Signal and Information Processing Laboratory

Prof. Dr. A. Lapidoth, Prof. Dr. H.-A. Loeliger, Dr. K. Heutschi

ANNUAL REPORT

2 0 0 6

Research Period   2006
Teaching Period   2005/2006

Foreword

Producing a yearly report is not always so much fun. It requires collecting data, compiling it in a meaningful way, and committing it to paper after lots of editing. For their enormous help in this production, I am grateful to Ms. Röösli and Ms. Brändle. But there is also a fun aspect to this process. It allows one to take a break from the hectic present in order to appreciate the not-so-distant past.

At our Institute we strive for excellence, and we are always challenged by the problems we are working on at the moment. But it is also good to look back from time to time in order to enjoy what we have already achieved.

When so many interesting research results are grouped into a single document there is always a tendency to summarize them all in a single number: the number of publications, the number of research grants awarded, etc. But I ask the reader to fight this tendency and to savor and appreciate each research topic or result on its own. Behind each of these results stand endless hours of concentration, frustration, and hard work.

Last year was a special year for me, because I took a mini-sabbatical to Stanford University, where I was a visiting professor at the Information Systems Laboratory. It was an academically stimulating stay that triggered collaborations with Prof. Weissman from Stanford University and Prof. Kim from UCSD on error exponents for Gaussian channels with noisy feedback. But it was also a nostalgic visit to the laboratory where I was a Ph.D. student. I enjoyed my visit immensely, but I was also delighted to return to the ETH.

2006 was also exciting in that we hosted, together with the Communication Technology Laboratory, the 19th International Zurich Seminar on Communication. I take this opportunity to thank all of you who have helped make this event such a success.

I extend a warm welcome the new members of our institute: Raphael Berner, Ligong Wang, Nikolai Nefedov, and Christoph Reller and send our best wishes to Matthias Frey who has left the Institute after obtaining his Ph.D.

March 2007   Amos Lapidoth

Contents

1. Personnel

Professor for Information Theory:

Prof. Dr. Amos Lapidoth

Professor for Signal Processing:

Prof. Dr. Hans-Andrea Loeliger

Adjunct Lecturer:	**Dr. Kurt Heutschi**	
Secretaries:	**Mrs. Bernadette Röösli**	
	Mrs. Marion Brändle	
Senior Researcher:	**Dr. Nikolai Nefedov**	
Research Assistants:	**Jonas Biveroni**	Dipl.El.Eng.
	Raphael Berner	MSc ETH since 1.9.05
	Murti Devarakonda	Dipl.El.Eng
	Matthias Frey	Dipl.El.Eng. left on 30.6.06
	Junli Hu	Dipl.El.Eng.
	Tobias Koch	Dipl.El.Eng.
	Volker Koch	Dipl.Eng.
	Ligong Wang	MSc ETH since 1.7.06
	Natalia Miliou	Dipl.El.Eng.
	Maja Ostojic	Dipl.El.Eng.
	Christoph Reller	MSc ETH since 1.10.06
	Stephan Tinguely	Dipl.El.Eng.
	Wigger Michèle	Dipl.El.Eng.
Technical Staff:	**Francesco Amatore**	
	Dr. Max Dünki	
	Thomas Schärer	
	Patrik Strebel	El.Eng.HTL

Academic Guests: (see 6.1 for report of activities)

Dr. Gerhard Kramer	Bell Laboratories Innovation, Murray Hill, NJ, USA	20.2.2006
Dr. Sadeghi Parastoo	The Australian National University (ANU), Canberra, Australia	23.6. –1.7.06
Prof. Dr. P. P. Sotiriadis	John Hopkins University, Baltimore, MD, USA	13.9.2006
Dr. Gerhard Kramer	Bell Laboratories Innovation, Murray Hill, NJ, USA	29.9.2006
Ashish Khisti	MIT, Cambridge, MA, USA	31.10-11.11.2006
Prof. W.-H. Steeb	International School for Scientific Computing, South Africa	30.11.2006

2. Teaching

2.1 Lectures

Sem.	Instructors	Title	ETH-No.
7th	Prof. H.-A. Loeliger	Signal and Information Processing	227-0427
5th	Prof. H.-A. Loeliger	Stochastic Models and Signal Processing	227-0101
8th	Prof. H.-A. Loeliger	Algebra, Codes, and Signal Processing	227-0416
5/7th	Prof. A. Lapidoth	Applied Digital Information Theory I	227-0417
6th	Dr. Th. Mittelholzer	Information Transfer	227-0104
8th	Dr. H.P. Schmid	Analog Signal Processing and Filtering	227-0468
7th	Dr. K. Heutschi	Acoustics I	227-0477
8th	Dr. K. Heutschi	Acoustics II	227-0478

2.2 Practica

Sem.	Instructors	Title	ETH-No.
5/6th	Practica	Laboratory for "Fundamentals in Electrical Engineering"	227-0095
1st/2nd	M. Wigger, N. Miliou	Cellular Automata in Matlab	PPS
3rd/4th	M.Ostojic, J. Hu	Practical Signal Processing using a DSP	PPS
2nd/3rd	Th. Schaerer	EMG Biofeedback Device	PPS

2.2 Semester Projects and Diploma Theses

During the winter semester 2005/06 and summer semester 2006, 10 Semester Projects (11 candidates) and 6 Diploma Theses (7 candidates) were carried out.

Candidates	Title	Supervisor
Semester Projects WS 2005/06		
Oliver Nagy	Numerical techniques for computing capacities of communications channels with memory	N. Miliou
Lukas Bolliger	EMG signal decomposition using factor graphs and message-passing algorithms with joint-Gaussian and discrete messages	V. Koch
Samuel Braendle	Training based decoding algorithms	M. Ostojic
Martin Renold	Spike sorting of tetrode data and EMG signal decomposition using loopy belief propagation algorithms	V. Koch
Semester Projects SS 2006		
Silvan Graf	Smart fire detection	H.-A. Loeliger
Thomas Hug Mirco Rossi	Seismosomnography: Heartbeat detection from pressure sensors	V. Koch, J. Hu H.-A. Loeliger
Audrey Schaufelberger	EMG signal decomposition using factor graphs: noise variance estimation	V. Koch
Florian Kind	Psychoakustische Bassverstärkung	K. Heutschi
Pengyu Wu	Training based decoding algorithms	M. Ostojic
Wanfang Yan	Decoding of shaped codes and lattices	H.-A. Loeliger
Diploma Theses WS 2005/6		
Christoph Reller	Bio-inspired analog-to-digital conversion	J. Biveroni M. Devarakonda
Michel Krebs	Spectral analysis of finite-state codes	R. Cidecyian, Th. Mittelholzer IBM Res.Lab.
Ligong Wang	On non-coherent fading channels at low SNR	T. Koch

Diploma Theses SS 2006

Shi Ting Jia	Calibration methods for ADCs and DACs	H.-A. Loeliger M. Frey, J. Biveroni
Nadim El Guindi	Robust telephone detection in monaural and binaural hearing instruments	Phonak AG
Roman Hauser Roman Stampfli	Calculation and optimization of the setting of a robotized line array	K. Heutschi
Oliver Nagy	Analysis of Interleave Division Multiple Access for Communication Systems	H.-A. Loeliger Marc Reed

3. Research

3.1 Research Areas

The Signal and Information Processing Lab focusses on research and teaching in the following areas:

Information Theory

Current topics:

- Combined Source-Channel Coding for Multi-Access Networks
- Multi-Access Channels with Noisy Feedback
- Network Coding
- Capacity of Fading Channels
- Carbon Copying with Dirty Paper

Digital Signal Processing

Current topics:

- Fundamentals and applications of graphical models (factor graphs)
- Decomposition of electromyographic signals
- Channel estimation and equalization in communications receivers

Analog and Hybrid Signal Processing

Current topics:

- Decoding of error correcting codes
- Digital-to-analog conversion and analog-to-digital conversion

3.2 Current Research Projects

Information Theory and Coding

On Multi Access Channels (MAC) at High SNR

Multi-access channels model many-to-one communication scenarios, as for example, the uplink in mobile cellular telephony. Contrary to the case of single-user communication via multiple transmit antennae, a multiple-access scenario allows for very limited cooperation among the transmitters, as each transmitter is assumed to be ignorant of the message transmitted by the other users.

In this project we investigate a fading multiple-access channel in the absence of receiver side information. We model the received signal as the sum of two signals, where the first signal is the result of passing the signal transmitted by the first user through a Ricean fading channel, and the second signal defined analogously.

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Professor: Dr. Amos Lapidoth

On the Capacity of a Gaussian MAC with Noisy Feedback

We study the capacity of the Gaussian MAC with noisy feedback. We prove that feedback strictly increases the capacity region irrespective of how noisy it is. Settling a longstanding open problem, we also show that the Cover-Leung region is sub-optimal even for the Gaussian MAC with partial feedback.

Contact Person: Michèle Wigger, Room ETF D 107, Phone 044 632 7604
E-Mail: wigger@isi.ee.ethz.ch

Professor: Dr. Amos Lapidoth

Duality-based bounds on error exponents

We study a dual expression for the random coding error exponent where the maximization over input distributions is replaced with a minimization over output distributions. Using this technique we can derive UPPER bounds on the random coding error exponent and on the sphere packing exponents.

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On the Computational cut-off rate for Rayleigh and Ricean fading channel without receiver side information

We demonstrate how duality theory can be used to derive upper bounds on the channel cut-off rate. For the Ricean fading channel, we obtain the high signal-to-noise ratio (SNR) expansion of the cut-off rate.

Contact Person: Natalia Miliou, Room ETF D 102, Phone 044 632 7601
E-Mail: miliou@isi.ee.ethz.ch

Professor: Dr. Amos Lapidoth

On the feedback capacity of discrete-time multi-access channels

An achievable region for the two-user discrete memoryless multiple-access channel with noiseless feedback is derived. The proposed region includes the Cover-Leung region, with the inclusion being for some channels strict.

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On the Asymptotic Capacity of Multiple-Input Single-Output Fading Channels with Memory

In this project we study the capacity of Gaussian fading channels with memory where neither the transmitter nor the receiver has access to the realization of the fading process. The emphasis is on the high signal-to-noise ratio (SNR) regime.

Contact Person: Tobias Koch, Room ETF D 107, Phone 044 632 6587
E-Mail: koch@isi.ee.ethz.ch

Professor: Dr. Amos Lapidoth

The feedback capacity of fading channels

We study the role of feedback in non-coherent wireless communciations with special emphasis on the capacity gains afforded by feedback. Special emphasis is placed on the fading number and the pre-log.

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Professor: Dr. Amos Lapidoth

The fading number of SIMO fading channels with memory

We study the high SNR asymptotic capacity of single-input multiple-output non-coherent fading channels with memory. Having established in previous work the double logarithmic increase of channel capacity we set.

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Multicasting with Transmitter Side Information

We consider sending a common message to two (or more) receivers. The channels from the transmitter to each of the receiver are controlled by "states" that are all known to the transmitter (but not receivers) a-causally. We investigate the maximal rate at which reliable communication is possible.

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Professor: Dr. Amos Lapidoth

Transmitting a Gaussian Source on the Gaussian Channel

We revisit the classical problem of sending a memoryless Gaussian source over the additive discrete-time Gaussian noise channel. We propose a continuum of asymptotically optimal schemes that include, as special cases, the classical source-channel separation approach and Goblick's uncoded scheme.

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Professor: Dr. Amos Lapidoth

Sending a Bi-Variate Gaussian Source over the Gaussian MAC

We study a distributed communication problem where each component of a bi-variate Gaussian source is observed by a different user. The users communicate to a single receiver via a Gaussian multiple-access channel. We study the optimal achievable distortions. Source-channel separation is sub-optimal.

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Professor: Dr. Amos Lapidoth

Error Exponents for the Gaussian Channel with Noisy Feedback

It is well known that, in the presence of a noise-free feedback link, the error exponents for the Gaussian channel can be greatly improved. Here we study the robustness of this result by studying the reliability Function in the presence of a "small" feedback noise. Results change dramatically!

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A Linear Interference Network with Local Transmitter Side Information

To study the role of local information on the throughput of a global wireless network we consider a linear model where each node suffers from interference caused by the previous J users. The node knows the interfering messages, but not signals. We study the high SNR throughput & degrees of freedom.

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Professor: Dr. Amos Lapidoth

The Capacity of a Channel that Heats Up

Motivated by on-chip communication scenarios, we study the capacity of a Gaussian channel corrupted by thermal noise, whose variance is determined by the temperature, and where the temperature is not only governed by the ambient room temperature but also by the amplitude of the previously-transmitted signals.

Contact Person: Tobias Koch, Room ETF D 107, Phone 044 632 6587
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Network Coding with Broadcast Subnets

We consider a multi-cast network coding problem where some of the subnets in the network are broadcast channels. We study optimization algorithms to find the operating points within the individual broadcast channel capacity regions that minimize a global cost on the global network.

Contact Person: Natalia Miliou, Room ETF D 102, Phone 044 632 7601
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Professor: Dr. Amos Lapidoth

MIMO Fading Channels at Low SNR

MIMO fading channels operating at low levels of SNR can sometimes model spread-spectrum systems utilizing multiple antennas. In this project we study the limiting ratio of the capacity of such channels to the SNR as the SNR tends to zero. This asymptotic regime corresponds to the wide-band limit.

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E-Mail: wang@isi.ee.ethz.ch

Professor: Dr. Amos Lapidoth

A Sensor Network with Feedback

We study the optimal mean squared-error in the transmission of a bi-variate Gaussian source over a Gaussian multiple-access channel. Transmitter 1 (resp. 2) computes the symbol to send at time k based on the first (resp. second) component of the source vector and on previous channel outputs.

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Professor: Dr. Amos Lapidoth

Digital Signal Processing

Channel Estimation and Equalization in Communication Receivers

We study iterative ("message passing") methods for joint channel estimation, decoding, and equalization for linear channels.

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E-Mail: hu@isi.ee.ethz.ch

Professor: Dr. Hans-Andrea Loeliger

Fundamentals and Applications of Graphical Models
Most of our research is somehow related to graphical models (factor graphs) and to message passing algorithms on such graphs. We are interested in a wide variety of conceptual and algorithmical issues. Examples include
- applications to practical signal processing problems
- adaptation and learning
- local formulation of Kalman filtering, expectation maximization
  particle methods, etc.
- improved message passing with structured summaries
- electrical networks and other physical systems as factor graphs
- Fourier and Lagrange duality

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Professor: Dr. Hans-Andrea Loeliger

Decomposition of EMG Signals
All muscular activity is triggered by electrical pulses in the nerve cells that control individual groups ("motor units") of muscle fibres. The measurement and the analysis of such electrical signals is of significant interest to physicians.

Our laboratory has a long tradition in the processing of such electromyographic (EMG) signals. The signals as measured by various types of electrodes consist of the linear superposition of (the signals corresponding to) many motor units. The main signal processing task is to identify the "signatures" of the individual motor units and to decompose the measured signal into the corresponding components.

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Digital Calibration of Analog Circuits

We study they use of digital calibration techniques to reduce the area and the power consumption of analog circuits such as, e.g., analog-to-digital converters and digital-to-analog converters.

Contact Person: Jonas Biveroni, Room ETF D 103, Phone 044 632 3615
E-Mail: biveroni@isi.ee.ethz.ch

Professor: Dr. Hans-Andrea Loeliger

Decoding and More in Analog VLSI Decoding and More in Analog VLSI
Error correcting codes may be represented by "factor graphs", and iterative "probability propagation" decoding operates by "message passing" along the edges of the graph. Back in 1998, we discovered that the factor graph of many error correcting codes (including trellis codes, turbo codes, and low-density parity check codes) can be translated directly into analog transistor circuits that operate in continuous time and in parallel. Such analog decoders are composed of "probability gates", where currents represent probabilities and voltages represent logarithms of probabilities (or of probability ratios). Such analog decoders might allow the use of error correcting codes in applications where digital decoders would be too slow or would consume too much power.
We have built simple decoder chips as well as a collection of "probability gates" as individual integrated circuits; the latter allowes us to put together and to study several simple decoders on the breadboard level.
More recently, we have extended analog probability-propagation to synchronization. We have demonstrated that a clockless continuous-time circuit can synchronize to a properly designed periodic waveform, even in the presence of substantial noise. This work also sheds some light on the connection between statistical state estimation and the subject of "entrainment" of dynamical systems.

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3.3 Completed Projects

FREY Matthias
On Analog Decoders and Digitally Corrected Converters
ETH Diss. Nr. 16536 (Referee Prof. Dr. H.-A. Loeliger)

The algorithms used for decoding modern error correcting codes are computationally very demanding and need great computing power to deliver real-time results. Mobile users, however, ask for low-power electronics; the combination of both demands led to an increased interest in analog communication circuits, e.g., in analog decoders for error correcting codes.

The first part of this thesis discusses various implementations of analog decoders. An analog decoder can be understood as a code-representing graph mapped on analog silicon, whereas the decoding algorithm corresponds to the settling behavior of the analog circuit. The performance gain of analog decoders compared to digital implementations in terms of speed or power-consumption is believed to be at least a factor of 100.

The following implementations of such analog decoders are discussed: Hamming decoders built out of two generations of discrete softgates, an integrated Hamming decoder and an integrated Reed-Muller decoder are presented. Extensive measurements prove their full functionality.

Furthermore, a novel circuit to compute the soft symbols for a PAM or QAM signal is presented. This transistor network blends in nicely with analog decoders - its outputs are currents proportional to the symbol-likelihoods.

The second part of this thesis is devoted to analog-to-digital and digital-to-analog converters with minimal-sized elements. Highly accurate converters usually require large elements to achieve minimal mismatch; large elements however require high currents for high speed. However, by using small (but imprecise) elements and adding digital post-correction circuitry, this trade-off can be circumvented.

We show that the effective resolution of a digitally-corrected analog-to-digital converter only weakly depends on the comparator mismatch. This was confirmed by measurements on an integrated flash analog-to-digital converter containing 256 low-precision comparators and achieving an effective resolution of nearly 7 bits.

A similar statement holds for current-steering digital-to-analog converters with almost minimal-sized current sources: for a converter containing 12 low-precision current sources and digital pre-correction, an effective resolution of more than 10 bits was achieved - virtually irrespective of the mismatch.

The thesis concludes with a summary of the obtained results and a collection of research proposals in the field of analog decoding and for digitally-corrected converters.

3.4 Completed Dissertations

FREY Matthias   On Analog Decoders and Digitally
       Corrected Converters

       ETH Diss. Nr. 16536
       Referee: Prof. Dr. H.-A. Loeliger
       Co-referees: Prof. V. Gaudet, Univers. Of Alberta
              Dr. N. Nefedov, Nokia

4. Conferences, Meetings and Committees

4.1 Conference Organization

Prof. Lapidoth

Member of the "Wahlkommission" for the Professorship in Applied Philosophy, 2006.

Member of the Technical Program Committee for the 2006 International Zurich Seminar held at Zurich, Switzerland from February 22-24, 2006.

Member of the International Advisory Committee of ISITA 2006, Seoul held at Korea from October 29-November 1, 2006.

Prof. Loeliger

Chairman of the 2006 International Zurich Seminar on Communications, February 22-24, 2006.

Member of the Technical Program Committee for the 4th International Symposium on Turbo Codes and Related Topics, Munich, Germany, April 2006.

4.2 Participation in Congresses and Meetings

Biveroni Jonas   Analog Decoding Workshop, Torino, Italy
                        5.-6.6.2006.

Frey Matthias   International Symposium on Circuits and Systems
                        2006, Island of Kos, Greece, 21.-24.5. 2006.

Frey Matthias   13th IEEE International Conference on Electronics,
                        Circuits and Systems, Nice, France, 10.-13.12.2006.

Koch Tobias   2006 International Zurich Seminar on Communications,
                        ETH Zurich, 22.-24.2.2006.

Koch Tobias   2006 IEEE International Symposium on Information
                        Theory, Seattle, USA, 9.-14.7.2006.

Koch Volker M.   Gemeinsame Jahrestagung der Deutschen, Oester-
                        reichischen Gesellschaften für Biomedizinische Technik,
                        ETH Zurich, Switzerland, 6.-9.9.2006.

Koch Volker M.   EMBC 2006, 28th Annual International Conference IEEE
                        Engineering in Medicine and Biology Society, New York
                        City, USA, 30. 8.-3.9.2006.

Koch Volker M.   Symposium on Electromyography – Principals and
                        Applications, Zurich, Switzerland, 27.4.2006.

Lapidoth Amos   2006 International Zurich Seminar on Communications,
                        ETH Zurich, 22.-24.2.2006.

Lapidoth Amos   IEEE Communication Theory Workshop, Dorado, Puerto
                        Rico, 21.-24.5.2006.

Lapidoth Amos   2006 IEEE International Symposium on Information
                        Theory, Seattle, USA, 9.-14.7.2006.

Lapidoth Amos   24th IEEE Convention of Electrical and Electronics
                        Engineers in Israel, Eilat, Israel, 15.-17.11.2006.

Loeliger H.-A.   2006 Information Theory and Applications Workshop, La
                        Jolla, CA, USA, San Diego, USA, 4.-10.2.2006.

Loeliger H.-A.   Analog Decoding Workshop, Torino, Italy, 4.-6.6.2006.

Loeliger H.-A.   International Symposium on Turbo Codes and
Hu Junli   Related Topics, Munich, Germany, 3.-7.4.2007.
Ostojic Maja

Loeliger H.-A.   Rolf Johannesson Fest, Lund, Sweden, 2.-4.7.2006.

Loeliger H.-A.   2006 IEEE International Symposium on Information
                        Theory (ISIT), Seattle, USA, 9.-14.7.2006.

Loeliger H.-A.   EUSIPCO 2006, 14th European Signal Processing
                        Conference, Florence, Italy, 4.-8.9.2006.

Loeliger H.-A.	44th Allerton Conference on Communication, Control and Computing, Monticello, ILL., USA, 26.9.-29.9.2006.
Miliou Natalia	2006 International Zurich Seminar on Communications, ETH Zurich, 22.-24.2.2006.
Tinguely Stephan	2006 International Zurich Seminar on Communications, ETH Zurich, 22.-24.2.2006.
Tinguely Stephan	2006 IEEE International Symposium on Information Theory, Seattle, USA, 9.-14.7.2006.
Wigger Michèle	2006 International Zurich Seminar on Communications, ETH Zurich, 22.-24.2.2006.
Wigger Michèle	The Kailath Lecture and Colloquium 2006, Stanford University, Stanford, USA, 6.-7. 7 2006.
Wigger Michèle	2006 IEEE International Symposium on Information Theory, Seattle, USA, 9.-14.7.2006.
Wigger Michèle	NATO ASI on Coding and Analysis of Multiple Access Channels 2006, Budapest, Hungary, 26.8.-5.9.2006.
Wigger Michèle	24th IEEE Convention of Electrical and Electronics Engineers in Israel, Eilat, Israel, 15.-17.11.2006.

4.3 Academic Visits Abroad

Prof. Dr. Amos Lapidoth

Electrical Engineering Department, Stanford University,
Stanford, CA, USA.   20.3.-20.6.2006

Natalia Miliou

Laboratory for Information and Decision Systems,
MIT Boston, MA, USA.   2.-28.3.2006

4.4 Service Activities and Society Memberships

Prof. Lapidoth

Fellow of the IEEE

Member of the IMS Institute of Mathematical Statistics, Bethesda, USA

Associate Editor for Shannon Theory, IEEE New York

Research Affiliate in the Research Laboratory of Electronics (RLE) at the Massachusetts Institute of Technology (MIT)

Member of the Center for Communication and Information Technologies (CCIT), Technion, Haifa, Israel

Prof. Loeliger

Fellow of the IEEE

Chairman of the IEEE Switzerland Chapter on Digital Communication Systems

Dr. Heutschi

Member, Acoustical Society of America

Member, Audio Engineering Society

Member, Swiss Acoustical Society (SGA)

Member, German Acoustical Society (DEGA)

4.5 Presentations by Institute Members

Dauwels Justin	"Particle Methods of Message Passing", 2006 IEEE International Symposium on Information Theory, Seattle, USA, 11.7. 2006.
Frey Matthias	"On Flash A/D-Converters with Low-Precision Comparators", International Symposium on Circuits and Systems 2006, Island of Kos, 24.5.2006.
Frey Matthias	"Analog Decoders and Digitally Corrected Converters", Philips Semiconductors, Zurich, Switzerland 30.5.2006.
Frey Matthias	"Decoding Error-Correcting Codes Using Analog Transistors: An Introduction to Analog Decoders and their Surroundings", FTW Vienna, Austria, 9.6.2006.
Frey Matthias	"An Introduction to Analog Decoders and Digitally Corrected Converters", Tokyo Institute of Technology, Tokyo, Japan, 14.9.2006.
Frey Matthias	"Analog Decoders and Digitally Assisted Converters", Tohoku University, Sendai, Japan, 19.10.2006.
Frey Matthias	"Analog Circuits for Symbol-Likelihood Computation", 13th IEEE International Conference on Electronics, Circuits and Systems, Nice, France, 10.-13.12.2006.
Koch Tobias	"Gaussian Fading is the Worst Fading", International Symposium on Information Theory Seattle, Washington (ISIT), 10.7.2006.
Koch Volker M.	"New Results in EMG Signal Decomposition Using Belief Propagation in Graphical Models", VA Palo Alto Rehabilitation R&D Center, Palo Alto, CA, USA, 28.3.2006.
Koch Volker M.	"Resolution of Superpostions in EMG Signals using Belief Propagation: Results for the Unknown Constituent Problem", Symposium on Electromyography – Principals and Applications, ETH Zurich, Zurich, Switzerland, 27.4.2006.
Koch Volker M.	"Resolution of Superpositions in EMG Signals using Belief Propagation: Results for the Known Constituent Problem", 28th Annual Internation Conference IEEE Engineering in Medicine and Biology Society (EMBC 2006), New York City, USA, 31.8.2006.

Koch Volker M.	"Resolution of Superpositions in EMG Signals, using Belief Propagation", Gemeinsame Jahrestagung der Deutschen, Oesterreichischen und Schweizerischen Gesellschaften für Biomedizinische Technik, ETH Zurich, Switzerland, 9.9.2006.
Lapidoth Amos	"Superimposed Coded and Uncoded Transmission of a Gaussian Source over the Gaussian Channel", Seattle, International Symposium on Information Theory (ISIT), 13.7.2006.
Lapidoth Amos	"Bounds on the Error Exponent of the AWGN Channel with AWGN-Corrupted Feedback", Israel, Eilat, 24th IEEE Convention of Electrical and Electronics Engineers in Israel, (ISIT), 17.11.2006.
Lapidoth Amos	"On Coded and Uncoded Transmissions of Gaussian Sources over Gaussian Channels", California, Berkeley, University of California, 31.5.2006.
Lapidoth Amos	"On Coded and Uncoded Transmissions of Gaussian Sources over Gaussian Channels", California, San Diego, University of San Diego, 15.6.2006.
Loeliger H.-A.	"On the Static Accuracy of Digitally corrected Analog-to-Digital and Digital-to-Analog Converters", The 2006 Information Theory and Applications Workshop, La Jolla, CA, USA, 4.-10.2006.
Loeliger H.-A.,	"Gaussian Message Passing on Linear Models: An Update", International Symposium on Turbo Codes & Related Topics, Munich, Germany, 3.-7.2006.
Loeliger H.-A.	"On Factor Graphs", Pattern Analysis and Machine Learning Group, ETH Zurich, Switzerland, 2.5.2006.
Loeliger H.-A.	"On Signal Processing and Analog Computation", Institute for Neuroinformatics, UNI/ETH Zurich, Switzerland, 23.6.2006.
Loeliger H.-A.	"A General Computation Rule for Lossy Summaries/Messages with Examples from Equalization", Rolf Johannesson Fest, Lund, Sweden, 2.-4.7.2006.
Loeliger H.-A.	"The Factor Graph Approach to Signal Processing", short course given at EUSIPCO, Florence, Italy, 4.-8.9.2006.
Loeliger H.-A.	"A General Computation Rule for Lossy Summaries/Messages with Examples from Equalization", 44th Allerton Conference on Communication, Control, and Computing, Monticello, ILL., USA, 27.-29.9.2006.
Loeliger H.-A.	"The Factor Graph Approach to Signal Processing", short course given at the National Chiao Tung University, Taiwan, ROC, 14.-15.10.2006.

Miliou Natalia	"Cost- Optimal Networks of Broadcast Channels", Massachussetts, Boston, MIT, März 2006.
Miliou Natalia	"On Error Exponents for Fading Channels and Network Coding for Wireless Networks", Switzerland, Zurich, PhD defense, 7.12.2007.
Tinguely Stefan	"Sending a Bi-Variate Gaussian Source over a Gaussian MAC", Seattle, International Symposium on Information Theory (ISIT), 13.7.2006.
Wigger Michèle	"Noisy Feedback Is Strictly Better Than No Feedback on the Gaussian MAC", The Kailath Lecture and Colloquium 2006, Stanford University, 7.7.2006.
Wigger Michèle	"Noisy Feedback Is Strictly Better Than No Feedback on the Gaussian Multiple-Access Channel", Austria, Vienna, The Telecommunications Research Center Vienna, 6.9.2006.
Wigger Michèle	"Noisy Feedback Is Strictly Better Than No Feedback on the Gaussian Multiple-Access Channel", Hungary, Budapest, NATO ASI on Coding and Analysis of Multiple Access Channels 2006, 2.9. 2006.
Wigger Michèle	"On the Gaussian MAC with Imperfect Feedback", Israel, Eilat, 24th IEEE Convention of Electrical and Electronics Engineers in Israel. 17.11.2006.

4.6 Organization of Lectures, Seminars, and Colloquia

Colloquium Speakers for the Colloquium "Electronics and Communications" were:

Invited by Prof. Loeliger:

26.06.06 **Dr. Parastoo Sadeghi,** The Australian National University Canberra**,** Australia
"The effect of memory order on the information capacity of finite-state Markov channels and its implications for the capacity analysis of time-varying fading channels".

29.06.06 **Dr. Parastoo Sadeghi,** The Australian National University Canberra**,** Australia
"Intrinsic Finite Dimensionality and Richness of Random Multipath Fields with Appliclations to MIMO Systems".

30.11.06 **Prof. Willi-Hans Steeb**, International School for Scientific Computing, South Africa
"Quantum Computing, Circuits and Algorithms".

Invited by Dr. Heutschi:

18.01.06 **PD Dr. med Alexander Huber,** Universitätsspital Zürich, Switzerland
"Vibrationen im Ohr: Akustisch-mechanische Gesichtspunkte der Schwerhörigkeit".

25.01.06 **Dr. Ullrich Isermann,** DLR Institut für Aerodynamik und Strömungstechnik, Göttingen, Germany
"Ansätze zur Modellierung von Schallquellen bei der Berechnung von Fluglärm".

17.05. 06 **Christian Beusch,** Filmtonmeister und Tonmeister, Tonstudio Beusch Zürich
"Der Ton im Kino – Raum- und Elektroakustik".

21.06.06 **Prof. Dr.-Ing. Hugo Fastl,** AG Technische Akustik, Lehrstuhl für Mensch-Maschinen-Kommunikation, TU Munich, Germany
"Anwendung der Psychoakustik in der Geräuschbeurteilung".

15.11.06 **Andreas Lang Dipl. Inform.,** Otto-von-Guericke Universität, ITI Research Group on Multimedia and Security, Magdeburg, Germany
"Einsatz von digitalen Wasserzeichen für Audiosignale".

5 Publications

Arnold Dieter, Loeliger Hans-Andrea Vontobel Pascal, Kavcic Alek, Wei Zeng	"Simulation-based computation of information rates for channels with memory", IEEE Transactions on Information Theory, vol. 52, no. 8, pp. 3498-3508, August, 2006.
Bross Shraga, Lapidoth Amos, Tinguely Stephan	"Superimposed Coded and Uncoded Transmissions of a Gaussian Source over the Gaussian Channel", in Proceedings of the IEEE International Symposium on Information Theory (ISIT), Seattle, USA, 2006.
Dauwels Justin, Korl Sascha, Loeliger Hans-Andrea	"Particle methods as message passing", Proc. 2006 IEEE Int. Symp. on Information Theory, pp. 2052-2056, Seattle, USA, July, 9-14, 2006.
Frey Matthias, Loeliger Hans-Andrea	"On the Static Accuracy of Digitally Corrected Analog-to-Digital and Digital-to-Analog Converters", Proceedings of the Information Theory and Applications Inaugural Workshop, La Jolla, CA, USA, Feb. 6-10, 2006.
Frey Matthias, Merkli Patrick, Loeliger Hans-Andrea	"On two topics in analog computation", Proceedings 2006 Analog Decoding Workshop, pp. 7-9, Torino, Italy, 5.-6.6.2006.
Frey Matthias, Merkli Patrick, Loeliger Hans-Andrea	"On Flash A/D Converters with Low-Presicion Comparators", Proceedings of the 2006 IEEE International Symposium on Circuits and Systems, Kos, Greece, 21.-26.5.2006.
Frey Matthias, Merkli Patrick, Loeliger Hans-Andrea	"On the Static Accuracy of Digitally Corrected Analog-to-Digital and Digital-to-Analog Converters", Proceedings of the Information Theory and Applications Inaugural Workshop, San Diego, USA, 4.-10.10.2006
Frey Matthias, Loeliger Hans-Andrea, Merkli Patrick	"Analog Circuits for Symbol-Likelihood Computation", IEEE International Conference on Electronic Circuits and Systems (ICECS), pp. 680-683, December 10-13, 2006.
Hu Junli, Loeliger Hans-Andrea, Dauwels Justin	"A General Computation Rule for Lossy Summaries/ Messages with Examples from Equalization". Proc. 44th Allerton Conference on Communication, Control and Computing, Monticello, ILL, USA, 27.-29.9.2006.
	"Bounds on the Error Exponent of the AWGN Channel

Kim Young-Han, Lapidoth Amos, Weissman Tsachy	with AWGN-Corrupted Feedback", Proceedings 24th IEEE Convention of Electrical & Electronics Engineers in Israel (IEEEI'06), pp. 184-188, Eilat, Israel, Nov. 15-17, 2006.
Kishti Ashish, Erez Uri, Lapidoth Amos, Wornell Gregory	"Carbon Copying Onto Dirty Paper", Proceedings 2006 International Zurich Seminar on Communications, pp. 182-185, February 22-24, 2006, ETH Zurich, Switzerland, 2006.
Koch Tobias, Lapidoth Amos	"Gaussian Fading is the Worst Fading", in Proceedings 2006 IEEE International Symposium on Information Theory (ISIT), Seattle, USA, 2006.
Koch Volker M., McGill Kevin, Loeliger Hans-Andrea	"Resolution of Superpositions in EMG Signals using Belief Propagation: Results for the Unknown Constituent Problem", Proc. of the Symposium on Electromyography – Principals and Applications, p.15, ETH Zurich, Switzerland, 27.4.2006.
Koch Volker M., McGill Kevin, Loeliger Hans-Andrea	"Resolution of Superpositions in EMG Signals Using Belief Propagation: Results for the Unknown Constituent Problem", Proc. of the 28th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC 2006), pp. 1260-1263, New York City, NY, USA, 30.8.-3.9.2006.
Koch Volker M., Loeliger Hans-Andrea	"Resolution of Superpositions in EMG Signals Using Belief Propagation", Proc. of the Gemeinsame Jahrestagung der Deutschen, Österreichischen und Schweizerischen Gesellschaften für Biomedizinische Technik, p. V193, Zurich, Switzerland, ETH Zurich, September 6-9, 2006.
Lapidoth Amos, Moser Stefan	"The fading number of single-input multiple-output fading channels with memory", IEEE Transactions on Information Theory, IT-52 No. 2, pp.437-453, February 2006.
Lapidoth Amos, Wang Ligong	"On the Low SNR Capacity of Peak-Limited Non-Coherent Fading Channels with Memory", arXiv:cs.IT/0604031, Apr 7, http://arxiv.org/abs/cs.IT/0604031, 2006.
Lapidoth Amos, Shamai (Shitz) Shlomo, Wigger Michèle	"On the Capacity of Fading MIMO Broadcast Channels with Imperfect Transmitter Side-Information", arXiv:cs.IT/0605079, May 17, http://www.arxiv.org/pdf/cs.IT/0605079, 2006.
Lapidoth Amos, Miliou Natalia	"Duality bounds on the cut-off rate with applications to Ricean fading", IEEE Transactions on Information Theory, IT-52 No.7, pp.3003-3018, July 2006
Lapidoth Amos,	"Sending a Bi-Variate Gaussian Source over a

Tinguely Stephan	Gaussian MAC", in Proceedings of the IEEE International Symposium on Information Theory (ISIT), Seattle, USA, with a typo corrected, 2006.
Lapidoth Amos, Wigger Michèle	"On the Gaussian MAC with Imperfect Feedback", Proceedings 24th IEEE Convention of Electrical & Electronics Engineers in Israel (IEEEI'06), pp. 203-207, Eilat, Israel, Nov. 15-17, 2006.
Loeliger Hans-Andrea, Hu Junli, Korl Sascha, Qinghua Guo, Li Ping	"Gaussian Message on Linear Models: an Update", Proceedings International Symposium on Turbo Codes & Related Topics, Munic, Germany, 2.-7.4.2006.
Vigoda Benjamin, Dauwels Justin, Frey Matthias, Gershenfeld Neil, Koch Tobias, Loeliger Hans-Andrea, Merkli Patrick	"Synchronization of Pseudorandom Signals by Forward-Only Message Passing with Application to Electronic Circuits", IEEE Transaction on Information Theory, vol. 52, no. 8, pp. 3843-3852, 2006.

6 Guests, Visitors

6.2 Activities of Academic Guests at the Institute

Guests of Prof. Lapidoth:

Dr. Gerhard Kramer
Bell Laboratories Innovation, Murray Hill, NJ
Held a Mini Course on "Selected Topics in Information
Theory"   20.2.2006

Prof. Dr. Paul P. Sotiriadis
John Hopkins University, Baltimore, MD
Presented a talk on "Connections between information theory
and circuits"   13.9.2006

Dr. Gerhard Kramer
Bell Laboratories Innovation, Murray Hill, NJ
Presented a talk on "Network coding Rates and
Edge-Cut Bounds"   29.9.2006

Ashish Khisti
MIT, Cambridge, Massachusetts, USA
Collaboration with Prof. Lapidoth, and Presentation of a
talk on "Secure Broadcasting over Fading Channels"   31.10-11.11.2006

Guests of Prof. Loeliger:

Dr. P. Sadeghi
The Australian National University (ANU), Canberra,
Australia, held 2 talks on
 "The effect of memory order on the information capacity
 of finite-state Markov channels and its implications for the
 capacity analysis of time-varying fading channels" and on
"Intrinsic finite dimensionality and richness of random
mulitpath fields with applications to MIMO systems".   26.-29.1.2006