


# Raman Venkataramani

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## Experience

- Sept 2021– Present **Senior Machine Learning Engineer**, *SoundHound Inc.*, Boulder, CO
- Worked on beamforming, speech enhancement algorithms and training of acoustic models for automatic speech recognition.
- Mar 2009– Sept 2021 **Senior Staff Engineer**, *Seagate Technology*, Longmont, CO
- Made algorithmic advances in a number of sequence processing applications using recurrent neural nets (RNNs), hidden Markov models (HMMs) and other deep learning models. This includes novel algorithms for base calling and event segmentation in nanopore DNA sequencing.
  - Enhanced the end-to-end system performance of hard disk drive (HDD) read channels using novel algorithms for Markov model optimization, channel equalization and track interference cancellation.
  - Devised custom signal processing algorithms and fixed-point implementation for a broad range of data storage technologies including conventional magnetic recording, bit patterned media, interleaved magnetic recording, multilevel and MIMO recording.
- Aug 2003– Feb 2009 **Staff Member**, *Seagate Technology*, Pittsburgh, PA
- Reduced the bit error rate in HDD read channels using a novel generalized-precoder design and optimal soft-output detection.
  - Boosted the performance of synchronization (timing recovery) and accuracy of sector failure rate estimation in HDD channels.
- Jan 2003– Aug 2003 **Postdoctoral Researcher**, *Division of Engineering and Applied Sciences, Harvard University*, Cambridge, MA
- Developed a class of codes for OFDM communication systems with low peak-to-average power ratios.
- Nov 2001– Dec 2002 **Term Member of Technical Staff**, *Bell Labs, Lucent Technologies*, Murray Hill, NJ
- Discovered fundamentally new results on the rate-distortion region for the multiple description coding with many channels.
  - Enhanced the throughput rate in MIMO wireless communications using a reciprocal training scheme.

## Computing Skills

Python, PyTorch, Matlab, Julia, C++, Java, Git

## Technical Skills

- Machine learning & deep learning
- Hidden Markov models
- Probabilistic graphical models
- Speech and Natural language processing
- Digital signal & image processing
- Statistical signal processing
- Digital communications
- Information theory
- Bioinformatics & computational biology
- Compressive sensing
- Algorithms & data structures
- Optimization

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## Education

- 1997–2001 **Ph.D. in Electrical Engineering**, *University of Illinois*, Urbana, IL  
1995–1996 **M.S. in Electrical Engineering**, *Johns Hopkins University*, Baltimore, MD  
1991–1995 **B.Tech. in Electrical Engineering**, *Indian Institute of Technology*, Chennai, India

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## Awards & Honors

- Seagate's *Technology and Innovation Award* for outstanding technical contributions in Signal Processing, Hawaii, 2014.
- *Robert T. Chien Memorial Award* for excellence in research at University of Illinois at Urbana-Champaign, 2002.
- Gold medal at the Indian National Physics Olympiad, 1991.
- Second on the Mathematics Olympiad at the regional level in Madras, India, 1991.

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## Personal Information

Languages English (fluent), Spanish and French (upper beginner), Italian (intermediate)  
Citizenship US Citizen

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## Patents

1. "Systems and methods for joint event segmentation and basecalling in single molecule sequencing," Feb. 4 2021, US Patent App. 16/525,914.
2. "Event timing detection for DNA sequencing," Oct. 30, 2018, US Patent App. 16/175,223.
3. "Channel error rate optimization using Markov codes," Oct. 15, 2019, US Patent 10,447,315.
4. "Adaptive MIMO channel equalization and detection," Dec. 4, 2018, US Patent 10,148,470.
5. "Partial zero forcing equalization," May 15, 2018, US Patent 9,973,354.
6. "Asynchronous interference cancellation," Apr. 17, 2018, US Patent 9,947,362.
7. "Obtaining a predetermined phase shift in data using different write precompensation associated with different NRZI patterns," Nov. 28, 2017, US Patent 9,830,942.
8. "Timing error processor that uses the derivative of an interpolator function," Mar. 7, 2017, US Patent 9,590,803.
9. "Noise prediction detector adaptation in transformed space," Nov. 8, 2016, US Patent 9,489,976.
10. "Adaptively combining waveforms," Nov. 24, 2015, US Patent 9,195,860.
11. "Time-multiplexed single input single output (SISO) data recovery channel," Oct. 20, 2015, US Patent 9,165,597.
12. "Detecting track information from overlapping signals read from a data storage medium," Sept. 1, 2015, US Patent 9,123,356.
13. "Track interference cancellation," July 28, 2015, US Patent 9,093,115.
14. "Universal modulation coding for a data channel," Mar. 10, 2015, US Patent 8,976,474.
15. "Channel detector implementation with postcoder," Nov. 11, 2014, US Patent 8,885,779.
16. "Equalizer and detector arrangement employing joint entropy-based calibration," May 27, 2014, US Patent 8,737,460.
17. "Programmable soft-output Viterbi algorithm system and method," Nov. 6, 2012, US Patent 8,307,267.
18. "Off-track aware equalizer design for bit-patterned media," June 12, 2012, US Patent 8,199,800.

19. "Converting timing errors into symbol errors to handle write mis-synchronization in bit-patterned media recording systems," Mar. 6, 2012, US Patent 8,130,459.
20. "Zone based timing recovery for bit patterned media," June 1, 2010, US Patent 7,729,074.
21. "Robust maximum-likelihood based timing recovery," July 21, 2009, US Patent 7,564,931.

## Publications

### Journal Papers

1. S. Hernández, Z. Liu, P. Jin, S. Granz, P. Krivosik, R. Venkataramani, W. Radich, T. Rausch, J. Dykes, and E. Gage, "Geometrical scaling limits of heat assisted magnetic recording," *IEEE Transactions on Magnetics*, 2020.
2. S.C. Venkataramani, R. Venkataramani, and J.M. Restrepo, "Dimension reduction for systems with slow relaxation," *Journal of Statistical Physics*, vol. 167, no. 3-4, pp. 892–933, 2017.
3. R. Venkataramani and M.F. Erden, "A posteriori equivalence: a new perspective for design of optimal channel shortening equalizers," *arXiv preprint arXiv:0710.3802*, 2007.
4. A.V. Kuznetsov and R. Venkataramani, "Macroscopic and microscopic approaches in sector failure rate estimation," *IEEE Trans. on Magnetics*, vol. 44, no. 1, pp. 187–192, 2008.
5. W. Zeng, M.F. Erden, A. Kavcic, E.M. Kurtas, and R.C. Venkataramani, "Trellis-based optimal baud-rate timing recovery loops for magnetic recording systems," *IEEE Trans. on Magnetics*, vol. 43, no. 7, pp. 3324–3332, 2007.
6. R. Venkataramani and Y. Bresler, "Multiple-input multiple-output sampling: necessary density conditions," *IEEE Trans. on Information Theory*, vol. 50, no. 8, pp. 1754–1768, 2004.
7. R. Venkataramani and Y. Bresler, "Filter design for MIMO sampling and reconstruction," *IEEE Transactions on Signal Processing*, vol. 51, no. 12, pp. 3164–3176, 2003.
8. R. Venkataramani and Y. Bresler, "Sampling theorems for uniform and periodic nonuniform MIMO sampling of multiband signals," *IEEE Transactions on Signal Processing*, vol. 51, no. 12, pp. 3152–3163, 2003.
9. C.V. Chong, R. Venkataramani, and V. Tarokh, "A new construction of 16-QAM Golay complementary sequences," *IEEE Transactions on Information Theory*, vol. 49, no. 11, pp. 2953–2959, 2003.
10. R. Venkataramani, G. Kramer, and V.K. Goyal, "Multiple description coding with many channels," *IEEE Transactions on Information Theory*, vol. 49, no. 9, pp. 2106–2114, 2003.
11. R. Venkataramani and Y. Bresler, "Optimal sub-Nyquist nonuniform sampling and reconstruction for multiband signals," *IEEE Transactions on Signal Processing*, vol. 49, no. 10, pp. 2301–2313, 2001.
12. R. Venkataramani and Y. Bresler, "Perfect reconstruction formulas and bounds on aliasing error in sub-Nyquist nonuniform sampling of multiband signals," *IEEE Transactions on Information Theory*, vol. 46, no. 6, pp. 2173–2183, 2000.

### Conference Papers

1. K. Li, A. Kavcic, R. Venkataramani, and M.F. Erden, "Channels with both random errors and burst erasures: Capacities, LDPC code thresholds, and code performances," in *Proc. IEEE International Symposium on Information Theory (ISIT)*, 2010, pp. 699–703.
2. R. Venkataramani and S. Sankaranarayanan, "Optimal channel shortening equalization for MIMO ISI channels," in *IEEE Global Telecommunications Conference*, 2008, pp. 1–5.
3. R. Venkataramani and M.F. Erden, "MAP-based timing recovery for magnetic recording," in *IEEE International Conference on Communications (ICC)*, 2008, pp. 1982–1985.
4. A.V. Kuznetsov and R. Venkataramani, "Microscopic and macroscopic approaches in sector failure rate estimation," in *The Magnetic Recording Conference (TMRC)*, 2007.
5. R. Venkataramani and M.F. Erden, "A family of equalizers for optimal sequence detection," in *IEEE Int. Conf. on Acoustics, Speech and Signal Processing*, 2006, vol. 4, pp. IV–IV.

6. R. Venkataramani and F. Erden, "Optimal equalizers and targets for detection in ISI channels," in *IEEE International Magnetism Conference (Intermag)*, 2006, pp. 796–796.
7. W. Zeng, M.F. Erden, A. Kavcic, E.M. Kurtas, and R.C. Venkataramani, "Trellis-based baud-rate timing recovery loop for magnetic recording channels," in *IEEE International Conference on Communications (ICC)*, 2006, vol. 7, pp. 3179–3184.
8. R. Venkataramani, M.F. Erden, and E. Kurtas, "Effect of preamplifier on timing recovery in magnetic recording channels," in *Joint Int. Conf. on Autonomic and Autonomous Systems and Int. Conf. on Networking and Services (ICAS-ICNS)*, 2005, pp. 95–95.
9. Y. Bresler and R. Venkataramani, "Optimal sampling and reconstruction in multiple-input-multiple-output (MIMO) systems," in *Sampling Theory Conference*, Samsun, Turkey, 2005.
10. R. Venkataramani and T.L. Marzetta, "Reciprocal training and scheduling protocol for MIMO systems," in *Proceedings of the 41st Annual Allerton Conference on Communications, Control and Computing*. The University of Illinois, 2003, pp. 334–343.
11. R. Venkataramani and Y. Bresler, "Necessary density conditions for MIMO sampling of multiband inputs," in *IEEE International Symposium on Information Theory*, 2002, p. 16.
12. R. Venkataramani, G. Kramer, and V.K. Goyal, "Bounds on the achievable region for certain multiple description coding problems," in *IEEE International Symposium on Information Theory*, 2001, pp. 148–148.
13. R. Venkataramani, G. Kramer, and V.K. Goyal, "Successive refinement on trees: A special case of a new MD coding region," in *IEEE Data Compression Conference*, 2001, pp. 293–301.
14. Y. Bresler, M. Gastpar, and R. Venkataramani, "Image compression on-the-fly by universal sampling in Fourier imaging systems," in *Proc. IEEE Information Theory Workshop on Detection, Estimation, Classification, and Imaging*, 1999, pp. 48–48.
15. R. Venkataramani and Y. Bresler, "Further results on spectrum blind sampling of 2D signals," in *Proc. IEEE Int. Conf. on Image Processing (ICIP)*, 1998, vol. 2, pp. 752–756.
16. R. Venkataramani and Y. Bresler, "Sub-Nyquist sampling of multiband signals: perfect reconstruction and bounds on aliasing error," in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing*, 1998, vol. 3, pp. 1633–1636.