Eric L. Miller

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235 Forsyth Building
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Boston, MA 02115
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Research Interests

Signal and image processing with emphasis on the use of statistical and multiscale (eg. wavelet) methods; exploration of theoretical and practical issues surrounding the use of these techniques for the solution of inverse problems in general and inverse scattering problems in particular; development of computationally efficient, physically-based models for use in signal processing applications; multiscale methods for reduction of computational complexity and regularization of ill-posed linear and non-linear inverse problems.

Education

Massachusetts Institute of Technology Cambridge, MA

PH.D. IN ELECTRICAL ENGINEERING, AUGUST 1994

Thesis with Professor Alan Willsky, *The Application of Multiscale and Stochastic Techniques to the Solution of Inverse Problems*, addresses the use of multiresolution, stochastic modeling and estimation techniques for the solution of inverse problems. Issues explored include regularization, sensor fusion, scale-recursive estimation algorithms and models, and computationally efficient implementations.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING, FEBRUARY 1992

Thesis with Professor Alan Willsky carried out under auspices of MIT VI-A Cooperative Program with Loral Infrared and Imaging Systems, *Statistical Estimation of Atmospheric Transmission Parameters*. Developed phenomenological model of atmospheric radiation propagation. Designed and analyzed algorithms based on model for estimation of parameters governing radiation absorption and scattering.

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING, FEBRUARY 1990

Experience

Northeastern University Boston, MA

September 1994 – present Assistant Professor in Department of Electrical and Computer Engineering. Concentrating in signal and image processing with emphasis on electromagnetic wavefield processing applications. Taught courses in discrete time signals and systems, digital signal processing, multirate filter banks theory, theory and application of linear inverse problems, wavelet signal processing, and C programming.

Massachusetts Institute of Technology Cambridge, MA

Fall 1991, Fall 1992 – Summer 1994 Research Assistant in the Laboratory for Information and Decision Systems. Performed Ph.D. thesis research in area of multiscale, statistical signal processing.

Spring 1992 Teaching assistant, Recursive Estimation course. Developed and taught bi-monthly recitations.

Spring 1990 and Spring 1991 Teaching Assistant, Probabilistic Systems Analysis course. Taught weekly recitation and tutorial sections.

Academic Year 1991 Served as academic advisor to three members of MIT freshman class. Counseled in choice of course schedules and aided in determination of academic major.

Schlumberger-Doll Research Ridgefield, CT

Summer 1991 and Summer 1992 Developed statistical estimation algorithms based on multiscale modeling techniques for the solution of inverse conductivity problem.

Loral Infrared And Imaging Systems Lexington, MA

Summers 1988-1990, Fall 1990. Master's Thesis research on the problem of statistical estimation of atmospheric transmission parameters. Developed single-scatter model of atmospheric radiation propagation. Utilized model and statistical methods for estimation of absorption and scattering parameters.

Journal Publications

Miller, Eric L., "Efficient Computational Methods for Multiscale Linear-Gaussian Signal Restoration Problems," accepted for publication in *IEEE Trans. on Signal Processing.*

Miller, Eric L., "Statistically Based Methods for Anomaly Characterization in Images from Observations of Scattered Radiation," accepted for publication in *IEEE Trans. on Image Processing.*

Miller, Eric L., Nicolaides, Lena, and Mandelis, Andreas, "Nonlinear inverse scattering methods for thermal wave slice tomography: A wavelet domain approach," *Journal of the Optical Society of America (A)*, Vol. 15, No. 6, pp. 1545-1556.

Şahin, Adnan and Miller, Eric L., "Recursive T-Matrix Methods for Scattering from Multiple Dielectric and Metallic Objects." *IEEE Trans. on Antennas and Propagation*, Vol. 46, No. 5, pp. 672–678.

Şahin, Adnan and Miller, Eric L., "Recursive T-Matrix Methods for Metallic Scattering Problem," *Microwave and Optical Technology Letters*, Vol. 15, No. 6, August 1997, pp. 360–363.

Miller, Eric L. and Willsky, Alan S., "Multiscale, Statistical Anomaly Detection Analysis and Algorithms for Linearized Inverse Scattering Problems," *Multidimensional Systems and Signal Processing* special issue on wavelets and multiresolution analysis, Vol. 8, No. 1, January, 1997, pp. 151–184.

Miller, Eric L. and Willsky, Alan S., "A Multiscale, Statistically-Based Inversion Scheme for the Linearized, Inverse Scattering Problem," *IEEE Trans. on Geoscience and Remote Sensing*, Vol. 34, No. 2, March 1996, pp. 346–357.

Miller, Eric L. and Willsky, Alan S., "Wavelet-based methods for the nonlinear inverse scattering problem using the Extended Born Approximation," *Radio Science*, Vol. 31, No. 1, January-February 1996, pp. 51–65.

Miller, Eric L. and Willsky, Alan S., "A Multiscale Approach to Sensor Fusion and the Solution of Linear Inverse Problems," *Applied and Computational Harmonic Analysis*, Vol. 2, pp. 127–147.

Publications in Progress

Sahin, Adnan and Miller, Eric L., "Model-Based Multiple Object Detection Using High-Resolution Near Field Array Processing", Submitted to *IEEE Transactions on Geoscience and Remote Sensing*, April 1998

Dufour, Roger and Miller, Eric L, "Statistical Signal Restoration with Wavelet Domain Prior Models," submitted to *Signal Processing*, May, 1998.

Belge, M., Kilmer, M. and Miller, Eric L., "Wavelet Domain Image Restoration with Adaptive Edge-Preserving Regularization", submitted to *IEEE Trans. on Image Processing*, August 1998.

Conference Publications

Miller, Eric L. and Karl, W. C. "Detection and Localization of Buried Objects from Near-Field Sensor Array Data: Physical Models and Statistical Processing," to be presented at 1998 *International Conference on Image Processing*, Chicago Il., October 1998.

Dufour, Roger and Miller, Eric L. "Image Restoration with 1/f-type Fractal Models and Statistical Estimation of Models Parameters," to be presented at 1998 *International Conference on Image Processing*, Chicago Il., October 1998.

Belge, Miller and Miller, Eric L. "Wavelet Domain Bayesian Image Restoration Using Edge Preserving Prior Models," to be presented at 1998 *International Conference on Image Processing*, Chicago Il., October 1998.

Belge, Murat and Miller, Eric L., and Kilmer, Misha, "Simultaneous Multiple Regularization Parameter Selection By Means of the L-Hypersurface with Applications to Linear Inverse Problems Posed in the Wavelet Transform Domain," to be presented at *SPIE International Symposium on Optical Science, Engineering, and Instrumentation: Bayesian Inference for Inverse Problems*, San Diego, July 1998.

Rappaport, Carey M., Marengo, Edwin, and Miller, Eric L. "Conductivity Profile Optimization for the PML ABC in FDFD ," submitted for consideration for presentation at 1998 *Progress in Electromagnetics Symposium*, Nantes, France, July 1998.

Johansen, Peter, Miller, Eric L., and Devaney, Anthony J. "Electromagnetic Inversion for Multi-Bistatic Ground Penetrating Radar," to be presented at 1998 *Progress in Electromagnetics Symposium*, Nantes, France, July 1998.

Miller, Eric L., Karl, W. C. "On the detection of buried objects from inductive arrays," to be presented at 1998 *Progress in Electromagnetics Symposium*, Nantes, France, July 1998.

Sahin, Adnan and Miller, Eric L. "High resolution processing algorithms for near field object detection: Performance bounds and sensitivity analyses," to be presented at 1998 *Progress in Electromagnetics Symposium*, Nantes, France, July 1998.

Raemer, H., Rappaport, C. M. , and Miller, E. L., Frequency domain simulation of focused array radar returns from buried mines in clutter," *SPIE AeroSense Symposium, Detection Technologies for Mines and Minelike Targets*, Orlando Fl., April 1997.

Miller, Eric L., Karl, W. C. , and Norton, Stephen J. ,"On the detection of buried mines from multifrequency, inductive measurements," *SPIE AeroSense Symposium, Detection Technologies for Mines and Minelike Targets*, Orlando Fl., April 1997.

Sahin, Adnan and Miller, Eric L. ,"Performance and sensitivity analyses in multiple object detection using high-resolution array processing," *SPIE AeroSense Symposium, Detection Technologies for Mines and Minelike Targets*, Orlando Fl., April 1997.

Raemer, H., and Miller, Eric L., "Signal Processing for Sub-Surface Object Detection," APS-URSI Meeting, Montreal, CA, July 1997.

(Invited talk) Miller, Eric L., Nicolaides, Lena, and Mandelis, Andreas, "Nonlinear Inverse Scattering Methods for Thermal Wave Diffraction Tomography." Third International Workshop Advances in Signal Processing for Non Destructive Evaluation of Materials, Quebec, CA, August, 1997.

(Invited talk) Sahin, Adnan, and Miller, Eric L., "Efficient T-Matrix Methods for GPR Forward Modeling," Progress in Electromagnetics Symposium in Boston, MA, July 1997.

(Invited talk) Sahin, Adnan, and Miller, Eric L., "GPR Localization of Buried, Multiple Objects Using High Resolution Array Processing," Progress in Electromagnetics Symposium in Boston, MA, July 1997.

(Invited talk) Miller, Eric L., Nicolaides, Lena, and Mandelis, Andreas, "Reduced Complexity, Newton-Type Methods for Nonlinear Inverse Scattering Problems," Progress in Electromagnetics Symposium in Boston, MA, July 1997.

Miller, Eric L., "Efficient methods for the solution and analysis of statistical linear inverse problems in the wavelet transform domain," *Conference on Information Sciences and Systems*, Baltimore Maryland, March 1997.

Dufour, Roger M. and Miller, Eric L., "Statistical Estimation with $1/f$-Type Prior Models: Robustness to Mismatch and Efficient model Determination," ICASSP 96, Atlanta, GA, May 1996.

Şahin, Adnan, and Miller, Eric L., "Object-based localization of buried metallic scatterers using high-resolution array processing techniques," *SPIE AeroSense Symposium, Detection Technologies for Mines and Minelike Targets II*, Orlando Fl., April 1996.

Miller, Eric L., "A Scale-Recursive, Statistically-Based Method for Anomaly Characterization in Images Based upon Observations of Scattered Radiation," the *Second International Conference on Image Processing*, Washington D.C., November 1995.

Miller, Eric L. and Willsky, Alan S., "Wavelet-Based, Stochastic Inverse Scattering Methods Using the Extended Born Approximation," (invited paper) presented at the *Progress in Electromagnetics Research Symposium*, Seattle, Washington, July, 1995.

Miller, Eric L. and Willsky, Alan S., "A Multiscale, Decision-Theoretic Algorithm for Anomaly Detection in Images Based upon Scattered Radiation," presented at the *First International Conference on Image Processing*, Austin, Texas, November 1994.

Miller, Eric L. and Willsky, Alan S.,"Wavelet Transforms and Multiscale Statistical Modeling Techniques for the Solution of Multisensor Inverse Problems, " *SPIE*

International Symposium on OE/Aerospace Sensing, Wavelets Applications Conference, Orlando, FL, 1994.

Miller, Eric *et al.*, "Multiresolution Signal Processing" (abstract only) presented at *The IMA Conference on Multiscale Stochastic Processes Analyzed using Multifractals and Wavelets*, Cambridge England, March, 1993.

Miller, Eric L. and Willsky, Alan S., "A Multiscale Approach to the Solution of One Dimensional Linear Inverse Problems" presented at *The IEEE-SP Symposium on Time-Frequency and Time-Scale Analysis*, Victoria, BC, Canada, October, 1992.

Technical Reports

Miller, Eric L., "Efficient Computational Methods for Wavelet Domain Signal Restoration Problems ," Northeastern University, Boston MA, CDSP Center Report TR-CDSP-97-41, February, 1997.

Miller, Eric L., "Statistically Based Methods for Anomaly Characterization in Images from Observations of Scattered Radiation," Northeastern University, Boston MA, CDSP Center Report TR-CDSP-96-35, January, 1996.

Grants and Contracts Awarded

"Wavelet-Based Signal Processing Methods for Automatic Target Recognition," submitted to Textron Systems Division, Wilmington MA by Prof. Eric Miller and Dr. Charles DiMarzio. Awarded in January, 1998. Level of Funding: This proposal represents a $70000 membership for Textron in the Center for Electromagnetics Research at Northeastern University for the 1998 fiscal year. Of this total, $35,000 will support Prof. Miller's research program.

"The Evaluation of Wavelet Transforms for Improved Damocles Clutter Rejection," submitted to Textron Systems Division, Wilmington, MA by Prof. Eric Miller. Awarded: August 1997. Level of funding: $40000 for the 1997-1998 academic year.

"Wavelet-Based Signal Processing Methods for Automatic Target Recognition," submitted to Textron Systems Division, Wilmington MA by Profs. Eric Miller, Carey Rappaport, and Dr. Charles DiMarzio. Awarded in January, 1997. Level of Funding: This proposal represents a $75000 membership for Textron in the Center for Electromagnetics Research at Northeastern University for the 1997 fiscal year. Of this total, $25,000 will support Prof. Miller's research program.

"An Integrated Approach to the Detection, Localization, and Classification of Mines," submitted to the Army Research Office (ARO) under the Multidisciplinary University Research Initiative (MURI) as a CO-PI with Prof. Carey Rappaport (PI) and a dozen other faculty from 4 universities and four industrial partners. Awarded in February, 1997. Level of funding: Total of $5 million over 5 years. Prof. Miller will receive approximately $90,000 in salary and support for 1 graduate student over this time period.

"An Integrated Approach to the Study of Inverse Methods in Electrical Engineering," submitted to NSF CAREER Award, MIPS Program by Prof. Eric Miller. Awarded in August, 1996. Total level of funding: $200,000 over 4 years.

"Anomaly Detection and Localization in Three Dimensions" submitted to the Northeastern College of Engineering for summer 1996 graduate student support through the Bellamy Philip Memorial Fund for Engineering. Awarded in June, 1996. Level of funding: $5000 to support graduate student research during the summer of 1996.

"Integrated Reduced Target Automatic Target Recognition," submitted to Multidisciplinary University Research Initiate Program as a Co-PI with Prof. W. Clem Karl (Boston University, PI) and roughly a dozen other faculty from Boston University, Northeastern, MIT, University of Minnesota, NYU, and Stanford University. Awarded in June, 1995. Level of funding: approx. $5 million over 5 years of which about $325,000 supported Prof. Miller's research program.

"Enhanced Research in Ground-Penetrating Radar and Multi-Sensor Fusion with Applications to the Detection and Visualization of Buried Waste," submitted by Prof. Eric Miller (Co-PI) and six other investigators from Northeastern University's Center for Electromagnetic Research. Awarded: April 1995. Level of funding: $200,000 of which about $25,000 supported Prof. Miller's research program.

Teaching Activities

Courses taught:

1. ECE 1333: Linear Systems II
2. ECE 1733: Linear System II, honors section
3. ECE 1456, Digital Signal Processing (Undergraduate level)
4. ECE 1234, Digital Signal Processing Laboratory (Undergraduate level)
5. ECE 3557, Special Topics in Signal Processing: Filter Banks and Wavelets
6. GE 1101, Engineering Problem Solving and Computation
7. GE 1001, Introduction to Engineering
8. ECE 3557, Special Topics in Signal Processing: Inverse Problems in Engineering and the Applied Sciences.
9. ECE 3321: Digital Signal Processing (Graduate level)
10. ECE 3558: Digital Filter Banks and Wavelets

Graduate Student Advising

Ph.D. Students

1. Adnan Sahin. Thesis title: *Near Field Forward Scattering, and Object-Based Localization Algorithms for Subsurface Objects.* Expected graduation date: August 1998.
2. Murat Belge. Thesis title: *Multiscale and Curvature Methods for the Regularization of Linear Inverse Problems.* Expected graduation date: June 1999.
3. Roger Dufour. Thesis topic: Multiscale, decision-directed methods for image segmentation with applications to automatic target recognition in IR and SAR imagery
4. W. Scott Hoge. Thesis topic: Adaptive signal processing methods for Magnetic Resonance Imaging
5. Xiaoyin Xu. Thesis topic: Detection localization, and imaging of buried objects from scattered field data.

MS Students

1. Roger Dufour. Thesis title: *Statistical Estimation with 1/f-Type Models.* Graduation date: May, 1997.
2. Tzipora Halevi. Thesis title: *Statistical Methods for Object Detection in a Three Dimensional Volume.* Graduation date: August, 1997.

MS Projects

1. Xiaoyin Xu. Project title: *Modeling and detection methods for rapidly moving objects.* Graduation date: March, 1998.
2. Pengyu Shi. Project title: *Recursive processing methods for object detection and shape determination from laser-induced acoustic scattering data.* Expected graduation date: June, 1999.
3. Ibrahim Yavuz. Project title: *Layer tripping models and methods for thermal wave depth profilometry.* Expected graduation date: June, 1999.

Service to ECE Dept.

Member of the Ph.D. Qualifying exam committee: 1994–1995.

Member of the Ph.D. Qualifying exam committee: 1995–1996.

Member of graduate affairs committee: 1995–1996.

Member of circuits and systems sub-committee for the revision of the undergraduate curriculum: 1995–1996.

Member of departmental computer advisory committee: 1996–1997

Member of graduate affairs committee: 1996–1997

Member of graduate affairs committee: 1997–1998

Member of ECE Chair Search Committee: 1997–1998.

Director of Computing Facilities for Communications and Digital Signal Processing Lab. 1997

Organizer of Seminar Series for Communications and Digital Signal Processing Laboratory: Winter/Spring 1998.

Professional Service

Technical reviewer for

1. *IEEE Transactions on Signal Processing*
2. *IEEE Transactions on Image Processing*
3. *IEEE Transactions on Antennas and Propagation*
4. *IEEE Transactions on Microwave Theory and Techniques*
5. *IEEE Transactions on Geoscience and Remote Sensing*
6. *IEE Proceedings on Image, Vision and Signal Processing*
7. *Journal of the Acoustic Society of America*
8. *Applied Optics*
9. *Electron Letters*
10. 1998 International Conference on Image Processing

Reviewer for text *Introduction to Wavelets and Wavelet Transforms: A Primer*, by C. Sidney Burrus, Ramesh A. Gopinath, and Haitao Guo, Prentice Hall, 1998.

Delivered October 1996 talk at the Boston section of the IEEE Geoscience and Remote Sensing Society entitled, "High Resolution Array Processing Methods For Buried Object Detection"

Delivered invited lecture at University of Rhode Island Electrical Engineering Seminar Series in January 1996. The talk was entitled "A Multiscale And Stochastic Signal Processing Approach To Inverse Scattering Problems."

Delivered invited talk at the Center for Interdisciplinary Research in Complex Systems at Northeastern University in February 1996 entitled "A Multiscale And Stochastic Signal Processing Approach To Inverse Scattering Problems."

Delivered December 1995 talk at the Boston section of the IEEE Signal Processing Society. entitled, "A Multiscale And Stochastic Signal Processing Approach To Inverse Scattering Problems."

Treasurer, Boston Section of IEEE, 1996–1997.

Chairman of the "Electromagnetics Methods I" session at *SPIE AeroSense Symposium, Detection Technologies for Mines and Minelike Targets*, Orlando, FL., April 1998.

Chairman of the "Imaging Holography and Tomography" session at *Progress in Electromagnetics Research Symposium*, Boston, MA, July 1997.

Member of technical program committee, *Progress in Electromagnetics Research Symposium*, Boston, MA, July 1997.

Honors and Awards

Recipient, National Science Foundation Faculty Early Career Development (CAREER) Award, 1996–2000.

Recipient, Air Force Office of Scientific Research Graduate Fellowship 1992-1995.

Recipient, Schlumberger - Doll Research Fellowship 1991-1992.

Member, MIT Chapters Tau Beta Pi, Phi Beta Kappa, Eta Kappa Nu Honor Societies

Academic and Professional Activities

Member, IEEE, 1995-present

Student Member, IEEE, 1991–1994