE Magnetic Letters
- Panel Reviewer:
  - National Science Foundation, CISE (CCF and CNS), ENG (CCSS)
- Organized the North American School of Information Theory 2016
- Chair of student travel award committee, IEEE ISIT 2020

Professional Activities

- IEEE Senior Member
- IEEE Communication Society Member
- IEEE Information Theory Society Member
- IEEE Young Professionals Member