

# Raman Venkataramani

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## EXPERIENCE

### **SoundHound Inc., Boulder, CO — Senior Machine Learning Engineer**

SEPTEMBER 2021 - PRESENT

- Worked on beamforming, speech enhancement algorithms and training of acoustic models for automatic speech recognition.

### **Seagate Technology, Longmont, CO — Senior Staff Engineer**

MARCH 2009 - SEPTEMBER 2021

- 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.

### **Seagate Technology, Pittsburgh, PA — Staff Engineer**

AUGUST 2003 - FEBRUARY 2009

- Reduced the bit error rates 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.

### **Harvard University, Division of Engineering and Applied Sciences, Cambridge, MA — Postdoctoral Researcher**

JANUARY 2003 - AUGUST 2003

- Developed a class of codes for OFDM communication systems with low peak-to-average power ratios.

### **Lucent Technologies (Bell Labs), Murray Hill, NJ — Member of Technical Staff**

NOVEMBER 2001 - DECEMBER 2002

- 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

## LANGUAGES

English (fluent), Spanish and French (upper beginner), Italian (intermediate)

## PERSONAL INFORMATION

Citizenship: USA

## EDUCATION

### **University of Illinois, Urbana, IL — *Ph.D. in Electrical Engineering***

JANUARY 1997 - DECEMBER 2001

### **Johns Hopkins University, Baltimore, MD — *M.S in Electrical Engineering***

SEPTEMBER 1995 - DECEMBER 1996

### **Indian Institute of Technology, Chennai, India — *B.Tech in Electrical Engineering***

AUGUST 1991 - JULY 1996

## AWARDS

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

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## PATENTS

1. Systems and methods for joint event segmentation and basecalling in single molecule sequencing, US Patent App. 16/525,914, Feb 4, 2021.
2. Event timing detection for DNA sequencing, US Patent App. 16/175,223, October 30, 2018.
3. Channel error rate optimization using Markov codes, US Patent 10447315, October 15, 2019.
4. Adaptive MIMO channel equalization and detection, US Patent 10148470, December 4, 2018.
5. Partial zero forcing equalization, US Patent 9973354, May 15, 2018.
6. Asynchronous interference cancellation, US Patent 9947362, April 17, 2018.
7. Obtaining a predetermined phase shift in data using different write pre-compensation associated with different NRZI patterns, US patent 9830942, November 28, 2017.
8. Timing error processor that uses the derivative of an interpolator function, US patent 9590803, March 7, 2017.
9. Noise prediction detector adaptation in transformed space, US patent 9489976, November 8, 2016.
10. Adaptively combining waveforms, US patent 9195860, November 24 2015.
11. Time-multiplexed single input single output (SISO) data recovery channel, US Patent 9165597, October 20, 2015.
12. Detecting track information from overlapping signals read from a data storage medium, US Patent 9123356, September 1, 2015.
13. Track interference cancellation, US Patent 9093115, July 28, 2015.
14. Universal modulation coding for magnetic recording channel, US Patent 8976474, March 10, 2015.
15. Channel detector implementation with postcoder, US Patent 8885779, November, 11 2014.
16. Equalizer and detector arrangement employing joint entropy-based calibration, US Patent 8737460, May 27, 2014.
17. Programmable soft-output Viterbi algorithm system and method, US Patent 8307267, November 6, 2012.
18. Off-track aware equalizer design for bit-patterned media, US Patent 8199800, June 12, 2012.
19. Converting timing errors into symbol errors to handle write mis-synchronization in bit-patterned media recording systems, US Patent 8130459, March 6, 2011.
20. Zone based timing recovery for bit patterned media, US Patent 7864471, June 1, 2010.
21. Robust maximum-likelihood based timing recovery, US Patent 7564931, July 21, 2009.

## PUBLICATIONS

### **Journal Papers**

1. "Geometrical scaling limits of heat assisted magnetic recording," S. Hernández, Z. Liu, P. Jin, S. Granz, P. Krivosik, R. Venkataramani, W. Radich, T. Rausch, J. Dykes, and E. Gage, IEEE Transactions on Magnetics, 2020.

2. "Dimension reduction for systems with slow relaxation," S. C. Venkataramani, R. Venkataramani, J. M. Restrepo, *J. Stat. Physics*, vol. 167, no. 3-4, pp. 892-933, 2017.
3. "A posteriori equivalence: a new perspective for design of optimal channel shortening equalizers," R. Venkataramani and M. F. Erden, arXiv preprint arXiv:0710.3802.
4. "Macroscopic and microscopic approaches in sector failure rate estimation," R. Venkataramani and A. Kuznetsov, *IEEE Transactions on Magnetism*, vol. 44, no. 1, January 2008.
5. "Trellis-based optimal baud-rate timing recovery for magnetic recording systems," W. Zeng, M. F. Erden, A. Kavcic, E. Kurtas and R. Venkataramani, *IEEE Trans. on Magnetism*, vol. 43, no. 7, July, 2007.
6. "Multiple-input multiple-output sampling: necessary density conditions," R. Venkataramani and Y. Bresler, *IEEE Trans. Information Theory*, vol. 50, no. 8, pp. 1754-1788, August 2004.
7. "Filter design for MIMO sampling and reconstruction," R. Venkataramani and Y. Bresler, *IEEE Trans. Signal Processing*, vol. 51, no. 12, pp. 3164-3176, December 2003.
8. "Sampling theorems for uniform and periodic nonuniform MIMO sampling of multiband signals," R. Venkataramani and Y. Bresler, *IEEE Trans. Signal Processing*, vol. 51, no. 12, pp. 3152-3163, December 2003.
9. "A new construction of 16-QAM Golay complementary sequences," C. V. Chong, R. Venkataramani, and V. Tarokh, *IEEE Trans. Information Theory*, vol. 49, no. 11, pp. 2953-2959, November 2003.
10. "Multiple description coding with many channels," R. Venkataramani, G. Kramer, and V. Goyal, *IEEE Trans. Information Theory*, vol. 49, no. 9, pp. 2106-2114, September 2003.
11. "Optimal sub-Nyquist nonuniform sampling and reconstruction for multiband signals," R. Venkataramani and Y. Bresler, *IEEE Trans. Signal Processing*, vol. 49, no. 10, pp. 2301-2313, October 2001.
12. "Perfect reconstruction formulas and bounds on aliasing error in sub-Nyquist nonuniform sampling of multi-band signals," R. Venkataramani and Y. Bresler, *IEEE Trans. Information Theory*, vol. 46, no. 6, pp. 2173-2183, September 2000.

## Conference Papers

1. "Channels with both random errors and burst erasures: Capacities, LDPC code thresholds, and code performances," K. Li, A. Kavcic, R. Venkataramani, and M. F. Erden, *IEEE International Symposium on Information Theory (ISIT)*, pp. 699-703. IEEE, 2010.
2. "Optimal Channel Shortening Equalization for MIMO ISI Channels," R. Venkataramani, S. Sankaranarayanan, *Globecom Conference*, New Orleans, November 2008.
3. "MAP-based timing recovery for magnetic recording," R. Venkataramani, M. F. Erden, *International Conference on Communications (ICC)*, Beijing, China, May 2008.
4. "Microscopic and macroscopic approaches in sector failure rate estimation," A. Kuznetsov and R. Venkataramani, *TMRC Conference*, Minneapolis, MN, May 2007.
5. "Optimal equalizers and targets for detection in ISI channels," R. Venkataramani and M. F. Erden, *Intermag Conference*, San Diego, CA, May 2006.
6. "A family of equalizers for optimal sequence detection," R. Venkataramani and M. F. Erden, *IEEE ICASSP*, Toulouse, France, May 2006.
7. "Effect of preamplifier on timing recovery in magnetic recording channels," R. Venkataramani, M. F. Erden, and E. Kurtas, *International Conference on Networking and Services*, Papeete, Tahiti, French Polynesia, October 23-28, 2005.
8. "Trellis-based baud-rate timing recovery loop for magnetic recording systems," W. Zeng, M. F. Erden, A. Kavcic, E. Kurtas and R. Venkataramani, *ICC 2006*, Istanbul, Turkey.
9. "Optimal Sampling and Reconstruction in Multiple-Input-Multiple-Output (MIMO) Systems," Y. Bresler and R. Venkataramani, *Sampling Theory Conference*, Samsun, Turkey, July 10-15, 2005.
10. "Reciprocal training and scheduling protocol for MIMO Systems," R. Venkataramani and T. L. Marzetta, *41st Annual Allerton Conf. on Commun., Control and Comp.*, (Monticello, IL, USA), Oct. 1-3, 2003.
11. "Necessary density conditions for MIMO sampling of multiband inputs," R. Venkataramani and Y. Bresler, *ISIT*, Lausanne, Switzerland 2002.
12. "Bounds on the achievable region for certain multiple description coding problems," R. Venkataramani, G. Kramer, and V. Goyal, *ISIT*, Washington, DC 2001.
13. "Successive refinement on trees: a special case of a new MD coding region," R. Venkataramani, G. Kramer, and V. Goyal, *Data Compression Conference*, Snowbird, UT, March 2001.
14. "Image compression on-the-fly by universal sampling in Fourier imaging systems," Y. Bresler, M. Gastpar,

and R. Venkataramani, in Proc. 1999 IEEE Information Theory Workshop on Detection, Estimation, Classification, and Imaging, Santa Fe, NM, pp. 48-48, February 1999.

15. "Further results on spectrum blind sampling of 2D signals," R. Venkataramani and Y. Bresler, IEEE ICIP, Chicago, IL October 1998.
16. "Sub-Nyquist sampling of multiband signals: perfect reconstruction and bounds on aliasing error," R. Venkataramani and Y. Bresler, IEEE ICASSP, Seattle, WA, May 1998.