

RADU VICTOR BALAN

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Education

- June 1998** **Princeton University, NJ**
Ph.D. in Applied and Computational Mathematics
Thesis: *A Study of Weyl-Heisenberg and Wavelet Frames*
Advisor: Ingrid Daubechies
- July 1994** **University of Bucharest, ROMANIA**
B.S. in Physics
Thesis: *Applications of Quantum Group Theory to Atomic Physics*
Advisor: Andrei Ludu
- September 1992** **Polytechnic Institute of Bucharest, ROMANIA**
B.S. in Electrical Engineering
Thesis: *The Disturbance Decoupling Problem and Stability*
Advisors: Andrea Bacciotti (Politecnico di Torino), Vlad Ionescu

Employment

- 2007-present** **University of Maryland, College Park, MD**
Associate Professor
- 2006-2007** **Siemens Corporate Research, Princeton NJ**
Senior Research Scientist (Senior Member of Technical Staff)
- 1999-2006** **Siemens Corporate Research, Princeton NJ**
Research Scientist (Member of Technical Staff)
- 1998-1999** **Institute of Mathematics and Its Applications, Minnesota MN**
IBM T.J. Watson Research Center, Hawthorn NY
Postdoctoral Associate

Visits to other research institutions

- Erwin Schrödinger Institute, Vienna (May 2005)
- Princeton University, NJ sabbatical (February – April 2005)
- Texas A & M, TX, visiting David Larson (November 1997, July 1999, July 2002)

Teaching Experience

- Spring 2005,2006** **Princeton University, PACM, Princeton NJ**
Lecturer – Wavelets and Time-Frequency Analysis (APC584/MAT594)

1997-1998

Princeton University, PACM, Princeton NJ

Teaching Assistant – Probability and Stochastic Systems (CIV309)

1992-1994

Polytechnic University of Bucharest, EE, Bucharest Romania

Teaching Assistant – Linear and Nonlinear Systems Theory (300 level)

Editorial Work

- **Editorial Advisory Board Member** of Journal of Applied and Computational Harmonic Analysis (since June 2005)
- **Guest Editor** of special issue of the EURASIP's Journal on Applied Signal Processing on "Frame theory in signal processing, communications, and information theory", Q4 of 2005

Conference/Session Organizer

- **Workshop Organizer:** "Mathematical Modeling in Industry", IMA, Minneapolis, MN, August 9-17, 2007.
- **General Conference Chair:** IEEE Sarnoff 2007
- **Program committee member and Special Session Organizer** for SPIE 2005 Joint Meeting – Wavelet Conference, August 2005; SPIE 2007
- **Program committee member and Tutorials Chair** for the IEEE Sarnoff 2005 Symposium, April 2005; **Technical Program co-Chair**, IEEE Sarnoff 2006
- **Siemens-Princeton MRI Data Processing Workshop co-organizer**, June 2005
- **Siemens-Princeton Wireless Communications Workshop co-organizer**, February 2005
- **Program Committee member:** since its inception SPIE's Wavelet Applications in Industrial Processing Conference (2003, 2004, 2005, 2006); ICA 2006; Globecom 2006

Industrial Advisory Boards

- **CAIP (Rutgers University):** 2002, 2003
- **EE Princeton University:** 2005

Invited Talks

Conferences

- January 2006: Special Session on Wavelets, Frames, and Gabor analysis, AMS Meeting, San Antonio, TX
- August 2005: SPIE Wavelets XI, San Diego, CA
- May 2005: Erwin Schrödinger Institute, Vienna, Austria; Workshop on Modern Time-Frequency Methods, Strobl, Austria
- September 2004: European Signal Processing Conference, Vienna, Austria: EUSIPCO 2004
- May 2004: 2nd International Conference on Computational Harmonic Analysis, Nashville, TN
- October 2003: WASPAA 2003, Mohonk, New Paltz, NY
- July 2003: IEEE International Conference on Multimedia and Expo, ICME 2003, Baltimore, MD
- May 2003: International Workshop on Sampling Theory and Applications, SampTA 2003, Strobl, Austria
- April 2003: 4th International Symposium on Independent Component Analysis and Blind Source Separation, ICA 2003, Nara, Japan
- April 2003: International Conference on Acoustics, Speech, and Signal Processing, ICASSP 2003, Hong Kong, China
- March 2003: Conference on Information Sciences and Systems, CISS 2003, Baltimore, MD
- January 2003: Special Session on Frames, Wavelets, and Operator Theory, 2003 AMS-MAA Meeting, Baltimore, MD

- August 2002: International Workshop on Operator Theory and Applications, IWOTA 2002, Blacksburg, VA
- August 2002: 2nd IEEE Workshop on Multisensor Signal Processing, SAM 2002, Rosslyn, VA
- May 2002: DIMACS Workshop on Harmonic Analysis and Source Coding, DIMACS, Rutgers University, NJ
- March 2002: Special Session on Wavelets, Frames and Gabor Analysis, AMS-MAA Regional Meeting, Atlanta, GA
- December 2001: 2nd International Gabor Symposium on Harmonic Analysis and Signal Processing, Vienna, Austria
- August 2001: Conference on Wavelet Applications in Signal and Image Processing, within SPIE 2001 Conference, San Diego, CA
- October 2000: Regional AMS Meeting, Birmingham, AL
- August 2000: Conference on Wavelet Applications in Signal and Image Processing, within SPIE 2000 Conference, San Diego, CA
- June 2000: 2nd International Conference on Independent Component Analysis and Blind Source Separation, Helsinki, Finland
- March 2000: Conference on Information Sciences and Systems, Princeton, NJ
- January 1999: Special Session on the Functional and Harmonic Analysis of Wavelets, AMS-MAA Meeting, San Antonio, TX
- January 1998: Special Session on Inverse Problem and Signal Processing, AMS-MAA Meeting, Baltimore, MD
- January 1997: Special Session on Wavelets, Multi-Wavelets and their Applications, AMS-MAA Meeting, San Diego, CA

Selected Colloquium/Seminars

- April 2007: University of Maryland, College Park, MD
- February 2007: University of Toronto, Toronto, CA
- February 2006: University of Texas at Dallas, Dallas, TX
- October 2005: Princeton University, Brown Bag Seminar, Princeton, NJ
- September 2005: Courant Institute of Mathematics, NYU, New York City, NY
- March 2005: Princeton University, EE, Princeton, NJ
- May 2004: Courant Institute of Mathematics, NYU, New York City, NY
- September 2002: University of Missouri, Department of Mathematics, Columbia, MO
- July 2002: College Station, TX
- November 2001: University of Minnesota, Institute of Mathematics and Its Applications, Minneapolis, MN
- October 2001: University of Maryland, College Park, MA
- October 2000: Georgia Institute of Technology, Department of Mathematics, Atlanta, GA
- January 2000: Drexel University, Department of Mathematics, Philadelphia, PA
- July 1999: College Station, TX

Mentoring/Supervising

- **PhD committee member and thesis reader** for Scott Rickard, Princeton University 2003; **thesis reader** for Cliona Golden, Princeton University 2005.
- 2000-2006: Supervised around 2 intern and summer students (BS and PHD) every year

Journal refereed for

Applied Mathematics: Applied and Computational Harmonic Analysis, Advanced Computational Mathematics, Constructive Approximations, Journal of Fourier Analysis and Applications, Linear Algebra and Applications, Journal of Approximation Theory, Journal of

Functional Analysis, Proceedings AMS, Transactions AMS, Journal of Sampling Theory in Signal and Image Processing

Engineering: IEEE Transactions on Speech and Audio Processing, Image Processing, Signal Processing, Information Theory, Signal Processing Letters, Pattern Analysis and Machine Intelligence; Journal of Applied Signal Processing, Computational Geometry Theory and Applications, Systems and Control Letters

Professional Societies

- AMS, IEEE (Senior Member)

List of Publications

Journal Papers and Book Chapters

24. R.Balan, Z.Landau, *Measure functions for frames*, Journal of Functional Analysis, 252 (2007), 630-676
23. R.Balan, *A Noncommutative Wiener Lemma and A Faithful Tracial State on Banach Algebra of Time-Frequency Operators*, Trans.Amer.Math.Soc., posted on January 11, 2008, S 0002-9947(08)04448-6 (to appear in print)
22. R.Balan, P.G.Casazza, D.Edidin, *Equivalence of Reconstruction from the Absolute Value of the Frame Coefficients to a Sparse Representation Problem*, IEEE Sig.Proc.Letters. vol.14, no.5 (2007), 341-343
21. F.Meshkati, H.V.Poor, S.C.Schwartz, R.Balan, *Energy-Efficient Resource Allocation in Wireless Networks with Quality-of-Service Constraints*, to appear in IEEE Trans. on Communications (2008)
20. R.Balan, P.G.Casazza, D.Edidin, G.Kutyniok, *A New Identity for Parseval Frames*, Proc. Amer. Math. Soc., 135 (2007), 1007-1015
19. R.Balan, P.G.Casazza, C.Heil, Z.Landau, *Density, Overcompleteness, and Localization of Frames. II Gabor Frames*, J.Fourier Anal. Applic., Vol.12, No. 3, (2006) 309-344
18. R.Balan, P.G.Casazza, C.Heil, Z.Landau, *Density, Overcompleteness, and Localization of Frames. I Theory*, J.Fourier Anal. Applic., Vol.12, No.2, (2006) 105-143
17. R. Balan, P.G. Casazza, D. Edidin, *On Signal Reconstruction without Noisy Phase*, Appl. Comput. Harmon. Anal., 20 (2006) 345-356
16. S. Rickard, R. Balan, H.V. Poor, S. Verdu, *Canonical time-frequency, time-scale, and frequency-scale representations of time-varying channels*, J. Comm. Infor. Syst., Vol. 5, No. 5, (2005) 1-30
15. R. Balan, J. Rosca, S. Rickard, *Equivalence Principle for Optimization of Sparse versus Low-Spread Representations for Signal estimation in Noise*, International Journal of Imaging Systems and Technology, vol.15, no.1, (2005) 10-17
14. R. Balan, P.G. Casazza, C. Heil, Z. Landau, *Excesses of Gabor Frames*, Appl. Comput. Harmon. Anal. , vol. 14, (2003) 87-106
13. R. Balan, P. Casazza, C. Heil, Z. Landau, *Deficits and Excesses of Frames*, Advances in Computational Mathematics, vol. 18, (2003) 93-116
12. R. Balan, I. Daubechies, *Optimal Stochastic Approximations and Encoding Schemes using Weyl-Heisenberg Sets*, chapter in "Gabor Analysis: Theory and Applications", Eds. H.Feichtinger and T.Strohmer, Birkhauser 2002.
11. R. Balan, I. Daubechies, V. Vaishampayan, *The Analysis and Design of Windowed Fourier Frame based Multiple Description Source Coding Schemes*, in IEEE Trans.on IT, vol.46, no.7, (2000) 2491-2537
10. R. Balan, G. Taubin, *3D Mesh Geometry Filtering Algorithms for Progressive Transmission Schemes*, Computer-Aided Design, vol.32, no.13, (2000) 825-846 in the Special Issue of Journal of CAD on Multiresolution Geometric Models (2000)
9. R. Balan, *Density and Redundancy of the Noncoherent Weyl-Heisenberg Superframes*, Contemporary Mathematics , AMS Providence R.I. (1999),
8. R. Balan, *Equivalence Relations and Distances between Hilbert Frames*, Proceedings of the AMS, vol.127 no.8, (1999) 2353-2366

7. R. Balan, *Extensions of No-Go Theorems to Many Signal Systems*, Contemporary Mathematics 216, AMS Providence R.I. (1998), 3-14
6. R. Balan, *An Uncertainty Inequality for Wavelet Sets*, Appl. Comput. Harmon. Anal., Vol.5, No.1, (1998) 106-108
5. R. Balan, *Stability Theorems for Fourier Frames and Wavelet Riesz Bases*, J.Fourier Anal. Applic., Vol.3, No.5, (1997), 499-504
4. R. Balan, *Horseshoe and Analytic Nonintegrability of a Spinless Axiallysymmetric Rigid Body in Central Newtonian Field*, Celestial Mechanics and Dynamics Astronomy, vol.63 (1995), 59-79
3. R. Balan, D. Aur, *An On-Line Robust Stabilizer*, Journal in Guidance, Control and Dynamics, (18) no.3, (1995), 642-644
2. R. Balan, *Homogeneous Polynomial Approximations of Nonlinear Control Systems*, Revue Roumaine de Science Techniques, serie Electrotechnique et Energetique, (39) no.4, (1994), 503-511
1. R. Balan, *A Note about Integrability of Distributions with Singularities*, Bollettino U.M.I. (7) 8-A (1994), 335-344

Peer Reviewed Conference Proceedings (Selected papers are highlighted)

35. R.Balan, *Estimator for Number of Sources using Minimum Description Length Criterion for Blind Sparse Source Mixtures*, ICA 2007, London, UK, Sept. 2007.
34. R.Balan, B.G.Bodmann, P.G.Casazza, D.Edidin, *Painless Reconstruction from Magnitudes of Frame Coefficients*, SPIE Wavelets Applications in Signal and Image Processing XII, Aug. 2007.
33. N.Fan, J.Rosca, R.Balan, *Speech Noise Estimation using Enhanced Minima Controlled Recursive Averaging*, ICASSP 2007, Hawaii, USA, April 2007.
32. F.Meshkati, H.V.Poor, S.C.Schwartz, R.Balan, *Energy-Efficient Power and Rate Control with QoS Constraints: A Game-Theoretic Approach*, Int. Wireless Comm. Mobile Comp. (IWCMC) Conf. 2006 - Cross-Layer Design and Protocols, Vancouver, Canada, July 2006.
31. R. Balan, J. Rosca, *Source Separation using Sparse Discrete Prior Models*, ICASSP 2006, Toulouse, France, May 2006.
30. R. Balan, J. Rosca, *Convolutive Demixing with Sparse Discrete Prior Models for Markov Sources*, Proc. ICA 2006, Charleston SC USA, March 2006.
29. N.Fan, J.Rosca, R.Balan, *Speaker Identification with Combined Threshold Identification Front-End & UBM*, 4th IEEE Workshop on Automatic Identification Advanced Technology (AutID 2005), Buffalo NY 2005.
28. P. Casazza, R. Balan, D. Edidin, G. Kutyniok, "Decomposition of frames and a new frame identity", SPIE Wavelets Applications in Signal and Image Processing XI, vol. 5914, (2005)
27. R. Balan, P. Casazza, C. Heil, Z. Landau, "Excess of Parseval frames", SPIE Wavelets Applications in Signal and Image Processing XI, vol. 5914, (2005)
26. R. Balan, P. Casazza, D. Edidin, "On signal reconstruction from absolute value of frame coefficients", SPIE Wavelets Applications in Signal and Image Processing XI, vol. 5914, (2005)
25. B. Grundlehner, J.Lecocq, R.Balan, J.Rosca, *Performance Assessment Method for Speech Enhancement Systems*, SPS-DARTS 2005, Antwerp, Belgium, April 2005.
24. N. Fan, R. Balan, J. Rosca, *Comparison of Wavelet and FFT based Single Channel Speech Signal Noise Reduction Techniques*, SPIE Industrial Applications of Wavelets Conference 2004, Philadelphia, PA, October 2004.
23. R. Balan, H.V. Poor, S. Rickard, S. Verdu, *Time-Frequency and Time-Scale Canonical Representations of Doubly Spread Channels*, EUSIPCO 2004, Vienna, Austria, September 2004.
22. L.Hong, J.Rosca, R.Balan, *Bayesian Single Channel Speech Enhancement Exploiting Sparseness in the ICA Domain*, EUSIPCO 2004, Vienna, Austria, September 2004.
21. R.Balan, J.Rosca, C.Beaugeant, V.Gilg, T.Fingscheidt, *Generalized Stochastic Principle for Microphone Array Speech Enhancement and Applications to Car Environments*, EUSIPCO 2004, Vienna, Austria, September 2004.

20. J. Rosca, C. Borss, R. Balan, *Generalized Sparse Signal Mixing Model and Application to Noisy Blind Source Separation*, ICASSP 2004, Montreal, Canada, May 2004
19. S. Rickard, C. Fearon, R. Balan, J. Rosca, *MINUET: Musical Interference Unmixing estimation Technique*, in Proceedings of CISS 2004, Princeton NJ, March 2004
18. J. Rosca, R. Balan, C. Beaugeant, *Multi-Channel Psychoacoustically Motivated Speech Enhancement*, ICASSP 2003, Hong Kong China, April 2003
17. R. Balan, J. Rosca, S. Rickard, *Scalable Non-Square BSS in the Presence of Noise*, ICASSP 2003, Hong Kong China, April 2003
16. J. Rosca, R. Balan, S. Rickard, *Scalable Audio Source Separation in the Presence of Noise*, DAGA 2003, Aachen Germany, June 2003.
15. R. Balan, J. Rosca, S. Rickard, *Non-square BSS under Coherent Noise by Beamforming and Time-Frequency Masking*, ICA 2003, Nara Japan, April 2003
14. S. Rickard, R. Balan, J. Rosca, *Blind Source Separation based on Space-Time-Frequency Diversity*, ICA and BSS Conference 2003, Nara Japan, April 2003
13. R. Balan, J. Rosca, S. Rickard, *A Stochastic Speech Model Supporting W-Disjoint Orthogonality*, CISS 2003, Baltimore MD, March 2003
12. J. Rosca, R. Balan, N. Fan, C. Beaugeant, V. Gilg, *Multichannel Voice Detection in Adverse Environments*, EUSIPCO 2002, Toulouse FRANCE, September 2002
11. R. Balan, J. Rosca, *Microphone Array Speech Enhancement by Bayesian Estimation of Spectral Amplitude and Phase*, IEEE Sensor Array and Multichannel Signal Processing Workshop, Rosslyn VA, Aug. 2002
10. S. Aalburg, C. Beaugeant, S. Stan, T. Fingscheidt, R. Balan, J. Rosca, *Single- and Two-Channel Noise Reduction For Robust Speech Recognition in Car*, ISCA Workshop, GERMANY, June 2002
9. R. Balan, J. Rosca, S. Rickard, *Robustness of Parametric Source Demixing in Echoic Environments*, ICA and BSS Conference, San Diego, CA, December 2001
8. J. Rosca, N. Fan, R. Balan, *Real-Time Audio Source Separation by Delay and Attenuation Compensation in the Time Domain*, ICA and BSS Conference, San Diego, CA, December 2001
7. S. Rickard, R. Balan, J. Rosca, *Real-Time Time-Frequency Based Blind Source Separation*, ICA and BSS Conference, San Diego, CA, December 2001
6. J. Rosca, S. Sudarsky, R. Balan, D. Comanicu, *Mobile Interaction with Remote Worlds: The Acoustic Periscope*, IJCAI 2001.
5. R. Balan, J. Rosca, *Statistical Properties of STFT Ratios for Two Channel Systems and Applications to Blind Source Separation*, ICA and BSS Conference 2000, Helsinki, FINLAND, June 2000
4. R. Balan, *Topological Obstructions to Localization Results in Wavelets Applications in Signal and Image Processing VIII*, vol. 4478, (2001) 184-192
3. R. Balan, *Multiplexing of Signals using Superframes in Wavelets Applications in Signal and Image Processing VIII*, vol.4119, (2000) 118-129
2. R. Balan, J. Rosca, S. Rickard, J.O' Ruanaidh, *The Influence of Windowing on Time Delay Estimates*, CISS 2000, Princeton NJ, March 15-17 2000
1. R. Balan, A. Jourjine, J. Rosca, *AR processes and sources can be reconstructed from degenerate mixtures*, ICA and BSS Conference, Aussois France, January 11-15 1999, 467-472

Issued Patents

1. "Separation of AR Sources from their Single Channel Measurement", US Patent # 6,343,268, January 29, 2002
- 2,3. "Optimal ratio estimator for multisensor systems", US Patent # 6,577,966, June 10, 2003, and US Patent # 6,868,365, Mar 15, 2005
4. "Method of denoising signal mixtures", US Patent # 6,901,363, May 31, 2005
5. "Online Blind Source Separation", US Patent # 6,954,494, October 11, 2005
- 6,7. "Method and Apparatus for Noise Filtering", US Patent # 6,952,482, October 4, 2005, and US Patent # 7,110,944, September 19, 2006

8. "Apparatus and Method for Estimating the Direction of Arrival of a Source Signal using a Microphone Array", US Patent # 7,084,801, August 1, 2006
 9. "Real-Time Audio Source Separation by Delay and Attenuation Compensation in the Time Domain", US Patent # 7,088,831, August 8, 2006
 10. "Multichannel voice detection in adverse environments", US Patent# 7,146,315, December 5, 2006
 11. "System and method for remotely experiencing a virtual environment", US Patent# 7,149,691, December 12, 2006
 12. "Multi-channel speech enhancement system and method based on psychoacoustic masking effects", US Patent# 7,158,933, January 2, 2007
 13. "System and Method for Adaptive Multi-Sensor Arrays", US Patent# 7,218,741, May 15, 2007
 14. "Method for Eliminating an Unwanted Signal from a Mixture Via Time-Frequency Masking", US Patent# 7,302,066, November 27, 2007
 15. "System and method for nonlinear signal enhancement that bypasses a noisy phase of a signal", US Patent# 7,392,181, June 24, 2008
- About 10 more Patent Applications.

SELECTED PAST AND CURRENT RESEARCH PROJECTS

(Numbers between brackets refer to my publication list, P for papers, C for conferences)

FRAMES (1995-present)

1. *Localization*: [C4, P12]
Localization of frames is one topic dear to my heart. I presented in [C4] an algebraic topology argument to no-go theorems of the Gabor analysis. In [P12] we obtained other forms of such a behavior.
2. *Stochastic Signals*: [P12]
We analyzed the approximation problem of stochastic signals in [P12]. There we constrained the Karhunen-Loev approximation to time-frequency invariant subspaces. In the process we obtained new localization results in Gabor analysis.
3. *Redundancy of Abstract Frames*. [P9, C3]
Jointly with Zeph Landau (CCNY) we formalize the notion of frame redundancy using abstract ultrafilter constructs and we studied topological and algebraic properties of this notion. Its conclusions were validated by the third paper recently submitted of our collaboration with Pete Casazza (U.Missouri) and Chris Heil (GaTech).
4. *Excess, Density and Localization of Frames*. [P13, P14, P18, P19]
Frame excess is defined as the number of vectors that can be removed and leave the set complete. But does the set remain frame? We analyzed this concept and gave answer to this and other question for general frame, Weyl-Heisenberg and wavelet frames. For Weyl-Heisenberg frames we discovered a new density-redundancy relation which has far-reaching applications. In [P18, P19] we introduced a concept of localization, similar to the one used by Karl-Heinz Groechenig (U.Vienna), and showed its usefulness in our excess related problems.
5. *Nonlinear Reconstruction from the Modulus of Frame Coefficients*. [P17, P20, PPA]
This project started from an academic curiosity (how much information is lost when passing to real cepstral coefficients, and in general how much information is in signal phase), but eventually evolved into a new direction. During the winter of 2003-2004 (January 2004) I had the visit of Pete Casazza who helped us obtaining new results along this question: when can a signal be reconstructed from the modulus of its frame coefficients. As a result of this research we filled a patent [PPA] and completed a conference [C22] and journal [P17] paper. Recently [C24], and subsequently submitted papers, we extended this work back into the general frame theory.

Stochastic Modeling and Control of WLAN (2006-present):

This research project with direct application to Siemens Communication business is focused on two aspect of 802.11 WLANs:

- MAC Layer Modeling of Channel Access, in particular estimating collision vs. bad channel packet loss probabilities
- Network Control (Management) for Link Adaptation, Load Balancing, Admission Control

Audio-Video based Person Recognition System (2005-2006):

In this research project two components were fused together in a statistically principled manner:

- Text-dependent speaker identification/verification component
- Face detection and recognition

Separately I worked also on a text-independent speaker ID component [C29] using non-MFCC features.

Time-Frequency and Time-Scale Analysis of Communication Channels (2003-present):

[P16,C20]

This research is joint with several people: Scott Rickard (SCR/University College Dublin), Vincent Poor (Princeton), Sergio Verdu (Princeton), Thomas Strohmer (U.C.Davis).

In a nut-shell, while most engineering and mathematics papers deal with a integral superposition of time-frequency shift operators (Weyl quantization/Time-varying channel models), we proposed a superposition of time-scale shifts. We obtained several results:

- Not all integral operators can be represented this way; the structure problem still remains an issue
- We obtained a canonical representation of the channel using discrete atoms on a time-scale lattice (or quasi-lattice).

Power Control in Wireless LAN (2004-2005) [P21,C32]:

This research project is jointly with Vincent Poor and his student Farhad Meshkati (Princeton). The problem is to find the degrees of freedom available in 802.11 WLANs and leverage these parameters to achieve an optimum use of power, subject to real-time streaming constraints for audio and video packets.

Multiple Description Coders for VoIP (2003-2004):

Based on my previous experience with the multiple description problem (joint paper with I.Daubechies (Princeton) and V.Vaishampayan (AT&T) [P11]) , I built a scalar coder that has been used in Voice over IP experiments. The basic problem is to encode a frame (window) of samples into two separate packets that can be sent independently to destination through the network. The receiver is able to partially reconstruct the signal even if only one packet (description) arrives.

Microphone Array Speech Enhancement (2001-2004): [C21,C17,C11,C10,PPA]

Simply stated the goal of this project was to enhance speech quality when given an array of microphones. Several issues were studied along:

- How to measure speech quality, and among different objective criteria how do they correlate with the perceptual quality, or recognition rates.
- To optimally process microphone array signals we proved a separation principle that simplified the overall architecture, and, in fact, saved one of our customer money.
- I developed a C++ framework to process audio signals, that accomodates for both mono and multichannel signals; it also unifies our processing schemes for noise reduction (SE) and signal separation (DUET).
- Array calibration turned out to be the thorniest issue of all. I proposed an approach for well-defined scenarios (e.g. car environment), but the general case remains open.

Blind Source Separation and Independent Component Analysis (1998-present):

[C31,C19,C18,C16,C15,C14,C9,C8,C7,C5,C1]

This was the first project at Siemens on which I worked, first during the summer of 1998 as an intern student, then for one year as a research consultant (1998-1999), and from 1999 onwards as a full-time employee. The main application we targeted was audio signal processing. We aimed for solving the cocktail party problem, that is, in a room full of people having conversations to one another there are a set of microphones that record the audio mixtures; the goal is to separate what each person is saying. We developed a completely new technology called DUET (Degenerate Unmixing and Estimation Technique) based on two microphone signals only. During the course of this project we built a model to explain why and how it works, and we expanded to more general scenarios in terms of number of microphones, mixing environment, and presence of background noise. Many students helped us during this project.

3D Geometry for Progressive Encoding of MPEG4 (1998-1999): [P10]

I worked on this research project as a postdoc at IBM with Gabriel Taubin (U.Brown). The goal of our research was to devise an advanced encoding scheme of 3D geometry for a fixed progressive coding method of 3D connectivity. The algorithm follows the MPEG prediction-correction approach, where the prediction is based on the Laplacian eigenvectors computed for the finer mesh.

Dynamical Systems (1992-1995): [P4]

My work on dynamical systems grew out of my personal interest in celestial mechanics. I owe to Toma Manciuciu in early '90s, and then to Phil Holmes at Princeton University my knowledge and passion for this subject. [P4] contains my contribution to this field.

Systems and Control Theory (1991-1994): [P1,P2,P3]

System and Control Theory was my first "love" in science. I debuted as a student with a differential topology paper ([P1]) where I pointed out and corrected a gap in a previous statement in literature; I subsequently worked on an algebraic approach in control theory [P2], and an application problem [P3]. Around 1993-1994 I continued working on two problems of systems theory: Lyapunov stability, and, jointly with my BS thesis advisor Vlad Ionescu, on nonlinear H^2 and H^∞ optimal control.