

2. Biographical Data

2.A Name: Grover, Pulkit

2.B Place and Date of Birth: Jaipur, India. June 25, 1981.

2.C Education:

Institution and location	Degree	MM/YY	Field of study
Indian Institute of Technology, Kanpur	B.Tech	05/2003	Electrical Engineering
Indian Institute of Technology, Kanpur	M.Tech	07/2005	Electrical Engineering
University of California Berkeley	Ph.D.	12/2010	Electrical Engineering and Computer Science

2.D Former positions

2011-2012:

Postdoctoral Scholar, Stanford University.

2013-:

Assistant Professor, Carnegie Mellon University.

3. Teaching and Education

3.A Courses Taught at CMU

Course Title	Units	Offered	Num Students	Num Resp	FCE Course	FCE Instr
18-898 Special Tpc Sig Proc Clinical neural data analysis*	12	Spring 2017	31	23	4.17	4.22
18-290 Signals and Systems Co-taught with B. Yu	12	Fall 2016	115	72	4.37	4.39
18-754 Error-correcting codes	12	Spring 2016	5	5	4.40	4.60
18-290 Signals and Systems Co-taught with B. Yu	12	Fall 2015	105	75	4.12	4.30
18-290 Signals and Systems Co-taught with B. Sinopoli	12	Spring 2015	65	29	3.66	3.83
18-859 Special Tpc comm n/ws in comm, compute, and brain*	12	Fall 2014	13	13	4.31	4.62
18-290 Signals and Systems Co-taught with B. Sinopoli	12	Spring 2014	59	53	2.94	3.25
18-290 Signals and Systems Co-taught with B. Sinopoli	12	Spring 2013	71	67	3.67	4.07

* New courses taught.

FCE: Faculty Course Evaluations, out of a maximum of 5.

3.B Student Projects

(a) Undergraduate Projects Supervised

1. Spencer Barton CIT Honors project, "Signal processing and app development for echolocation," Fall '14 - Fall '15.
2. Rudina Morina, "Signal processing and app development for assistive devices," Spring '14 - Spring '15.
3. Rahshel Brown, "Wireless information and power transfer on the same link," Summer & Fall '13.
4. Ana Beisy Cruz, "Neurostimulation techniques: a novel strategy for focusing ultrasound," 2013-2015.
5. Max Regan, "Securing circuits, and securing wireless power transfer," Summer and Fall '13.
6. Arley Schenker, "Echolocation: human studies and app development," Spring 15.
7. Chidimma Onwuegbule, "EEG for neuroprostheses," Fall 2014.
8. Matthew Boring (Pitt Neuroscience), "Ultra-high-density EEG," Fall 2014 - present.
9. Arnelle Etienne, "Ultra-high-density EEG: electrode design," Spring 16-present.

10. Wanqiao (Ivy) Ding, “Diagnoses relevant to Traumatic Brain Injury and Epilepsy,” Spring 15-present.
11. Lily Kramer (Pitt neuroscience), “Neural disorders and their diagnoses using EEG,” since Fall 2016.
12. Vaibhav Sharma (Pitt neuroscience), “Neural disorders and their diagnoses using EEG,” since Fall 2016.
13. Mark McElwaine, CIT Honors project, “Instrumenting the first ultra-resolution EEG,” 2016-2017.

(b) Master’s Students

1. Rachel Sun, “Algorithms and systems for epilepsy diagnosis and treatment”
2. Shilpa Anna George, “Automated algorithms for inferences relevant to Traumatic Brain Injury”
3. Tejal Kudav, “Sensory Supplementation via Echolocation,” September 2014 - Dec. 2015, co-advised with B. Sinopoli, L. Heller
4. Anirudh Mendiratta, “Echolocation-based navigation for the visually impaired,” May 2014 - Dec. 2015.
5. Ramon Cepeda, “Minimizing energy in mm-wave communication systems,” July 2013 - December 2014.
6. Majid Mahzoon, “Energy-efficient sensing and communication for the goal of inference,” Aug 2013 – July 2015.

(c) Ph.D. Students

1. Yaoqing Yang (since 2013), “Coded computation at gate and processor level” co-advised with Soumya Kar.
2. Praveen Venkatesh (since 2014), “Information theory of noninvasive brain imaging and applications to epilepsy diagnosis and treatment”
3. Haewon Jeong (since 2014), “Energy-adaptive code design for short-distance communication; coded computation”
4. Sanghamitra Dutta (since 2015), “Coded computation for machine learning and beyond”
5. Alireza Chamanzar (since 2016), “Signal processing and information theory of measurements on traumatic brain injuries”

(d) Postdoctoral scholars advised

1. Amanda Robinson, “Validating utility of ultra-resolution EEG,” co-advised with Dr. Marlene Behrmann, 2016-2017.
2. Ashwati Krishnan, “Instrumenting information-theoretically optimal neural sensing systems,” co-advised with Shawn Kelly, and Jeff Weldon, 2017-2018.

3.C Educational Contributions

- **Signals and systems:** Introduced applications-oriented material into the (18290) Signals and Systems course with the goal of bringing in one practical application every week and complementary video lectures. I am delighted that the course perception has turned in the last four years! (thanks in no small way to dedicated TAs that we got – including one who received the university-wide best TA award – and joint efforts of 4 instructors)
- **Interdisciplinary course projects:** Designed interdisciplinary course projects on implementation architectures for LDPC codes in Shawn Blanton’s Digital Computation course (18-340 Spring 2013, Spring 2015) at CMU, and Jan Rabaey’s Digital Circuits course (EE-141 in Spring 2010) at UC Berkeley.
- **New graduate courses designed and offered:**
 - **Fall 2014: Networks of communication, computing, and the brain:** the course observed commonalities and differences in theories of communication, computing, and the neuronal networks. 13 students took the course from all parts of the department.
 - **Spring 2017: Intro to data-science and clinical neural data analysis:** Motivated by examining neural disorders, the course makes connection between classical signal processing theory and modern statistical inference tools. Guest lectures have included a neurosurgeon (Dr. Mark Richardson) giving a lecture live from the operating room! Approximately 30 students, a mix of undergraduate, MS, and PhD students, are taking the course.
- **Outreach**
 - Tutor for Math 50, elementary mathematics, at San Quentin State Prison, California (2008-09). This is a part of the *Prison University Project (PUP)* run by volunteers in the area.
 - Organized several workshops for K-12 students and teachers, giving live demonstrations of brain-machine interface games and giving them a tour of my neural sensing lab. I am also advising a middle-school team of students to build an app using brain-machine interfaces.

4. Publications

4.A Books

None.

4.B Archival Papers Critically Reviewed Before Publication

Journal Papers

- [J1] Yaoqing Yang, Soumya Kar, and Pulkit Grover. “Energy Efficient Distributed Coding for Data Collection in a Noisy Sparse Network”. In: *Submitted to IEEE Trans. on Information Theory, arXiv preprint arXiv:1601.06095* ().
- [J2] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Rate Distortion for Lossy In-network Function Computation: Information Dissipation and Sequential Reverse Water-Filling”. In: *IEEE Transactions on Information Theory, to appear, arXiv preprint arXiv:1601.06224* (Aug. 2017).
Notable paper: The work provides fundamental limits as well as achievable strategies on distortion accumulation in distributed linear computing problems. Distortion accumulation By successfully characterizing the overall distortion-rate function with accumulated distortion in high-rate regime, we tighten earlier bounds of Cuff, Su, and El Gamal (2009) by a factor that can be arbitrarily large even in simple line networks.
- [J3] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Computing linear transformations with unreliable components”. In: *IEEE Transactions on Information Theory, to appear, 2017, arXiv preprint arXiv:1506.07234* (June 2017).
Notable paper: The work provides the first coding strategies that provably requires fewer gates in scaling sense than replication for computing finite-field linear transforms with *all* computational nodes being error prone. Main insight is that allowing all nodes to be error-prone necessitates repeated error suppression through embedding of decoders inside the computation, resulting in a “coded computation” setup. The work also incorporates energy models from devices literature that allow for dynamically changing energy of gates to make the case that lower energy (in scaling sense) can be attained with coded computation as compared to replication or uncoded strategies.
- [J4] Pulkit Grover and Praveen Venkatesh. “An information-theoretic view of EEG imaging”. In: *Proceedings of the IEEE* 105.2 (Feb. 2017), pp. 367–384.
- [J5] O. Ozel, S. Ulukus, and P. Grover. “Energy Harvesting Transmitters That Heat Up: Throughput Maximization Under Temperature Constraints”. In: *IEEE Transactions on Wireless Communications* 15.8 (Aug. 2016), pp. 5440–5452. ISSN: 1536-1276. DOI: 10.1109/TWC.2016.2558509.
- [J6] K. Ganesan, P. Grover, J. Rabaey, and A. Goldsmith. “On the Total Power Capacity of Regular-LDPC Codes With Iterative Message-Passing Decoders”. In: *IEEE Journal on Selected Areas in Communications* 34.2 (Feb. 2016), pp. 375–396. ISSN: 0733-8716.
- [J7] Majid Mahzoon, Christy Li, Xin Li, and Pulkit Grover. “Energy-Constrained Distributed Learning and Classification by Exploiting Relative Relevance of Sensors’ Data”. In: *IEEE Journal on Selected Areas in Communications* 34.5 (2016), pp. 1417–1430.
- [J8] Pulkit Grover. “Information Structures, the Witsenhausen Counterexample, and Communicating Using Actions”. In: *Encyclopedia of Systems and Control* (2015), pp. 567–571.
- [J9] Pulkit Grover. ““Information Friction” and Its Implications on Minimum Energy Required for Communication”. In: *IEEE Transactions on Information Theory* 61.2 (2015).
Notable paper: The paper provides the simplest and the most general model of computation where moving information to longer distances costs linearly more energy. Under this model, fundamental limits on energy consumption for encoding and decoding are obtained, which are combined with fundamental limits on transmit energy (from classical Shannon theory) to obtain impossibility results on total energy.
- [J10] Pulkit Grover, Aaron B Wagner, and Anant Sahai. “Information embedding and the triple role of control”. In: *IEEE Transactions on Information Theory* 61.4 (2015), pp. 1539–1549.

- [J11] Sennur Ulukus, Elza Erkip, Pulkit Grover, Kaibin Huang, Osvaldo Simeone, Aylin Yener, and Michele Zorzi. “Guest Editorial: Wireless Communications Powered by Energy Harvesting and Wireless Energy Transfer (Parts I and II)”. In: *IEEE Journal on Selected Areas in Communications* 33.3 (2015), pp. 357–359.
- [J12] Sennur Ulukus, Aylin Yener, Elza Erkip, Osvaldo Simeone, Michele Zorzi, Pulkit Grover, and Kaibin Huang. “Energy Harvesting Wireless Communications: A Review of Recent Advances”. In: *IEEE Journal on Selected Areas in Communications* 33.3 (2015), pp. 360–381.
- [J13] Pulkit Grover, S Park, and Anant Sahai. “Approximately-Optimal Solutions to the Finite-Dimensional Witsenhausen Counterexample”. In: *IEEE Transactions on Automatic Control* 58.9 (2013).
Notable paper: The work provides the first provably approximately optimal solutions in the 40+ year history of the counter-example which had become a bottleneck in design of decentralized control systems.
- [J14] Pulkit Grover, Kristen Woyach, and Anant Sahai. “Towards a communication-theoretic understanding of system-level power consumption”. In: *IEEE Journal on Selected Areas in Communications* 29.8 (2011). **Winner of the 2012 Leonard G. Abraham award. Also featured in top 25 accessed JSAC articles, Sept. 2011 and Oct. 2011. Also voted as one of the “best reads” in “Green communications” by the IEEE Communications Society** (<http://www.comsoc.org/best-readings/topics/green-communications>), pp. 1744–1755.
- [J15] A. Sahai and P. Grover. “Demystifying the Witsenhausen Counterexample”. In: “Ask the Experts,” *IEEE Control Systems Magazine*, 30.6 (Dec. 2010), pp. 20–24. ISSN: 0272-1708. DOI: 10.1109/MCS.2010.938539.
- [J16] P Grover and A Sahai. “Witsenhausen’s counterexample as Assisted Interference Suppression”. In: *International Journal on Systems, Control and Communications (IJSCC), Special issue on Information Processing and Decision Making in Distributed Control Systems* 2.1 (2010), pp. 197–237.
- [J17] Pulkit Grover and Ajit Kumar Chaturvedi. “Upper bounds on the rate of LDPC codes for a class of finite-state Markov channels”. In: *IEEE Transactions on Information Theory* 53.2 (2007), pp. 794–804.

Archival Conference Papers (archival conferences are recognized by ECE CMU as ones with a thorough review processes)

- [AC1] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Coded computation for speeding up distributed graph mining”. In: *Neural Information Processing Systems (NIPS) submitted*. Dec. 2017.
- [AC2] Sanghamitra Dutta, Viveck Cadambe, and Pulkit Grover. “Coded convolution can provide arbitrarily large gains in successfully computing before a deadline”. In: *IEEE International Symposium on Information Theory (ISIT)*. Aachen, Germany, July 2017.
- [AC3] Haewon Jeong, Christopher Blake, and Pulkit Grover. “Energy-Adaptive Polar Codes: Trading Off Reliability and Decoding Energy with Adaptive Polar Coding Circuits”. In: *IEEE International Symposium on Information Theory (ISIT)*. Aachen, Germany, July 2017.
- [AC4] Omur Ozel, Sennur Ulukus, and Pulkit Grover. “Communicating under Temperature and Energy Harvesting Constraints”. In: *IEEE International Symposium on Information Theory (ISIT)*. Aachen, Germany, July 2017.
- [AC5] Praveen Venkatesh and Pulkit Grover. “Lower Bounds on the Minimax Risk for the Source Localization Problem”. In: *IEEE International Symposium on Information Theory (ISIT)*. Aachen, Germany, July 2017.
- [AC6] Omur Ozel, Sennur Ulukus, and Pulkit Grover. “Wireless Information and Energy Transfer under Temperature Constraints”. In: *IEEE International Conference on Communications (ICC)*. Paris, France, May 2017.
- [AC7] Yaoqing Yang, Siheng Chen, Mohammad Ali Maddah-Ali, Pulkit Grover, Soumya Kar, and Jelena Kovacevic. “Fast Path Localization on Graphs via Multiscale Viterbi Decoding”. In: *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. 2017.

- [AC8] Sanghamitra Dutta, Viveck Cadambe, and Pulkit Grover. ““Short-Dot”: Computing Large Linear Transforms Distributedly Using Coded Short Dot Products”. In: *Advances on Neural Information Processing Systems (NIPS)*. *Notable paper*: Proposes a novel class of codes called “Short-Dot codes” that enable coded-computation strategies for matrix-vector multiplication. These strategies reduce per-processor communication and computing complexity by introducing structured patterns of sparsity in the coded matrix. The technique is shown to outperform classical Algorithm-Based Fault-Tolerance (ABFT) techniques as well as more recent techniques developed by the information theory community. Barcelona, Spain, Dec. 2016.
- [AC9] Sanghamitra Dutta and Pulkit Grover. “Adaptivity provably helps: information-theoretic limits on L_0 cost of non-adaptive sensing”. In: *IEEE International Symposium on Information Theory (ISIT)*. July 2016.
- [AC10] Pulkit Grover. “Fundamental limits on source-localization accuracy of EEG-based neural sensing”. In: *2016 IEEE International Symposium on Information Theory (ISIT)*. July 2016, pp. 1794–1798.
- [AC11] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Coding for lossy function computation: Analyzing sequential function computation with distortion accumulation”. In: *IEEE International Symposium on Information Theory (ISIT)*. July 2016, pp. 140–144.
- [AC12] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Computing linear transforms with unreliable components”. In: *IEEE International Symposium on Information Theory (ISIT)*. July 2016, pp. 1934–1938.
- [AC13] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Energy Efficient Distributed Coding for Data Collection in a Noisy Sparse Network”. In: *IEEE International Symposium on Information Theory (ISIT)*. July 2016.
- [AC14] Simon Du, Yichong Xu, Hongyang Zhang, Christy Li, Pulkit Grover, and Aarti Singh. “Novel Quantization Strategies for Linear Prediction with Guarantees”. In: *International Conference on Machine Learning (ICML), Workshop on “on-device intelligence.”* New York, July 2015.
- [AC15] Omur Ozel, Sennur Ulukus, and Pulkit Grover. “Optimal scheduling for energy harvesting transmitters under temperature constraints”. In: *IEEE International Symposium on Information Theory (ISIT)*. July 2015, pp. 1129–1133.
- [AC16] Pulkit Grover. “Is “Shannon-capacity of noisy computing” zero?” In: *IEEE International Symposium on Information Theory (ISIT)*. 2014, pp. 2854–2858.
- [AC17] Pulkit Grover. ““Information-friction” and its impact on minimum energy per communicated bit”. In: *IEEE International Symposium on Information Theory (ISIT)*. 2013, pp. 2513–2517.
- [AC18] Karthik Ganesan, Yang Wen, Pulkit Grover, Andrea Goldsmith, and Jan Rabaey. “Choosing “green” codes by simulation-based modeling of implementations”. In: *IEEE Global Communications Conference (GLOBECOM)*. 2012, pp. 3286–3292.
- [AC19] Pulkit Grover, Andrea Goldsmith, and Anant Sahai. “Fundamental limits on the power consumption of encoding and decoding”. In: *IEEE International Symposium on Information Theory (ISIT)*. 2012, pp. 2716–2720.
- [AC20] Pulkit Grover and Cedric Langbort. “The role of common “context” in signaling”. In: *50th IEEE Conference on Decision and Control and European Control Conference*. 2011, pp. 5535–5540.
- [AC21] Pulkit Grover and Anant Sahai. “The “source-simplification” aspect of signaling”. In: *IEEE International Symposium on Information Theory Proceedings (ISIT)*. 2011, pp. 2432–2436.
- [AC22] Kristen Woyach, Pulkit Grover, and Anant Sahai. “Near vs. far field: Interference aggregation in TV whitespaces”. In: *IEEE Global Telecommunications Conference (GLOBECOM)*. 2011, pp. 1–5.
- [AC23] P. Grover and A. Sahai. “Distributed signal cancelation inspired by Witsenhausen’s counterexample”. In: *IEEE International Symposium on Information Theory (ISIT)*. 2010, pp. 151–155.

- [AC24] Pulkit Grover, Hari Palaiyanur, and Anant Sahai. “Information-theoretic tradeoffs of throughput and chip power consumption for decoding error-correcting codes.” In: *IEEE International Symposium on Information Theory (ISIT)*. 2010, pp. 2373–2377.
- [AC25] Pulkit Grover and Anant Sahai. “Shannon meets Tesla: Wireless information and power transfer.” In: *IEEE International Symposium on Information Theory (ISIT)*. 2010, pp. 2363–2367.
- [AC26] Pulkit Grover and Anant Sahai. “Green codes: Energy-efficient short-range communication”. In: *IEEE International Symposium on Information Theory (ISIT)*. 2008, pp. 1178–1182.
- [AC27] Pulkit Grover and Anant Sahai. “Writing on Rayleigh faded dirt: a computable upper bound to the outage capacity”. In: *IEEE International Symposium on Information Theory (ISIT)*. 2007, pp. 2166–2170.
- [AC28] Pulkit Grover, R Agarwal, and Ajit Kumar Chaturvedi. “Geolocation using transmit and receive diversity”. In: *IEEE Global Telecommunications Conference (GLOBECOM)*. Vol. 6. 2004, pp. 3681–3684.

4.C Papers in Symposium or Conference Proceedings Fully Reviewed Prior to Publication (but not archival conferences)

- [C1] Christy Li, Xin Li, and Pulkit Grover. “Energy efficient learning and classification for distributed sensing”. In: *8th International Conference on Communication Systems and Networks (COMSNETS)*. 2016, pp. 1–6.
- [C2] Tongxin Li, Mayank Bakshi, and Pulkit Grover. “Fundamental limits and achievable strategies for low energy compressed sensing with applications in wireless communication”. In: *17th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC)*. 2016, pp. 1–6.
- [C3] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Fault-tolerant Parallel Linear Filtering using Compressive Sensing”. In: *International Symposium on Turbo Codes & Iterative Information Processing (ISTC)*. 2016.
- [C4] Pulkit Grover, Jeff Weldon, Shawn Kelly, Praveen Venkatesh, and Haewon Jeong. “A Novel Information-Theoretic Sensing Strategy for Ultra High-Density EEG”. In: *Allerton Conference on Communication, Control, and Computing*. Monticello, IL, Oct. 2015, pp. 901–908.
- [C5] Ana Beisy Cruz and Pulkit Grover. “Coding for improved focusing of ultrasound, and an application to neurostimulation”. In: *49th Asilomar Conference on Signals, Systems and Computers*. 2015, pp. 940–942.
- [C6] Pulkit Grover. “Ultra-high-density EEG: How many bits of resolution do the electrodes need?” In: *49th Asilomar Conference on Signals, Systems and Computers*. 2015, pp. 943–947.
- [C7] Haewon Jeong and Pulkit Grover. “Energy-adaptive codes”. In: *53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*. 2015, pp. 132–139.
- [C8] Praveen Venkatesh and Pulkit Grover. “Is the direction of greater Granger causal influence the same as the direction of information flow?” In: *53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*. 2015, pp. 672–679.
- [C9] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Information dissipation in noiseless lossy in-network function computation”. In: *53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*. 2015, pp. 445–452.
- [C10] Yaoqing Yang, Pulkit Grover, and Soumya Kar. “Can a Noisy Encoder Be Used to Communicate Reliably?” In: *Proceedings of the Allerton Conference on Communication, Control, and Computing*. Monticello, IL, Oct. 2014, pp. 659–666.
- [C11] Xin Li, Ronald D Shawn Blanton, Pulkit Grover, and Donald E Thomas. “Ultra-low-power biomedical circuit design and optimization: Catching the don’t cares”. In: *2014 International Symposium on Integrated Circuits (ISIC)*. 2014, pp. 115–118.

- [C12] Majid Mahzoon, Hassan Albalawi, Xin Li, and Pulkit Grover. "Using relative-relevance of data pieces for efficient communication, with an application to Neural data acquisition". In: *52nd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*. 2014, pp. 160–166.
- [C13] Pooja Vyavahare, Majid Mahzoon, Pulkit Grover, Nutan Limaye, and D Manjunath. "Information friction limits on computation". In: *Communication, Control, and Computing (Allerton), 52nd Annual Allerton Conference on*. 2014, pp. 93–100.
- [C14] Pulkit Grover. "What do we need to do to green data-center networks? A fundamental perspective". In: *IEEE Online Conference on Green Communications (GreenCom)*. 2013, pp. 82–87.
- [C15] Max Regan and Pulkit Grover. "Intrusion detection for wireless power networks, near-field communication, and side-channel attacks". In: *IEEE Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA*. 2013, pp. 619–621.
- [C16] Pulkit Grover. "Fundamental limits on power consumption for lossless signal reconstruction". In: *IEEE Information Theory Workshop (ITW)*. 2012, pp. 527–531.
- [C17] Abhishek Gupta, Pulkit Grover, Cedric Langbort, and Tamer Basar. "On myopic strategies in dynamic adversarial team decision problems". In: *2012 46th Annual Conference on Information Sciences and Systems (CISS)*. 2012.
- [C18] Pulkit Grover, Anant Sahai, and Ji-Hoon Park. "Simple models for power optimization across transmission, equalization and decoding". In: *Proceedings of the 19th European Signal Processing Conference (EUSIPCO)*. Barcelona, Spain, Aug. 2011.
- [C19] Karthik Ganesan, Pulkit Grover, and Jan Rabaey. "The power cost of over-designing codes". In: *IEEE Workshop on Signal Processing Systems (SiPS)*. 2011, pp. 128–133.
- [C20] Pulkit Grover, Andrea Goldsmith, Anant Sahai, and Jan Rabaey. "Information theory meets circuit design: why capacity-approaching codes require more chip area and power". In: *Communication, Control, and Computing (Allerton), 2011 49th Annual Allerton Conference on*. 2011, pp. 1392–1399.
- [C21] Pulkit Grover and Anant Sahai. "Is Witsenhausen's counterexample a relevant toy?" In: *49th IEEE Conference on Decision and Control (CDC), Atlanta, Georgia, USA*. Dec. 2010, pp. 585–590.
- [C22] Pulkit Grover and Anant Sahai. "Implicit and Explicit Communication in Decentralized Control". In: *Proceedings of the Allerton Conference on Communication, Control, and Computing*. Monticello, IL, Oct. 2010.
- [C23] Pulkit Grover, Aaron B Wagner, and Anant Sahai. "Information embedding meets distributed control". In: *IEEE Information Theory Workshop (ITW) 2010*. 2010, pp. 1–5.
- [C24] Pulkit Grover, Kristen Ann Woyach, Hari Palaiyanur, and Anant Sahai. "An interference-aware perspective on decoding power". In: *6th International Symposium on Turbo Codes & Iterative Information Processing (ISTC)*. 2010, pp. 457–461.
- [C25] Pulkit Grover, Anant Sahai, and Se Yong Park. "The finite-dimensional Witsenhausen counterexample". In: *7th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOPT)*. 2009, pp. 1–10.
- [C26] Se Yong Park, Pulkit Grover, and Anant Sahai. "A constant-factor approximately optimal solution to the witsenhausen counterexample". In: *48th IEEE Conference on Decision and Control (CDC)*. 2009, pp. 2881–2886.
- [C27] Pulkit Grover and Anant Sahai. "A vector version of Witsenhausen's counterexample: Towards convergence of control, communication and computation". In: *Proceedings of the 47th IEEE Conference on Decision and Control (CDC)* (Dec. 2008).
- [C28] Pulkit Grover. "Bounds on the Tradeoff Between Decoding Complexity and Rate for Sparse-Graph Codes". In: *IEEE Information Theory Workshop (ITW)*. Lake Tahoe, CA, 2007, pp. 196–201.

- [C29] Pulkit Grover and Anant Sahai. “On the need for knowledge of the phase in exploiting known primary transmissions”. In: *IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks (DySPAN)*. 2007, pp. 462–471.
- [C30] Pulkit Grover and Ajit Kumar Chaturvedi. “Upper bounds on the rate of LDPC codes for Gilbert-Elliott channels”. In: *Proc. Information Theory Workshop (ITW)*. 2004, pp. 230–235.

4.D Other Papers in Symposium or Conference Proceedings

- [O1] Alireza Chamanzar, Shilpa George, Praveen Venkatesh, Wanqiao (Ivy) Ding, and Pulkit Grover. “Systematic and automated algorithms for detecting cortical spreading depolarizations using EEG and ECoG to improve TBI diagnosis and treatment”. In: *12th World Conference on Brain Injury*. New Orleans, LA, 2017.
- [O2] Praveen Venkatesh, Wanqiao Ding, and Pulkit Grover. “Data processing for Reliable Detection of Cortical Spreading Depolarizations using High-Density EEG”. In: *The Annual Meeting of the American Epilepsy Society (AES)*. Houston, TX, Dec. 2016.
- [O3] A. Robinson, M. J. Boring, P. Venkatesh, X. Kuang, M. Behrmann, M. J. Tarr, and P. Grover. “Using high-density EEG to harness high spatial frequency neural information”. In: *Annual Retreat of the Center for Neural Basis of Cognition*. Pittsburgh, PA, Oct. 2016.
- [O4] Matthew J Boring, Shawn Kelly, Jeffrey Weldon, Michael Tarr, Amanda Robinson, Marlene Behrmann, and Pulkit Grover. “Experimentally challenging theoretical EEG correlations: Does a hierarchical-referencing strategy lead to bit savings?” In: *Workshop on Information Theory and its Applications (ITA)*. San Diego, CA, 2016.
- [O5] Praveen Venkatesh and Pulkit Grover. “Is the direction of Granger causality same as the direction of information flow?” In: *The Annual Meeting of the Society for Neuroscience (SfN)*. Chicago, IL, Oct. 2015.
- [O6] Lav R Varshney, Pulkit Grover, and Anant Sahai. “Securing inductively-coupled communication”. In: *Information Theory and Applications Workshop (ITA)*. 2012, pp. 47–53.
- [O7] Pulkit Grover, Anant Sahai, Karthik Ganesan, and Jan Rabaey. “Green codes with short wires at the decoder: Fundamental limits and constructions”. In: *Information Theory and Applications Workshop (ITA), 2011*. 2011, pp. 1–4.

4.E Sections or Chapters in Edited Monographs or Similar Volumes

- [BC1] Pulkit Grover. “Information Structures, the Witsenhausen Counterexample, and Communicating Using Actions”. In: *Encyclopedia of Systems and Control* (2015), pp. 567–571.

4.F Published Abstracts, Discussions, Reviews

4.G Other Writings (Technical Reports and Testimony)

- [T2, Ph.D. Thesis] “Actions can speak more clearly than words,” UC Berkeley, December’10. 2011 Eliahu Jury Award.
- [T1, MS Thesis] “Low-Density Parity-Check Codes: Bounds on the rate and some results on minimal stopping sets,” IIT Kanpur, July’05.

4.H Discussion or Reviews of Candidate's Work

1. Dr. Chris Blake's Ph.D. thesis at UToronto ("Energy-Consumption of Error-Control Coding Circuits", 2016; advised by Dr. Frank Kschischang) discusses extensively my work on the "information-friction model," extends it to 3D computational models, dedicating Chapter 8 on discussing whether its fundamental a law of nature.
2. My work [J14] was featured as one of IEEE Communication Society's "Best Readings" on Green Communications: <http://www.comsoc.org/best-readings/topics/green-communications#1>
3. My work providing the first provably-approximately-optimal solutions to the Witsenhausen counterexample [J16, J13] was discussed in the book by Serdar Yüksel and Tamer Basar, "Stochastic Networked Control Systems (Systems & Control: Foundations & Applications)," 2013.

4.I Patents (Indicate whether the item is an invention disclosure, patent application or an issued patent)

Invention disclosure 2015-462: "Hierarchical referencing mechanism for potential measurement using multiple sensors," Pulkit Grover, Jeffrey Weldon, Shawn Kelly

5. Grants and Contracts Awarded to Date

Overview: The share for my group totals approximately \$2 million. I am the PI on most of my awards. The awards include an NSF CAREER award, 3 NSF awards overall, a Google faculty award, and an industry collaboration through the SRC SONIC center.

5.A Principal Investigator

1. NSF CAREER Award (NSF CCF-1350314) "CAREER: Towards Green Communications Using an Information-Lens: Foundations of the Joint Design of Communication Strategies and Circuits": \$612,000, Award period: 2014 - 2019.
The award will enable discovery of fundamental limits on energy and complexity requirements for communication and signal processing systems.
2. NSF WiFiUS Program (NSF CNS-1702694) "Fault-Tolerant Cognitive IoT Systems Using Sensors of Limited Field-of-View": \$299,115, Award Period: April 2017-2019.
Co-PI: Teemu Roos, U. Helsinki.
The award enables understanding of fundamental limits and strategies to attain these limits for fault tolerant sensing and computing.
3. CMU BrainHUB Proseed Grant for testing the information-theoretic "hierarchical referencing" compression strategy in building a 10,000 electrode wireless (ambulatory) EEG system; \$50,000
Co-PIs: Jeff Weldon, Shawn Kelly, Marlene Behrmann, Michael Tarr, Lori Holt.
4. Google Research Award for testing whether human perceptual system is information-limited through a "multiple-access channel," and what this means for design of optimal cues for blind navigation; \$70,000
Co-PIs: Bruno Sinopoli, Laurie Heller
5. SONIC Year 4 Fabrication Project CF-2385-20 for instrumenting an "Ultra-Resolution" EEG system; \$25,000
Co-PI: Jeffrey Weldon
6. SONIC Year 5 Fabrication Project CF-2385-20: Proof of concept *subdermal* EEG; \$20,000
Co-PI: Jeffrey Weldon. Collaborators: Shawn Kelly, Ashwati Krishnan
7. CIT Incubation Pilot proposal: Inferring information flows in neural systems noninvasively, \$112,985
Co-PIs: Shawn Kelly, Jeffrey Weldon.

8. Sub-contract from NSF CSoI (centered at Purdue university); \$10,000, Award period: 9/1/2013 - 12/31/2014
The sub-contract enabled research geared towards “The Science of Information,” and teaching a class that presents networks in communication, computation, and the brain, to graduate students.
9. Innovations in Engineering Education (IEE) award from the CIT Dean; \$16,940, Award period: 6/1/2014 - 6/1/2015
Co-PI: Aswin Sankaranarayanan
For new course material, demonstrations, and lab design for 18-290 using EEG sensing.

5.B Co-Principal Investigator

10. NSF ECCS-1343324 (NSF EARS Program) \$345,000 (share allocated to my group out of a total \$808,000); PI: Paramesh 1/15/2013 - 1/15/2017
The goal is to design and implement energy and area-efficient of mm-wave communication systems.
11. Pennsylvania Infrastructure Technology Alliance (PITA) \$20,000; PI: Shawn Kelly 2017 - 2018
The project enables instrumentation efforts towards validating our theory on the potential of EEG’s high resolution.
12. Systems on Nanoscale Fabrics (SONIC) Center, Semiconductor Research Corporation (SRC) \$369,000 (share allocated to my group out of a total \approx 27 million), PI: Naresh Shanbhag (UIUC), 10/1/2015-9/30/2017
I work with circuit and device designers to obtain fundamental limits and practical strategies for computing in presence of noise and errors. We joined the center in Year 4 of its operation.

5.C Faculty Associate

None.

6. Professional Activities

6.A Seminars (Include only invited seminars and invited talks at conferences and not talks corresponding to contributed papers)

- “Codes for Distributed Computing,” Tutorial at IEEE International Symposium on Information Theory (ISIT) June 2017, Aachen, Germany.
- “Coded Computation,” CISE Seminar, Boston University, March 17, 2017.
- “Combating information-dissipation in error-prone computing,” Distinguished lecturer series on "Advanced Networking Colloquium," Institute for Systems Research (ISR), University of Maryland (UMD), May 6, 2016.
- “Combating information-dissipation through error-correction for energy-efficient communication and computing networks,” WiOpt’16, GREENNET workshop semi-tutorial talk, May 9 2016.
- “Three SONIC Screwdrivers for Error-correction and Suppression in Machine Learning, Sensing, and Linear Computing with Noisy Elements,” Semiconductor Research Corporation (SRC) SONIC e-Workshop for SRC Industry members, Feb. 23, 2016.
- “Opportunities in clinical neuroengineering: fundamental limits, hardware, and algorithms,” workshop on computational brain research at IIT Madras, Jan 4-8 2016.
- “Error-correction and suppression in computing, sensing, and communication: fundamental tradeoffs between information and energy dissipation,” Bombay Information Theory Seminar celebrating the Shannon centenary, IIT Bombay, Jan 2-4, 2016.
- “Reducing Energy of Communication and Massively Parallel Computing: From Maxwell’s Demon to Practical Strategies,” Keynote talk, SICCE, Beirut, Lebanon, 2014.
- “Energetic information theory,” Speaker, School on Information Theory, 2014.
- “Fundamental limits on energy consumption of noisy computing,” Invited Talk, Workshop on Information Theory & its Applications (ITA), San Diego, 2014

- “Information-Friction” and minimum energy for communicating and computing,” SONIC Seminar, UIUC, Nov 2013.
- “Fundamental Limits on Communication Energy via Information-Friction,” IIT Bombay, IIT Delhi, LNMIIT (Jaipur) and TIFR (Mumbai), Aug-Sep. 2013
- “Intrusion detection for wireless power networks, near-field communication, and side-channel attacks,” Asilomar Conference on Signals, Systems and Computers, Nov. 2013.
- “Green Communication: from Maxwell’s Demon to Information Friction,” Invited Talk, Workshop on Information Theory & its Applications (ITA), San Diego, 2013.
- “Flows of Information in Communication, Computation and Control,” MIT, Feb. 29, 2012
- “Cyber-Physical Systems: the need to look beyond Turing’s machine”, Georgia Tech Summer School on Cyber-Physical Systems, June 28, 2011.
- “Low-power wireless systems: communication and computation” LIDS, MIT, May 13, 2011.
- “Understanding information flows in decentralized systems” Georgia Tech, April 25, 2011, University of Toronto, April 20, 2011.
- “Good codes with short wires at the decoder: Fundamental limits and constructions” Workshop on Information Theory and Applications (ITA), San Diego, CA, Feb. 10, 2011.
- “Decentralized control: when actions speak,” Control Seminar, University of Michigan, Ann Arbor, Jan. 7, 2011.
- “Actions can speak more clearly than words,” Comm/Net/Sys Seminar, USC, Oct. 27, 2010; EE Visitor Seminar, UCLA, Oct. 26, 2010; LIDS, MIT, Oct. 18, 2010.
- “Implicit and Explicit Communication in Decentralized Control,” Allerton Conference, UIUC, Illinois. Sept 29, 2010.
- “Low-Power Wireless Systems: A Theory-Practice Ping-Pong,” BWRC Summer Retreat, Berkeley, CA. June 7, 2010.
- “Approximating hard problems in distributed control using information theory,” Net/Comm/DSP Seminar, UC Berkeley. May 4, 2010.
- “Distributed control: a new frontier of information theory,” ISS Seminar, Princeton University. March 26, 2010; Graduation day, ITA Workshop, San Diego. March 3, 2010.
- “Understanding Implicit Communication in Distributed Control,” Control Center Symposium, UC San Diego. Nov. 13, 2009.
- “Green Codes for Short-Distance Wireless Communication,” The LNM Institute of Information Technology (LNMIIT), Jaipur. Jan. 17, 2007.

6.B Government Committees, Civic Appointments, Board Memberships

None.

6.C Membership and Activities in Honorary Fraternities, Professional Societies

- Senior Member, IEEE
- Member, IEEE Information Theory Society

6.D Editorial Roles on Publications, Major Activities in Professional Meetings

- Journal Guest co-editor, IEEE Communication Society: Journal of Selected Areas in Communications, Special Issue on Wireless Communications Powered by Energy Harvesting and Wireless Energy Transfer, 2013 - 2015.
- Journal Guest co-editor, IEEE Jour. of Selected Areas in Communication, Special Issue on Green Communications, 2015-17.
- Co-organizer, Video Abstracts and Graduation Day at Information Theory and Applications (ITA) Workshop, San Diego, 2012, 2013, and 2014. **Video abstracts:** This was motivated by the desire to make deep ideas in information theory more accessible to people outside the field. More than 50 researchers created 2-min videos on their work. **Graduation day:** this is the standard ITA event where graduating students are invited to present their work at a conference where otherwise only faculty give talks.
- TPC Member, IEEE ISIT 2016, Barcelona, Spain.
- TPC Member, IEEE ISIT 2017, Aachen, Germany.

- Invited speaker, North American School on Information Theory (NASIT), 2013, San Diego, CA.
- Tutorial speaker on “Coded Computation,” International Symposium on Information Theory (ISIT) June 2017, Aachen, Germany.
- TPC Member, IEEE Global Conf on Signal and Information Processing: Workshop on Green Communications, 2013 - 2014.
- TPC Member, IEEE WiOpt 2015.
- TPC Member IEEE International Conference on Distributed Computation Systems (ICDCS) 2015.

6.E Awards, Prizes, Honors (reverse chronological order)

- 2017 Tutorial at IEEE International Symposium on Information Theory (ISIT), Aachen, Germany on “Distributed Coded Computation”.
- 2015 Google Faculty Research Award.
- 2014 Keynote speaker, SICCE 2014: Data Science in a Big Data World.
- 2014 Best Paper Award at International Symposium on Integrated Circuits (ISIC) 2014, Singapore (co-authored work with Xin Li, Ronald Blanton, and Don Thomas).
- 2014 NSF CAREER Award.
- 2012 IEEE Leonard G Abraham award for best paper in IEEE Communication Society Journals in the past three years.
- 2011 Eliahu Jury award by the department of EECS, UC Berkeley, for best thesis in systems, control, communications or signal processing, 2011.
- 2010 Best student paper award at IEEE Conference on Decision and Control (CDC), Atlanta, GA, 2010 for the paper “Is Witsenhausen’s counterexample a relevant toy?”
- 2010 Finalist for best student paper award at IEEE International Symp on Information Theory (ISIT).
- 2009 Winner of the General Chairs’ Recognition award for Interactive Papers, IEEE Conference on Decision and Control (CDC), Shanghai, China (presented by A. Sahai).
- “Vodafone Fellowship” for 2005-06, and 2006-07 by Dept. of EECS, UC Berkeley.
- “Microsoft Award for Innovation” at IEEE Computer Society International Design Competition (CSIDC) 2002.
- National Talent Search Scholarship (Govt. of India. ’97-’03) and State Science Talent Search Scholarship (Govt. of Rajasthan) in recognition of science talent.

Awards received by my advisees

Graduate:

- 2017 Tan Endowed Graduate Fellowship, Sanghamitra Dutta, 2016-2017.
- 2016 CIT Dowd Fellowship, Praveen Venkatesh, 2016-2017.
- 2015 Henry H. Hillman Presidential Fellowship, Praveen Venkatesh, 2015-16.
- 2015 Bertucci Fellowship: Yaoqing Yang, 2015-16.
- 2015 Prabhu and Poonam Goel Graduate Fellowship: Sanghamitra Dutta, 2015-16.

Undergraduate

I’ve had undergraduates from CMU as well as outside CMU (esp. neuroscience undergraduates at Pitt) join my research group for collaborative work.

- 2017 Frank J. Marshall Scholar Award (best undergraduate research by an ECE student): Ivy (Wanqiao) Ding
- 2017 NSF CSOI Channels Scholar award: Lily Kramer (U. Pittsburgh)
- 2016 CMU SURF Award: Wanqiao (Ivy) Ding

- 2016 Jennings fund SURE award: Arnelle Etienne
- 2016 James E. Bradler Jr. Award for Excellence in Undergraduate Research (University of Pittsburgh Neuroscience): Matthew J Boring
- 2016 E.M. Williams Award for “superior scholastic achievement and community service”: Rudina Morina
- 2015 Frank J. Marshall Scholar Award (best undergraduate research by an ECE student): Ana Beisy Cruz
- 2015 NSF CSoI Channels Scholar award: Rudina Morina
- 2014 CNBC Undergraduate research fellowship in computational neuroscience: Matthew J Boring
- 2014 CMU SURF Award: Ana Beisy Cruz
- 2014 NSF CSoI Channels Scholar award: Ana Beisy Cruz

6.F Service on CMU Committees

1. Department, Co-founder, Energy and Information Systems Seminar, Started the EIS Seminar series. Invited speakers locally and nationally to enhance interactions among students, and among students and faculty.
2. Department, Committee Member, Undergraduate advising committee: interacting regularly with 14 undergraduate students, guiding them through classes and coursework. Using this information to design and teach a better signals and systems class (18-290).
3. Department, Committee Member, Department’s Strategic Planning Committee, February 2014 - Present.
4. On PhD thesis committee for:
ECE CMU:
 - (i) June Wang (advised by Jose’ Moura);
 - (ii) Rohan Chabukeswar (advised by Bruno Sinopoli);
 - (iii) Sabina Zejnilovic (advised by Bruno Sinopoli);
 - (iv) Yongjune Kim (advised by B Vijay Kumar)Outside ECE CMU:
 - (v) Andrew Bean (UIUC, advised by Andrew Singer, UIUC);
 - (vi) Ying Yang (Statistics, CMU; co-advised by Rob Kass and Mike Tarr)
5. College, Guest Speaker, CMU Electricity conference 2014.
6. CMU BrainHub representative at Workshop on Computational Brain Research, IIT Madras, 2016 & 2017.
7. Reviewed proposals for CMU internal grants (e.g. CMU Instrumentation Award).

7. Other

Publicly available software: Auto-TotEM: finds a family of error-correcting codes that minimize total (transmit + circuit) power for communication over changing distances, within a constant factor of the optimal for any circuit technology.

Game-app for enabling visually-impaired individuals navigate through echolocation: “EchoExplorer”: the app is built specifically to understand the neuroscience of echolocation. The work is led by CMU undergraduates (> 5 undergraduates have helped) and is in collaboration with Prof. Laurie Heller in psychology and Prof. Bruno Sinopoli in ECE.