

## CV of Robert M. Gray

Alcatel-Lucent Technologies Professor of Communications and Networking  
in the School of Engineering, Stanford University, Emeritus  
Professor of Electrical Engineering, Stanford University, Emeritus  
Research Professor, Boston University



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### Education

|                      |            |      |                        |
|----------------------|------------|------|------------------------|
| MIT, Cambridge, MA   | B.S.& M.S. | 1966 | Electrical Engineering |
| USC, Los Angeles, CA | Ph.D.      | 1969 | Electrical Engineering |

### Professional Experience

4 semesters during 1962–1965: Engineer, U.S. Naval Ordnance Laboratory, White Oak, Maryland (As MIT cooperative student.) Digital logic design, passive sonar systems.

1965–1966: Teaching Assistant, MIT

Summers 1966, 1967: Engineer, Jet Propulsion Laboratory, Pasadena, Calif. Tracking loop analysis for Mariner 5, studies of flicker noise in phase-locked loops, sequential decoding for deep space communications.

1967–1969: NSF Graduate Trainee, University of Southern California

1969: Lecturer, University of Southern California.

1969–2013: Department of Electrical Engineering, Stanford University: 69–75 Asst. Prof., 75–80 Assoc. Prof., 80–2011 Prof., 2011 – Prof. Emeritus; 2004 – 2011 Lucent Technologies Professor of Communications and Networking in the School of Engineering, 2011–Alcatel-Lucent Technologies Professor of Communications and Networking in the School of Engineering, Emeritus. Recalled to half-time duty 2011 – 2013.

1972–1973: Nonresident instructor, M.I.T. (taught Applied Probability class as part of the MIT VI-A Cooperative program)

1984–1987: Director, Information Systems Laboratory, Stanford University  
1993– 2007: Vice Chair, Dep't. of Electrical Eng., Stanford  
2007 – 2013 Faculty Affiliate of the Michelle R. Clayman Institute for Gender Research, Stanford University  
2008 – 09 – Faculty Research Fellow, Michelle R. Clayman Institute for Gender Research, Stanford University  
2011 – Member, Executive Committee, France-Stanford Center for Interdisciplinary Studies

### **Selected Professional Activities**

#### *Editorial*

- Associate Editor (1977-1981) and Editor-in-Chief (1981-1983), *IEEE Transactions on Information Theory*;
- Editorial Board, *IEEE Signal Processing Magazine*, 1998 – 2001
- Member, Editorial Board of *Signal Processing: Image Communications*, published by EURASIP and Elsevier, 2000 – 2009.
- Editor-in-Chief, *Foundations and Trends in Signal Processing*, 2007–2012, 2013 – Founding Editor, Emeritus

#### *Boards*

- IEEE Information Theory Society Board of Governors, 1974–1980, 1984–1987.
- IEEE Signal Processing Society Board of Governors, 1/99 – 12/2001.
- Review Board, Swiss National Science Foundation, Center of Competence on Mobile Information and Communication Systems 2002–2009
- Banff International Research Station (BIRS) Scientific Advisory Board (2006–2009 ) and Program Committee (2006–2009)
- Advisory Board, Ming Hsieh Department of Electrical Engineering, USC, 2007–2010

#### *Conference/Symposia Program Committees:*

- IEEE International Symposium on Information Theory, 1977–1983, 1998, 2005, 2007
- IEEE Data Compression Conference, 1991–2000, 2003–2011
- IEEE International Conference on Image Processing, 1994–2005

- IEEE International Conference on Acoustics, Speech, and Signal Processing, 1994–2005

*Conference/Symposia/Workshop Organization*

- Secretary-Treasurer, IEEE 1971 International Symposium on Information Theory
- Co-Chair, IEEE 1993 International Symposium on Information Theory, San Antonio, TX
- Program Co-Chair, 1997 (Santa Barbara) and 2004 (Singapore) IEEE International Conference on Image Processing
- Co-Chair (with Professor Rabab Ward), Banff International Research Station Workshop on Multimedia and Mathematics, July 23–28, 2005.
- Co-Chair (with Professors Rabab Ward, Eve Riskin, and Sheila Hemami), Banff International Research Station Workshop on Mentoring in Engineering Academia, July 2007.

IEEE Signal Processing Society Image and Multidimensional Signal Processing Technical Committee (1994–2003): Vice Chair (1998–2000), Chair (2000–2001); IEEE Signal Processing Society Multimedia Signal Processing Technical Committee (1997–2000)

1992: National Science Foundation (NSF) Signal Processing Advisory Committee Member

Chair, National Science Foundation Workshop/Panel on Signal Processing for the National Information Infrastructure, Arlington, VA, 17-18 August 1994.

Ad Hoc Mammography Committee, Breast Cancer Research Program, U.S. Army Medical Research and Material Command, May 1995 – January 1996.

Chair, PAESMEM/Stanford School of Engineering Workshop on Mentoring in Engineering, June 21-22 2004. Proceedings Editor: <http://ee.stanford.edu/~gray/proceedings.pdf>

**Honors**

IEEE Information Theory Society: 1976 Prize Paper Award, Golden Jubilee Award for Technological Innovation (1998), 2008 Claude E. Shannon Award

IEEE Signal Processing Society: 1983 Senior Award, 1993 Society Award, 1997 Technical Achievement Award, 2006–2007 Distinguished Lecturer, 2005 Meritorious Service Award, 2009 Education Award

IEEE: Elected Fellow of IEEE (1980), Centennial Medal (1984), Third Millennium Medal (2000), 2008 Jack S. Kilby Signal Processing Medal

Institute for Mathematical Statistics (IMS): Elected Fellow (1992)

Okawa Foundation Research Grant, 1996

Fellowships from the Japan Society for the Promotion of Science at the University of Osaka (1981), the John Simon Guggenheim Foundation at the University of Paris XI (1982), and NATO/Consiglio Nazionale delle Ricerche at the University of Naples (1990). Vinton Hayes Distinguished Visiting Scholar at the Division of Applied Sciences, Harvard University (spring 1995).

2002 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM)

University of Southern California 2003 Distinguished Alumni in Academia Award

First Lucent Technologies Chair in Communications and Networking in the School of Engineering (January 2004). Name subsequently changed to Alcatel-Lucent Technologies Chair.

National Academy of Engineering, 2007

2008–2009 Research Fellowship at the Michelle R. Clayman Institute for Gender Research, Stanford University

2013 Stanford University President's Award for Excellence through Diversity

### **Visiting Positions**

- University of Michigan 1984
- University of Osaka, fall 1981
- University of Paris XI, spring 1982
- University of Naples, summer 1991
- Harvard University, spring 1994
- Technical University of Tampere, spring 1996
- University of Erlangen/Nuremberg, spring 1997
- University of Auckland, March 2006
- L'École Centrale, Paris, April 2006
- MIT, autumn 2009

### **Other Technical Activities**

Advanced Class Amateur Radio License (KB6XQ).

**Students** A list of all 55 PhD students may be found at <http://ee.stanford.edu/~gray/students.pdf>. Of these students, 17 are women, 6 of whom

are tenured professors. One is a department chair (Hemami) and three are or have been Associate Deans (Riskin, Ostendorf, Cosman).

**Selected Publications** from approximately 140 refereed journal articles, 9 books, 4 edited collections, and numerous book chapters and conference presentations. A complete list is available at <http://ee.stanford.edu/~gray/publications.pdf>

### Journal Articles

R. M. Gray and R. C. Tauseworth, "Frequency-counted measurements and phase locking to noisy oscillators," *IEEE Trans. on Comm. Tech.*, Vol. COM-19, No. 1, pp. 21-30, Feb. 1971.

R. M. Gray and L. D. Davisson, "Source coding without the ergodic assumption," *IEEE Trans. on Info. Theory*, Vol. IT-20, No. 4, pp. 502-516, July 1974. (Received the 1976 IEEE Information Theory Group Paper Award.)

R. M. Gray and A. D. Wyner, "Source coding over simple networks," *Bell Systems Tech. J.*, Vol. 53, No. 9, pp. 1681-1721, Nov. 1974.

D.L. Neuhoff, R. M. Gray and L. D. Davisson, "Fixed rate universal block source coding with a fidelity criterion," *IEEE Trans. on Info. Theory*, Vol. IT-21, No. 5, pp. 511-523, Sept. 1975.

R. M. Gray and A. Macovski "Maximum a posteriori estimation of position in scintillation cameras," *IEEE Trans. on Nucl. Sci.*, Vol. NS-23, No. 1, pp. 849-852, Feb. 1976.

Y. Linde, A. Buzo and R. M. Gray, "An algorithm for vector quantizer design," *IEEE Trans. on Comm.*, Vol. COM-28, pp. 84-95, Jan. 1980.

R. M. Gray, D. S. Ornstein and R. L. Dobrushin, "Block synchronization, sliding-block coding, invulnerable sources, and zero error codes for discrete noisy channels," *Ann. Prob.*, Vol. 8, pp. 639-674, Aug. 1980.

A. Buzo, A.H. Gray, Jr., R.M. Gray, and J.D. Markel, "Speech coding based upon vector quantization," *IEEE Transactions on Acoustics, Speech, and Signal Processing*, Vol. ASSP-28, pp. 562-574, October 1980. (Received the 1983 IEEE ASSP Senior Award.)

L.C. Stewart, R.M. Gray, and Y. Linde, "The design of trellis waveform coders," *IEEE Transactions on Communications*, Vol. COM-30, pp.702-710, April 1982. (First codebook-excited linear predictive speech codes.)

R.M. Gray, "Vector Quantization," *IEEE ASSP Magazine*, Vol. 1, pp. 4-29, April 1984.

R.M. Gray, "Oversampled Sigma-Delta Modulation," *IEEE Transactions on Communications*, Vol. COM-35, pp. 481-489, April 1987.

P. A. Chou, T. Lookabaugh, and R. M. Gray, "Entropy constrained vector quantization," *IEEE Transactions on Acoustics, Speech, and Signal Processing*, Vol. ASSP-37, pp. 31-42, January 1989. (Received an IEEE Signal Processing Society Paper Award for best paper by an author under 30 (Chou and Lookabaugh).)

P.A. Chou, T. Lookabaugh, and R.M. Gray, “Optimal pruning with applications to tree-structured source coding and modeling,” *IEEE Trans. on Information Theory*, pp. 299–315, March 1989.

R. M. Gray, “Spectral analysis of quantization noise,” *IEEE Transactions on Information Theory*, Vol. 36, pp. 1220–1244, November 1990.

R. M. Gray and T. G. Stockham, Jr. “Dithered quantizers,” *IEEE Transactions on Information Theory*, Volume 39, No. 3, May 1993, pp. 805–812.

P. C. Cosman, E. A. Riskin, K. L. Oehler, and R. M. Gray, “Using Vector Quantization for Image Processing,” *Proceedings of the IEEE*, vol 81, no 9, pp. 1326–1341, September 1993.

P. C. Cosman, H C. Davidson, C. J. Bergin, C. Tseng, L. E. Moses, E. A. Riskin, R. A. Olshen, and R. M. Gray, “The Effect of Lossy Compression on Diagnostic Accuracy of Thoracic CT Images,” *Radiology*, 190:517–524, January 1994.

P. C. Cosman, R. M. Gray, and R. A. Olshen, “Evaluating Quality of Compressed Medical Images: SNR, Subjective Rating, and Diagnostic Accuracy,” *Proceedings of the IEEE*, Volume 82, pp. 919–932, June 1994.

K.L. Oehler and R.M. Gray, “Combining image compression and classification using vector quantization,” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, volume 17, pp. 461–473, May 1995.

S. M. Perlmutter, P. C. Cosman, R. M. Gray, R. A. Olshen, D. Ikeda, C. N. Adams, B.J. Betts, M. Williams, K. O. Perlmutter, J. Li, A. Aiyer, L. Fajardo, R. Birdwell, and B. L. Daniel “Image Quality in Lossy Compressed Digital Mammograms,” *Signal Processing*, Special Section on Medical Image Compression, pp. 189–210, Vol. 59, No. 2, June 1997.

S.M. Perlmutter, P.C. Cosman, C. Tseng, R.A. Olshen, R.M. Gray, K.C.P. Li, and C.J. Bergin, “Medical image compression and vector quantization,” *Statistical Science*, Vol. 13, No. 1, February 1998.

B. Girod, R.M. Gray, and Jelena Kovacevic, “Image and Video Coding,” *IEEE Signal Processing Magazine*, Vol. 15, pp. 40–46, March 1998.

R.M. Gray and D.L. Neuhoff, “Quantization,” *IEEE Transactions on Information Theory*, Vol. 44, pp. 2325–2384, October 1998. (Shannon Commemorative Issue, 1948–1998).

R.M. Gray, T. Linder, and J. Li, “A Lagrangian Formulation of Zador’s Entropy-Constrained Quantization Theorem,” *IEEE Transactions on Information Theory*, pp. 695–707, Vol. 48, Number 3, March 2002.

Robert M. Gray, “The 1974 origins of VoIP,” *IEEE Signal Processing Magazine*, Vol. 22, July 2005, pp. 87–90.

Robert M. Gray, Tamás Linder, and John T. Gill III, “Lagrangian vector quantization,” *IEEE Transactions on Information Theory*, Volume 54, Issue 5, May 2008, pp. 2220 – 2242.

Mark Z. Mao, Robert M. Gray, and Tamás Linder, “Rate-constrained simulation and source coding IID sources,” *IEEE Transactions on Information Theory*, Vol. 57, no. 7, pp. 4516–4529, July 2011.

## Books and book chapters

Robert M. Gray, *Linear Predictive Coding and the Internet Protocol: A survey of LPC and a History of Realtime Digital Speech on Packet Networks*, Now Publishers, 2010.

Robert M. Gray, Sheila Hemami, Eve Riskin, Rabab Ward, Suzanne Brainard, Pamela Cosman, Norman Fortenberry, Janet Rutledge, Telle Whitney, Eds., *Mentoring for Engineering Academia II: Proceedings of a Workshop at the Banff International Research Station*, Grayphics Press, Santa Barbara, 2007. Copies may be downloaded at <http://birs07.stanford.edu/>

Eve Riskin, Mari Ostendorf, Pamela Cosman, Michelle Effros, Jia Li, Sheila Hemami, Robert M. Gray, Eds., *Mentoring for Academic Careers in Engineering: Proceedings of the PAESMEM/Stanford School of Engineering Workshop*, Grayphics Press, Santa Barbara, 2005. Copies may be downloaded at <http://paesmem.stanford.edu/>

R.M. Gray, *Probability, Random Processes, and Ergodic Properties*, Springer-Verlag, 1988. Second Edition, Springer, 2009.

R. M. Gray, *Entropy and Information Theory*, Springer-Verlag, 1990. Second Edition, Springer, 2011.

A. Gersho and R.M. Gray, *Vector Quantization and Signal Compression*, Kluwer Academic Press, 1992.

R. M. Gray, P. C. Cosman, and K. Oehler, “Incorporating visual factors into vector quantization for image compression,” contributed chapter in *Digital Images and Human Vision*, B. Watson, Ed., MIT Press, Cambridge, Mass, 1993, pp. 35–52.

P.C. Cosman, R.M. Gray, and R.A. Olshen, “Vector quantization: Clustering and classification trees,” pp. 93–108, in *Advances in Applied Statistics: Statistics and Images:2*, K.V. Mardia, Ed., Carfax Publishing Company, Abingdon, UK, 1994.

R.M. Gray “Quantization noise in  $\Delta\Sigma$  A/D converters,” Chapter 2 of *Delta-Sigma Data Converters*, edited by S. Norsworthy, R. Schreier, and G. Temes, IEEE Press, 1997, pp. 44–74.

Pamela Cosman, Robert M. Gray, and Richard Olshen, “Quality evaluation for compressed medical images: fundamentals,” pp. 803 – 819 of *Handbook of medical imaging*, Ed. Isaac N. Bankman, Academic Press, 2000. Second Edition, 2009.

Pamela Cosman, Robert M. Gray, and Richard Olshen, “Quality evaluation for compressed medical images: diagnostic accuracy,” pp. 821 – 839, *Ibid.*.

Pamela Cosman, Robert M. Gray, and Richard Olshen, “Quality evaluation for compressed medical images: statistical issues,” pp. 841 – 850, *Ibid.*

Chee Son Won and Robert M. Gray, *Stochastic Image Processing*, Springer/Kluwer/Plenum, 2004.

Robert M. Gray and Lee D. Davisson, *Introduction to Statistical Signal Processing*, December 2004, Cambridge University Press. Corrected soft cover edition, May 2010.

**Personal** Married to Arlene Gray. Two children, six grandchildren.