

Chad M. Spooner
cmspooner@ieee.org
cyclostationary.blog

OBJECTIVE

To contribute to the advanced R&D of signal processing methods for scientific, industrial, or military applications involving natural or manmade systems.

EDUCATION

Ph.D. in Electrical Engineering, University of California, Davis, 1992, with an emphasis on statistical signal processing and a minor in pure mathematics. Winner of two best-dissertation awards.

MS in Electrical Engineering, University of California, Davis, 1988.

BS in Electrical Engineering, University of California, Berkeley, 1986.

AS, Santa Rosa Junior College, Santa Rosa, CA, 1984, with *High Honors*.

PROFESSIONAL EXPERIENCE

Senior Scientist/Engineer, NorthWest Research Associates, Monterey, CA, 10/05-present. Currently principal investigator on multiple contracts involving advanced signal processing research and development. Customers include the Naval Research Lab, Air Force Research Lab, Lockheed Martin Company, Tektronix, Echo Ridge, SDSI, BAE Systems, and Virginia Polytechnic Institute and State University.

Applications for the developed technology include RF surveillance; government regulation of public bands; RF equipment failure diagnosis; spectrum monitoring, survey, and planning; interference characterization and mitigation for radio astronomy and industry; preprocessing for signal separation; and signal detection, classification, and white-space detection for cognitive radio networks.

Other recent contract work: wavelet-based signal processing for EEG-based brain-state classification, adaptive transmit filtering using the modified DFT filterbank, signal processing algorithms for wideband ionospheric probes, development of low-cost noise-tolerant signal detection and classification algorithms for modern communication standards such as ATSC DTV, 802.11a/b/g, Bluetooth, etc.

Author of the Cyclostationary Signal Processing Blog, cyclostationary.blog, 2015-present. The blog explores all aspects of the theory and practice of cyclostationary signal processing, providing accessible explanations and illustrations of mathematical results and algorithms found in the literature.

Member of Drexel University's team for DARPA's Spectrum Collaboration Challenge (Dragon Radio), 2017. Contributing algorithms and software for RF environment understanding.

Visiting Scholar, Nanyang Technical University, Singapore, February 2017.

Lecturer, Naval Postgraduate School, 2008-2010: Introduction to Linear Systems, Digital Signal Processing. Responsible for all aspects of courses.

Scientist/Engineer, ATK Mission Research, Monterey, CA, 9/99-10/05.

Responsible for obtaining funding and providing technical labor for government contracts and commercial opportunities involving communication theory, system design, and performance evaluation. Areas of expertise include automatic signal detection and classification, cyclostationary signal processing, error-control coding including turbo codes, wavelet-based image classification, spectral analysis, higher-order statistics, and scientific computing. As Principal Investigator, I managed contracts worth \$1.6M during the period of 2000-2005.

Scientist/Engineer, Statistical Signal Processing, Inc., 4/97-6/99.

I performed R&D in the area of communication systems with emphasis on signals intelligence applications.

Scientist/Engineer, Mission Research Corporation, Monterey, CA, 2/94-3/97.

R&D on sophisticated digital signal processing algorithms for problems in the area of communication signal processing.

Visiting Professor, University of Naples “Federico II”, Naples ITALY, 11/94.

Presented a series of six lectures on statistical signal processing using higher-order moments and cumulants.

Postdoctoral Researcher, UC Davis, 6/92-1/94.

Research focused on the further development of the theory of higher-order cyclostationarity.

Programmer, SSPI, 1/90-6/95.

Implemented in C a commercially available cyclic spectrum analyzer program and associated data-handling routines.

Engineering Consultant, SSPI, 11/88-1/94.

Responsible for the continuing development of signal processing algorithms for signal detection and parameter estimation.

System Administrator, UC Davis, 6/92-1/94.

Responsible for maintaining Unix workstations and peripherals for the Cyclostationarity Signal Processing Laboratory staff.

Teaching Assistant, UC Davis, 9/86-10/87, 1/89-4/89.

Responsible for instructing upper-division students in analog and digital circuit theory and practice, and digital signal processing.

Instructor, Far West High School, Oakland, CA, 1/86-5/86.

Taught computer familiarization and the BASIC programming language to sophomore high-school students.

Student Engineering Assistant, Hewlett-Packard Corp., 6/84-9/84.

ACADEMIC SERVICE

Adjunct Research Professor, Virginia Tech, 2008-present.

Academic Advisor to MS students at the Naval Postgraduate School, 1995-2000, PhD Students at SUNY Buffalo (2008-2015), and Virginia Tech (2007-2011).

Student Representative (Elected) to the Graduate Program and Research Committee of the faculty of the Department of ECE, UC Davis, 1990-1992.

Technical Reviewer for multiple academic journals, ongoing.

Organizer of the *Second Workshop on Cyclostationary Signals*, The DoubleTree Hotel, Monterey, CA, Aug. 1-2, 1994.

Organizer of a special session on cyclostationary signals, *The Twenty-Ninth Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 31-Nov. 2, 1995.

President, Treasurer, and Founding Member of The Engineering Club (TEC), Santa Rosa Junior College, Santa Rosa, CA, 1982-1984.

HONORS

Lockheed Martin MUOS Program Award for Technical Excellence, 7/2007 and 1/2011.

Mission Research Corporation's Technical Achievement Award: Best MRC Paper of 1996 for *Algorithm Development for Signals Intelligence Applications*.

The Allen G. Marr Prize for Distinguished Doctoral Dissertation in Mathematics, Engineering, and the Physical Sciences (UCD) 6/95.

The Sigma Xi Award of Recognition for Doctoral Research, 5/94.

Toward Outstanding Post-Graduate Studies Award (UCD), 2/89.

William Carr Memorial Scholarship for Transferring Engineering Students (SRJC), 6/84.

Milton Hoehn Mathematics Scholarship (SRJC), 6/84.

The SRJC Engineering Department Scholarship, 6/84.

MEMBERSHIP IN PROFESSIONAL ASSOCIATIONS

The Institute of Electrical and Electronics Engineers, Senior Member, 1988-present.

Sigma Xi, The Scientific Research Society, 1992-present.

LINKS

Research Gate:

http://www.researchgate.net/profile/Chad_Spooner/

Google Scholar:

<http://scholar.google.com/citations?user=hwCQv-4AAAAJ&hl=en&oi=ao>

NorthWest Research Associates:

<http://www.nwra.com/people.php#chadspooner>

LinkedIn:

<http://www.linkedin.com/pub/chad-spooner/2/160/999>

Cyclostationary Signal Processing Blog:

<https://cyclostationary.blog>

PUBLICATIONS

Peer-reviewed journal papers: Twelve (1992-2016), in *IEEE Transactions on Signal Processing*, *IEEE Transactions on Communications*, and *IEEE Transactions on Wireless Communications*.

Book chapters and theses: Six book chapters, two academic theses.

Conference papers: Over twenty five.

Internal technical reports: Over one hundred.

Journal Papers

W. A. Gardner and C. M. Spooner, "Signal Interception: Performance Advantages of Cyclic-Feature Detectors," *IEEE Transactions on Communications*, **40**, 1, Jan. 1992, pp. 149-159.

W. A. Gardner and C. M. Spooner, "Comparison of Auto- and Cross-Correlation Methods for Signal-Selective TDOA Estimation," *IEEE Transactions on Signal Processing*, **40**, 10, Oct. 1992, pp. 2606-2608.

C. M. Spooner and W. A. Gardner, "Robust Feature Detection for Signal Interception," *IEEE Transactions on Communications*, **42**, 5, May 1994, pp. 2165-2173.

W. A. Gardner and C. M. Spooner, "Detection and Source Location of Weak Cyclostationary Signals: Simplifications of the Maximum-Likelihood Receiver," *IEEE Transactions on Communications*, **41**, 6, June 1993, pp. 905-916.

W. A. Gardner and C. M. Spooner, "The Cumulant Theory of Cyclostationary Time-Series, Part I: Foundation," *IEEE Transactions on Signal Processing*, **42**, 12, Dec. 1994, pp. 3387-3408.

C. M. Spooner and W. A. Gardner, "The Cumulant Theory of Cyclostationary Time-Series, Part II: Development and Applications," *IEEE Transactions on Signal Processing*, **42**, 12, Dec. 1994, pp. 3409-3429.

A. Napolitano and C. M. Spooner, "Median-Based Cyclic Polyspectrum Estimation," *IEEE Transactions on Signal Processing*, **48**, 5, May 2000, pp. 1462-1466.

A. Napolitano and C. M. Spooner, "Cyclic Spectral Analysis of Continuous-Phase Modulated Signals," *IEEE Transactions on Signal Processing*, **49**, 1, Jan. 2001, pp. 30-44.

A. Punchihewa, Q. Zhang, O. A. Dobre, C. M. Spooner, S. Rajan, and R. Inkol, "On the Cyclostationarity of OFDM and Single Carrier Linearly Digitally Modulated Signals in Time Dispersive Channels: Theoretical Developments and Applications," *IEEE Transactions on Wireless Communications*, Vol 9, No 8, August 2010, pp 2588-2599.

P. H. Sahmel, J. H. Reed, and C. M. Spooner, "Eigenspace Approach to Specific Emitter Identification," *Frequenz*, December 2010.

C. M. Spooner and N. Khambekar, "A Signal-Processing Perspective on Signal-Statistics Exploitation in Cognitive Radio," *Journal of Communications*, Vol 7, No 7, July 2012.

C. M. Spooner and A. N. Mody, "Wideband Cyclostationary Signal Processing Using Sparse Subsets of Narrowband Subchannels," *IEEE Trans. Cognitive Communications and Networking*, (submitted 2016).

M. Carrick, J. H. Reed, and C. M. Spooner, "Paramorphic Multicarrier Communications for Interference Mitigation," *EURASIP Journal on Advances in Signal Processing*, (submitted 2017).

Book Chapters and Academic Theses

C. M. Spooner, "Performance Evaluation of Detectors for Cyclostationary Signals," MS Thesis, University of California, Davis, June 1998.

C. M. Spooner, "Theory and Application of Higher-Order Cyclostationarity," Ph.D. Dissertation, University of California, Davis, June 1992.

C. M. Spooner, "Higher-Order Statistics for Nonlinear Processing of Cyclostationary Signals," Chapter in *Cyclostationarity in Communications and Signal Processing*, New York: IEEE Press, 1994, pp. 91-167.

W. A. Gardner and C. M. Spooner, "Cyclostationary Signal Processing," Chapter in *Control and Dynamic Systems, Vol. 65, Stochastic Techniques in Digital Signal Processing Systems, Part 2 of 2*, New York: Academic Press, 1994, pp. 1-92.

C. M. Spooner and R. B. Nicholls, "Spectrum Sensing Based on Spectral Correlation," Chapter 18 in *Cognitive Radio Technology*, Second Edition, Ed. Bruce Fette, 2009.

Conference Papers

W. A. Gardner and C. M. Spooner, "Cyclic Spectral Analysis for Signal Detection and Modulation Recognition," *Proceedings of the Conference on Military Communications (MILCOM)*, San Diego, CA, Oct. 1988, pp. 419-423.

W. A. Gardner and C. M. Spooner, "Higher-Order Cyclostationarity, Cyclic Cumulants, and Cyclic Polyspectra," *Proceedings of the International Symposium on Information Theory and Its Applications (ISITA)*, Honolulu, HI, Nov. 27-30, 1990, pp. 355-358.

C. M. Spooner and W. A. Gardner, "Estimation of Cyclic Polyspectra," (invited paper) *Proceedings of the Twenty-Fifth Annual Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 4-6, 1991, pp. 370-376.

C. M. Spooner and W. A. Gardner, "An Overview of the Theory of Higher-Order Cyclostationarity," *Proceedings of the Workshop on Nonstationary Stochastic Processes*, Singapore: World Scientific, 1992, pp. 110-125.

C. M. Spooner and W. A. Gardner, "Exploitation of Higher-Order Cyclostationarity for Weak-Signal Detection and Time-Delay Estimation," *Proceedings of the Sixth Workshop on Statistical Signal & Array Processing*, Victoria, British Columbia, Canada, Oct. 7-9, 1992, pp. 197-201.

C. M. Spooner and W. A. Gardner, "Performance Evaluation of Cyclic Polyspectrum Estimators," (invited paper) *Proceedings of the Twenty-Sixth Annual Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 26-28, 1992, pp. 477-483.

W. A. Gardner, C. M. Spooner, and G. K. Yeung, "Frequency-Shift Filtering for Cochannel Signal Separation," *Proceedings of the CRASP Conference on Cochannel Demodulation*, Fort Meade, MD, June 2, 1994.

G. Fong, C. M. Spooner, and W. A. Gardner, "An Algorithm for Further Improvements in Signal-Selective Time-Difference Estimation," *Proceedings of the Second Workshop on Cyclostationary Signals*, Monterey, CA, Aug. 1-2, 1994, pp. 10.1-10.7.

C. M. Spooner, "An Overview of Recent Developments in Cyclostationary Signal Processing," *Proceedings of the Second Workshop on Cyclostationary Signals*, Monterey, CA, Aug. 1-2, 1994, pp. 1.1-1.17.

C. M. Spooner, "Classification of Cochannel Communication Signals using Cyclic Cumulants," (invited paper) *Proceedings of the Twenty-Ninth Annual Asilomar Conference on Signals, Systems, and Computers*, Oct. 31-Nov. 2, 1995, pp. 531-536.

C. M. Spooner, W. A. Brown, and G. K. Yeung, "Automatic Radio-Frequency Environment Analysis," *Proceedings of the Thirty-Fourth Annual Asilomar Conference on Signals, Systems, and Computers*, Oct. 31, 2000.

C. M. Spooner, M. P. Clark, and L. T. McWhorter, "Wavelet-Based Compression of HRR Radar Data for Moving Targets," *Proceedings of the Thirty-Fourth Annual Asilomar Conference on Signals, Systems, and Computers*, Oct. 31, 2000.

C. M. Spooner, "On the Utility of Sixth-Order Cyclic Cumulants for RF Signal Classification," *Proceedings of the Thirty-Fifth Annual Asilomar Conference on Signals, Systems, and Computers*, Nov. 4-7, 2001.

C. M. Spooner, "Applications of Local Discriminant Bases to HRR-Based ATR," *Proceedings of the Thirty-Fifth Annual Asilomar Conference on Signals, Systems, and Computers*, Nov. 4-7, 2001.

K. Kim, I. A. Akbar, K. K. Bae, J. Um, C. M. Spooner, and J. H. Reed, "Cyclostationary Approaches to Signal Detection and Classification in Cognitive Radio," *Proceedings of DySPAN 2007*.

C. M. Spooner, "Filterbanks for Adaptive Transmit Filtering," *Proceedings of MILCOM 2007*, Orlando FL, October 2007.

C. M. Spooner, "Multi-Resolution White-Space Detection for Cognitive Radio," *Proceedings of MILCOM 2007*, Orlando FL, October 2007.

K. Kim, C. M. Spooner, I. Akbar, and J. H. Reed, "Specific Emitter Identification in Cognitive Radio Applications," *Global Communications Conference 2008*, New Orleans, LA, December 2008.

N. V. Khambekar, C. M. Spooner, and V. Chaudhary, "Listen-While-Talk for Primary User Protection," *Wireless Communications and Networking Conference*, Budapest, Hungary, April 2009.

C. M. Spooner and N. Khambekar, "Spectrum Sensing for Cognitive Radio: A Signal Processing Perspective on Signal-Statistics Exploitation," Invited Position Paper for the *International Conference on Computing, Networking, and Communications*, Maui, Hawaii, January 2012.

C. M. Spooner, E. Viirre, and B. Chase, "From Explicit to Implicit Speech Recognition," Invited Paper in *Proceedings of the 2013 HCI International Conference*, Las Vegas, NV, July 2013.

D. L. Knepp, C. M. Spooner, and M. A. Hausman, "A Wideband Channel Probe for

Space Situational Awareness," *2013 Beacon Satellite Symposium*, Bath, UK, July 8-10, 2013.

C. M. Spooner, A. N. Mody, J. Chuang, and M. P. Anthony, "Tunnelized Cyclostationary Processing: A Novel Approach to Low-Energy Spectrum Sensing," Invited Paper in *Proceedings of the 32nd Annual Conference on Military Communications (MILCOM '13)*, San Diego, CA, November 2013.

N. V. Khambekar, C. M. Spooner, and V. Chaudhary, "On Improving Serviceability with Quantified Dynamic Spectrum Access," *Proceedings of DySPAN 2014*, McLean, VA, April 2014.

N. V. Khambekar, V. Chaudhary, and C. M. Spooner, "Estimating the Use of Spectrum for Defining and Enforcing the Spectrum Access Rights," *Proceedings of the 34th Annual Conference on Military Communications (MILCOM '15)*, Tampa, Florida, October 2015.

N. V. Khambekar, C. M. Spooner, V. Chaudhary, "Quantified Discrete Spectrum Access (QDSA) Framework", *Telecommunications Policy Research Conference (TPRC)*, Sep. 2015 (Poster Presentation).

N. V. Khambekar, C. M. Spooner, V. Chaudhary, "Characterization of the Missed Spectrum-Access Opportunities Under Dynamic Spectrum Sharing," *Proceedings of COMSNETS 2016*, Bangalore, India, Jan. 2016 (in press).

N. V. Khambekar, C. M. Spooner, and V. Chaudhary, "MUSE: A Methodology for Quantifying Spectrum Usage," *Proceedings of Globecom 2016*, Washington DC, December 2016.

C. M. Spooner, A. N. Mody, J. Chuang, and J. Petersen, "Modulation Recognition Using Second- and Higher-Order Cyclostationarity," *Proceedings of DySPAN 2017*, Baltimore, MD, March 2017.