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Institute of Networked and Embedded Systems

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Professor Mario Huemer
Professor Bernhard Rinner

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Institute of Networked and Embedded Systems

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Foreword

Dear research partners, colleagues and students, dear friends:

The second year of existence of the Institute of Networked and Embedded Systems (NES) was a very important one for us. We had to reflect on the starting phase and think about what went well and what needs to be improved. It was a time – after the administrative efforts in launching the institute and courses – to define larger research activities and present results at international conferences.

I quite well remember my personal objectives when coming to Klagenfurt three years ago. I wanted to create a unique atmosphere where "bright minds" come together to do collaborative research, enjoy teaching, and contribute to the advances in science and technology in a fundamental manner. The team I had in mind was supposed to have an international and multidisciplinary flavor since I am convinced that people coming from different backgrounds form creative teams. I am very happy to say that the past year has brought us a good step closer in attaining this goal.

The year 2008 was a year of expansion and internationalization. Pursuing an active recruiting strategy, we managed to hire several very qualified and motivated young people which made the number of scientific staff members rise from 14 to 25. Our team is truly international: researchers come from Austria, Belarus, France, Germany, Hungary, Italy, Macedonia, Portugal, and Turkey, so that in total 40 % of the scientific staff is from abroad.

Our research activities have been strengthened by a number of new research projects. With the launch of Lakeside Labs – a platform for science, technology, and innovation in the area of self-organizing networked systems – we are in the excellent position to cluster the expertise of several groups from Klagenfurt and perform joint research. Let me mention two examples: the project "collaborative microdrones" that aims at advancing the state-of-the-art in the domain of networked unmanned aerial vehicles (four PhD researchers and two PostDocs) and the project "cooperative relaying in wireless networks" that aims at new techniques for wireless communications (four PhD researchers and one PostDoc).

Besides these funded projects, the institute is in close collaboration with international and national industry. Our list of partners currently comprises DICE, DOCOMO Euro-Labs, EADS, EFKON, Infineon Technologies, NXP Semiconductors, and Orange Labs. They provide us with a "reality check" of our ideas as well as with funding. All in all, the good mix of projects enables all PhD candidates to focus on research and teaching.

The year 2008 was also a year of evaluation and recognition. Most important, the institute was evaluated by three external university professors who based their judgment on a self-assessment report and a two-day visit. The evaluators were "positively surprised and im-

pressed by the scientific productivity, the success in teaching and institute management achieved in short time".

Furthermore, it made me very happy to see young researchers being awarded for the results of their work. This year, we were able to celebrate two best paper awards: one at the IEEE Vehicular Technology Conference and another at an interdisciplinary workshop on biologically-inspired ICT systems. These moments of success show that we are on the right path to becoming an internationally recognized research and education institution in the domain of networked communication systems.

Two events we organized highlighted the past year: the Lakeside Research Days, where we invited worldwide experts in the domain of self-organizing systems to join us for a week of discussions and joint work; and Austria's Lange Nacht der Forschung, where we presented a microdrone night flight to a large audience.

Yet, besides research, there is still work to be done. It is no secret that the number of undergraduate students in the new study program ‚Informationstechnik' is still unsatisfactory. With the help of the university administration, it will be our ambition to better inform the public about the excellent study conditions and the high-quality research-oriented course program that we offer. As a first step, I encourage everyone reading these lines to "spread the word" about this new study program.

Last but not least, I would like to thank everybody who makes our institute what it is. Enjoy this report!

Christian Bettstetter
Professor and Head of Institute

Table of Contents

The Institute at a Glance

The Institute of Networked and Embedded Systems of the Klagenfurt University is engaged in the design, modeling, and analysis of networked and embedded systems of the future.

Our research and teaching areas consist of algorithms, protocols, architectures, signal processing, network theory, and their applications.

The main emphasis of our research is on wireless and mobile systems. Current projects are concerned with, for example, intelligent cameras, cooperation and self-organization in wireless networks as well as energy-efficient hardware components in mobile communications.

The curriculum comprises lectures, tutorials, seminars and practical training in the laboratory for the study programs 'Information Technology' and 'Informatics'. Bachelor degree courses are offered specifically in the subjects 'Electricity and Magnetism', 'Signals and Systems' and 'Circuits and Electronics'.
In the master degree program, students can specialize in 'Mobile and Wireless Systems', 'Embedded Systems' and 'Pervasive Computing'. International guest professors complete the teaching program.

The institute was founded in January 2007 as part of the Department of Technical Sciences and is located in the Lakeside Science & Technology Park. Currently 34 employees work in three research groups: Embedded Systems and Signal Processing (Professor Huemer), Mobile Systems (Professor Bettstetter) and Pervasive Computing (Professor Rinner). The portfolio includes not only basic research but also projects with selected international and national partners in industry and science. A particular focus is on projects at Lakeside Labs, a research center for self-organizing networked systems, closely linked to the university.

Our mission is to create the future with excellent achievements in research and teaching, in an international and impressive atmosphere.

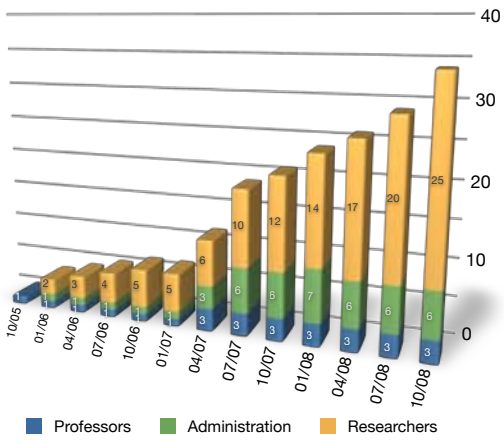
Personnel Development

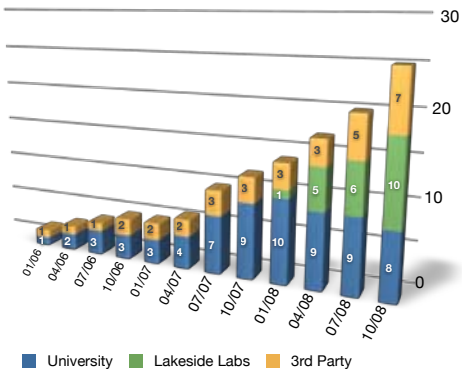
The first graph on the right shows the personnel development since the foundation of the Chair for Mobile Systems in October 2005. Our institute has 14.75 positions in total: 3 professors, 3 secretariats, 1 technician and 7.75 scientific assistants.

Furthermore the institute employs 17 research assistants with third party funds (13 PhD students and 4 post doctorate positions). The second graph on the right shows the development of the scientific staff divided into institute positions and third party funds, the latter being sub-divided into projects within the scope of Lakeside Labs and those financed by other funding agencies. Three years after the occupancy of the first position, with altogether 34 employees the institute is already the largest in the faculty of technical sciences.

We have a very international orientation, which is also reflected in our employees: 40% of the scientific assistants come from abroad or have an international degree, including the excellent universities, RWTH Aachen University, Carnegie Mellon, EPFL, University of Michigan and the Technical University of Munich, as well as renowned universities in Budapest, Erlangen, Istanbul, Paris, Porto and Udine. The Austrian scientific assistants come from Klagenfurt University and the technical Universities in Graz and Vienna, and the College of Higher Education of Upper Austria. Nearly all scientific assistants have gained experience abroad during their studies or whilst working on their PhDs. Notably, all scientific assistants are from Europe.

The competence of our team focuses not only on the core subject of the institute but also has definite interdisciplinary components. The scientific assistants have degrees in the fields of information technology, telematics, electrical engineering, computer science, mathematics, mechatronics and mechanical engineering.





Infrastructure

We maintain our own research and teaching infrastructure, comprising a laboratory for teaching ('ICT Laboratory'), three research laboratories and a pool of servers, workstations, and software tools.

The 'ICT Laboratory' was set up together with the sister institute of Intelligent System Technologies and contains 16 workplaces for bachelor and master degree laboratory courses in the field of information and communication technology. The workplaces are equipped as measuring stations with signal generators, oscilloscopes, soldering stations, and various measuring devices.

The 'Embedded Systems and Signal Processing' laboratory contains eight workplaces for PhD and diploma students. The equipment includes laboratory workplaces with measuring devices for the analysis of mobile radio signals, signal generators, and devices for the analysis of power electronics. The laboratory 'Future Networking' offers three workplaces for development in the field of wireless sensor networks (Tmotes), four workplaces on a FPGA-based hardware platform for the development and testing of innovative mobile radio protocols as well as measuring equipment.

The 'Pervasive Computing' laboratory is equipped with six workplaces for the development of pervasive computing applications on various embedded platforms and with three workplaces for developments in the field of sensor networks (SunSpots). The laboratory is also used for the testing of multi-camera applications.

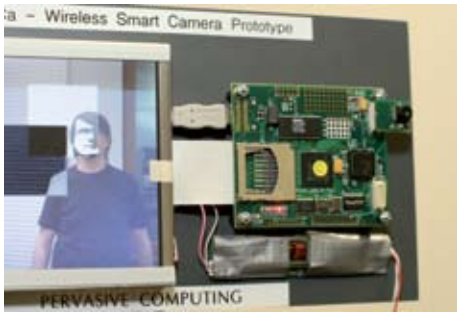
The software equipment comprises licenses for Matlab, Maple, Mathematica, the C++ library LEDA, Adobe Creative Suite as well as licenses for program development on various embedded platforms.

Research Areas

We engage in selected research questions for the design, modeling and analysis of networked, wireless and embedded systems. The spectrum ranges from hardware components and network protocols to applications, from pure knowledge-driven basic research to prototype realization. This focus is unique in the Austrian academic environment.

A high value was placed on a 'good mix' of research projects. For this reason the institute portfolio currently includes the following project types (end of 2008):

- Institute's own projects, scholarship projects as well as projects funded by the 'FWF' (Austrian Science Fund), in which basic and technological questions are studied at a high scientific level;
- Projects funded by the 'FFG' (Austrian Research Promotion Agency), in particular within the scope of the FIT-IT und COMET programs, in which a small consortium of industrial and academic partners deals with technological and application-oriented questions;
- Research assignments from industrial partners, in which both sides work on technological and application-oriented questions;
- Projects within the scope of Lakeside Labs, which enable large research ventures to be carried out in collaboration with several institutes and external partners and in this way to create a thematic main focus;
- A project funded by the European Research Council (ESF) for the mobility and international networking of junior scientists.



People

Embedded Systems and Signal Processing

Professor

Mario Huemer

Mario Huemer received the Dipl.-Ing. degree in Mechatronics and the Dr. techn. (Ph.D.) degree from the Johannes Kepler University of Linz, Austria, in 1996 and 1999, respectively. Before joining Klagenfurt University he was with the University of Linz (1997-2000), Infineon Technologies Austria (2000-2002), the University of Applied Sciences of Upper Austria (2002-2004), and the University of Erlangen-Nuremberg, Germany (2004-2007), where he held the position of an associate professor. In March 2007 he was appointed as a full professor for Embedded Systems and Signal Processing at Klagenfurt University. He authored and co-authored more than 100 articles in journals, magazines, books, and conference proceedings. He is member of the IEEE, VDE, EURASIP, and ÖVE.

Office Management

Ursula Rotter

Member since 02.04.2007

Ursula Rotter was born in Klagenfurt in 1974. After A-level at the secondary educational establishment for financial occupations in Klagenfurt she passed a young entrepreneurs-training at the WIFI. In 1995 she started her basic training for civil service at Klagenfurt University. During her work at the Admission Department and later at the Faculty for Interdisciplinary Research she started to study Education specializing in Adult and Vocational Education which she finished in May 1995. From 1999 – 2007 she worked as secretary at the press department. Since April 2007 she supports the Embedded Systems and Signal Processing Group.

Matteo Agostinelli

Research Staff member since 01.09.2008

Matteo Agostinelli was born in Udine in 1981. In 2006 he received the Laurea Magistrale (M.S.) degree at the University of Udine in Electronics Engineering. From 2006 to 2008 he worked as a research associate at the University of Udine, focusing on low-power digital circuit techniques and nanoscale innovative devices (Multi-Gate FETs, FinFETs). In September 2008 he started his PhD work in the Embedded Systems and Signal Processing Group in cooperation with Infineon Technologies and Lakeside Labs. His research is currently focused on energy-efficient PWM DC-DC converters for wireless applications.

Christian Hofbauer

Research Staff member since 01.09.2007

Christian Hofbauer was born in St. Peter am Wimberg, Austria, in 1982. From 2002 to 2006, he studied Hardware/Software Systems Engineering at the College of Higher Education (Applied Sciences) of Upper Austria. He received his Dipl.-Ing. (FH) degree in 2006. He did his internship and made his diploma thesis at the research institute IMEC in Belgium. In September 2007 he joined the Embedded Systems and Signal Processing Group. Currently, he focuses his research activities on physical layer aspects of cooperative relaying.

Christian Lederer

Research and Teaching Staff member since 01.12.2007

Christian Lederer was born in Villach in 1982. His technical education started at the HTL for Electronics, Telecommunication and Computer Techniques in Klagenfurt. After school he was working at the Carinthian Tech Research (CTR) till he started his studies of Telematics at the Graz University of Technology. During the studies he was involved in several projects for the automotive industry and wrote his master thesis in the field of "Chipcards" at Infineon. In December 2007 he joined the Embedded Systems and Signal Processing Group, where his research focuses on digitally enhanced RF-transceiver architectures.

Jakob Mayring

System Administrator since 01.07.2007

Jakob Mayring was born in Munich in 1983. He moved to Klagenfurt in 2002. During his school days he helped to plan and deploy photovoltaic systems. In Klagenfurt he finished the school and enrolled in the bachelor program of computer science at the University of Klagenfurt in 2003. In the winter semester 2006/2007 he worked at the Information Technology Services of the University (Zentraler Informatik Dienst). In July 2007 he brought his knowledge to the Embedded Systems and Signal Processing Group where he is working as a System Administrator.

Alexander Onic

Research and Teaching Staff member since 15.04.2007

Alexander Onic was born in 1981. He started his studies of electrical engineering at the University of Erlangen-Nuremberg in 2001. After choosing information technology as his major subject he emphasized on signal processing and information theory in his education. He concluded his studies and received the Dipl.-Ing. degree in April 2007. In the same month he joined the Embedded Systems and Signal Processing Group at Klagenfurt University. His current research focuses on the theory and on applications of compressive sampling.

Robert Priewasser

Research Staff member since 15.09.2007

Robert Priewasser was born in Salzburg, Austria, in 1982. He received the Dipl.-Ing. (FH) degree at the College of Higher Education (Applied Sciences) of Upper Austria, study direction Hardware/Software Systems Engineering with distinction. During his studies he spent 9 months at the research institute IMEC in Belgium, working on low power design for a wireless software defined radio platform. He also wrote his diploma thesis at IMEC in the field of forward error correction codes. In autumn 2007 he started his PhD work in Klagenfurt. The research focus is on efficient power supplies for embedded platforms in general, and on PWM-based DC-DC converters in particular.

Thomas Schlechter

Research and Teaching Staff member since 01.04.2007

Thomas Schlechter was born in Treuchtlingen, Germany, in 1979. He received the Dipl.-Ing. degree in EEI (Electrical Engineering, Electronics and Information Technology) from the University of Erlangen-Nuremberg, Germany, in 2007. In April 2007 he moved to Klagenfurt, where he is working as a research and teaching staff member at the Embedded Systems and Signal Processing Group. In Klagenfurt he is doing research in the field of RFID/NFC in cooperation with the company NXP, Gratkorn, Austria.

Andreas Weiss

Research Staff member since 07.05.2008

Andreas Weiss was born in 1981 in Güssing, Austria. After completing the HTL for Electronic Data Processing and Organisation in 2000, he started studying Telematics at Graz University of Technology. In his master thesis he developed an embedded Prototype Platform for Sensor Fusion in Traffic Monitoring. In May 2008 he joined the Embedded Systems and Signal Processing Group as a research assistant. His PhD thesis is done in cooperation with EADS Germany. The research is focused on the topic of Track-before-Detect Radar Signal Processing Algorithms on FPGA and Microprocessor systems.

People

Mobile Systems

Professor

Christian Bettstetter

Christian Bettstetter studied electrical engineering and information technology at the Technische Universität München, Germany, where he received the Dr.-Ing. (summa cum laude) and Dipl.-Ing. degree in 2004 and 1998, respectively. From 2003 to 2005, Christian was a senior researcher at DoCoMo Euro-Labs. From 1998 to 2003, he was a research and teaching staff member at the Institute of Communication Networks at TU München. He co-authored the Wiley book "GSM - Architecture, Protocols, and Services", and published 20 articles in journals, magazines, and books, and more than 50 papers in conference proceedings. One of this papers received the 2004 outstanding paper award from the German ITG. In 2005, he was appointed as a full professor for Mobile Systems at the Alpen-Adria-Universität Klagenfurt.

Office Management

Kornelia Lienbacher

Member since 01.12.2008

Kornelia Lienbacher graduated from the secondary educational facility for financial occupations in 1984 and subsequently spent a year in the USA. She started her professional career as a bilingual secretary at the sales department of an export-oriented company in Klagenfurt. In 1993 her first of three children was born and her priorities shifted to developing her soft skills and engaging in voluntary services. In order to brush up her administrative skills she completed the ECDL and an Italian language course in 2007 which led to her job as an assistant to the technical management of a multinational company near Villach. She joined the staff of NES in December 2008.

Andrea Krammer

Member from 21.12.2005 until 31.12.2008

Andrea Krammer did her language studies at the Karl-Franzens-Universität Graz, the Università per Stranieri and the Università degli Studi (Italy), and she spent a year in Milan teaching German as a foreign language. She obtained a Master of Arts in German and Italian (Secondary School Teacher Accreditation) (with distinction) from the University of Klagenfurt in 2001. Before she joined the Mobile Systems Group, she worked as a teacher and trainer in Austria and Italy and as an office manager at the European Academy of Sciences and Arts in Vienna. She left the Mobile Systems Group in December 2008.

Helmut Adam

Research and Teaching Staff member since 01.04.2006

Helmut Adam studied telematics at TU Graz, where he received the Dipl.-Ing. degree in 2005. In the course of his master thesis, which was in the field of wireless sensor networks, he worked at the sense and control department of Infineon Technologies Austria. After his graduation he rejoined Infineon as a verification engineer responsible for sensor networks and the automation of chip verification. At the Mobile Systems Group, his research area is in the field of cooperative spatial diversity in wireless ad hoc networks. He is also tutoring an introductory course about electrical engineering and physics for information technology.

Günther Brandner

Research Staff member since 15.03.2008

Günther Brandner was born in 1982. He attended the Business Academy in Villach and worked for a Credit Institute between September 2001 and January 2002. Between 2002 and 2007 he studied Computer Science, specializing on cryptography, at the University of Klagenfurt, where he received the Dipl.-Ing. degree with distinction. Since March 2008 he is a member of the Mobile Systems Group at Klagenfurt University where he is working towards his PhD. He is focusing his research activities in the field of cooperative relaying in wireless networks. In particularly, he is concerned with relay selection protocols.

Sérgio Crisóstomo

Research Scholar since 01.10.2006

Sérgio Crisóstomo studied electrical and computer engineering at the University of Porto, where he received the MSc and Dipl.-Ing. degree in 2003 and 1997, respectively. From 1997 to 2002 he worked as a researcher at INESC Porto. From 2002 to 2006 he was a researcher at the Laboratory of Artificial Intelligence and Computer Science, University of Porto. In 2006, he was granted a PhD fellowship from the Portuguese Science & Technology Foundation, and is now doing its PhD research both at the University of Porto and at Klagenfurt University. His topic is flooding in random networks including network coding based approaches.

Dominik Egarter

System Administrator since 05.11.2007

Dominik Egarter was born in 1986 in Spittal an der Drau. He attended the Higher Technical School in Klagenfurt for Electrical Engineering and graduated in 2007. Since autumn 2007 he is a student at Klagenfurt University. He studies Information Technology. In December 2007 he joined the Mobile System Group as a part-time technician. His tasks are to maintain the homepage of the institute and to organize orders. Furthermore he is responsible for technical support of IT infrastructure.

Wilfried Elmenreich

Senior Research Staff member since 05.11.2007

Wilfried Elmenreich studied at the Engineering School for Electrotechnics and Control in Weiz, Styria and graduated at the Vienna University of Technology where he received a Master's degree in computer science in 1998 and a Ph.D. degree in technical sciences in 2002. He has contributed significantly to the development of the TTP/A fieldbus protocol and the standardization of the OMG Smart Transducer Interface Standard. In the last five years, he has published more than 40 papers in the field of embedded real-time systems. He is a senior researcher at Lakeside Labs, a research center investigating self-organizing networked systems.

István Fehèrvári

Research Staff member since 01.09.2008

István Fehérvári was born in 1984 in Mór, Hungary. He studied mechanical engineering at the Budapest University of Technology and Economics specializing in Integrated Engineering. In July 2008 he received his master degree, doing his thesis in the field of vision-guided robot disassembly processes. Since September 2008 he is employed as a researcher at Lakeside Labs in Klagenfurt where he is working towards his PhD. His research is currently focused on design problems of self-organizing systems.

Michael Gyarmati

Research and Teaching Staff member since 01.06.2006

Michael Gyarmati studied Telematics at Graz University of Technology and the teacher training degree program in the school subjects of Informatics and Informatics Management and Mathematics at Klagenfurt University. In 2002 he spent a year abroad (Erasmus) at the University of Leeds, UK. In February 2005 he received the Dipl.-Ing. degree with distinction. The Mag.rer.nat. degree for the teaching degree program he earned in March 2007. Since June 2006 he is with the Mobile Systems Group as a research and teaching staff member and is writing his dissertation in the area of mobility in sparse networks.

Johannes Klinglmayr

Research Staff member since 01.09.2008

Johannes Klinglmayr studied technical mathematics at Vienna University of Technology between 2002 and 2007. He received his Dipl.-Ing. degree in the field of optimization of nonlinear systems. He also focused on the field of the finite element method in its mathematical theory. In 2007 and 2008 he studied at the University of Michigan, USA. There he obtained the Master of Arts degree in the field of applied mathematics. His center of interest were partial differential equations and their applications in physics. Since September 2008 he is part of the research staff at Lakeside Labs, working towards his PhD in the area of self-organized synchronization.

Nikolaj Marchenko

Research Staff member since 15.01.2008

Nikolaj Marchenko graduated at RWTH Aachen in 2007 with Diploma degree in Computer Engineering and main focus on Wireless Communications. During his studies he was also working with Ericsson Eurolab Aachen and Siemens Corporate Research, Princeton, NJ, USA. Since January 2008 he is employed as a researcher at Lakeside Labs in Klagenfurt where he is working towards his PhD in the area of cooperative relaying in wireless systems.

Udo Schilcher

Research and Teaching Staff member since 01.12.2005

Udo Schilcher studied applied computing and technical mathematics at Klagenfurt University, where he received two Dipl.-Ing. degrees (with distinction) in 2005 and 2006, respectively. He contributed in the standardization of the Mobile IKE protocol and the area of number theory and cryptography. He is now working for the Mobile Systems Group, where his research topic is cooperative networking, network coding, and stochastic modeling of networks. He teaches excercises in mobile and wireless systems and a lab on network simulation.

Alexander Tyrrell

Research Scholar since 01.11.2005

Alexander Tyrrell studied at the Ecole Supérieure d'Ingénieurs en Electronique et Electrotechnique (ESIEE) in Paris, where he received a master's degree in electrical engineering with a major in signal processing and telecommunications in 2005. He also did a master of research in digital telecommunications systems at the Ecole Nationale Supérieure des Télécommunications (ENST) in Paris. From 2003 to 2004, he worked as a DSP support engineer at Texas Instruments in Freising, Germany. In 2005, he started as a PhD scholar at DOCOMO Euro-Labs in Munich, under the supervision of Christian Bettstetter in the area of self-organized synchronization.

Evsen Yanmaz

Senior Research Staff member since 01.10.2008

Evsen Yanmaz received the B.S. degree in electrical and electronics engineering from Bogazici University, Istanbul, Turkey in 2000; the M.S. degree in electrical engineering from the State University of New York (SUNY) in 2002; and the Ph. D. degree in electrical and computer engineering in 2005. From November 2006 to October 2008, she held a Postdoctoral Fellowship in Computer, Computational & Statistical Sciences Division at the Los Alamos National Laboratory, where she worked on the design and development of self-organizing wireless networks. Since October 2008, she is a senior researcher working on collaborative microdrones and cooperative relaying.

People

Pervasive Computing

Professor

Bernhard Rinner

Bernhard Rinner received both his PhD and MSc in Telematics from Graz University of Technology in 1996 and 1993, respectively. Before joining Klagenfurt University he was with Graz University of Technology and held research positions at the Department of Computer Sciences at the University of Texas at Austin in 1995 and 1998/99. His research interests include parallel and distributed processing, embedded systems as well as mobile and pervasive computing. Bernhard Rinner is currently working on pervasive computer systems, multi-DSP architectures, embedded multimedia systems, and distributed smart cameras. He has authored and co-authored more than 100 papers for journals, conferences and workshops, lead several research projects and served as reviewer, program committee member, program chair and editor-in-chief. He is member of the IEEE and IFIP.

Office Management

Heidelies Aschbacher

Member since 02.04.2007

Heidelies Aschbacher was born in 1977 in Klagenfurt, Austria. She attended the Business Academy in Feldkirchen and graduated 1996. Heidelies started her professional education in tourism. She was employed as front- and backoffice manager and as manager's assistant in hotels of premium categories and was responsible for sales and marketing. In 2005 she decided for an occupational change and started to work as sales manager for both national and international businesses. Since April 2007 she supports the Pervasive Computing Group as secretary.

Bernhard Dieber

Research Staff member since 01.05.2008

Bernhard Dieber was born 1984 in Friesach, Austria. He studied Applied Informatics with a focus on distributed multimedia systems at Klagenfurt University. In 2006 he attended an exchange semester at the Swiss Federal Institute of Technology Zürich (ETHZ). In 2008 he received his Dipl.-Ing. degree, doing his diploma thesis in the field of RFID-Localization at the Institute of Networked and Embedded Systems (Pervasive Computing Group). Parallel to his studies he worked as a developer for custom software systems, mostly for sports- and medical-related systems. In May 2008 he joined the Pervasive Computing Group at Klagenfurt University.

Markus Quaritsch

Senior Research Staff member since 01.05.2008

Markus Quaritsch was born 1979 in Großpetersdorf, Austria. He studied Telematics at Graz University of Technology. In 2005 he earned his Dipl.-Ing. degree with distinction, doing his thesis in the field of embedded video surveillance systems at the Institute for Technical Informatics. In fall 2005 he started his dissertation on the SmartCam project at the Institute for Technical Informatics in cooperation with the Austrian Research Centers GmbH and received his Ph.D. degree in technical sciences in 2008 with distinction. In May 2008 he joined the Pervasive Computing Group where he works as senior researcher on the project Collaborative Microdrones.

Wolfgang Schriebl

Research and Teaching Staff member since 01.06.2007

Wolfgang Schriebl was born in 1979 in Voitsberg, Austria. He studied Telematics at Graz University of Technology, where he did his master thesis in the field of embedded video surveillance systems at the Institute for Technical Informatics (ITI). In June 2007, after working one year as an embedded software engineer at Efkon AG, he joined the Pervasive Computing Group at Klagenfurt University as a research and teaching staff member. His research interests are currently in the field of pervasive smart cameras, with a focus on distributed smart camera architectures for distributed embedded vision.

Andreas Starzacher

Research Staff member since 01.06.2007

Andreas Starzacher was born in 1982 in Klagenfurt, Austria. He studied Informatics at Klagenfurt University specializing in interactive systems. In May 2007 he received his Dipl.-Ing. degree, doing his master thesis in the field of intelligent vehicle technologies at the Institute of Smart System Technologies. In the same month he joined the Pervasive Computing Group as a scientific project member. He is currently working on the "EVis" project focusing on embedded systems technologies and sensor fusion.

Emil Stojanovski

Research Staff member since 25.03.2008

Emil Stojanovski completed his Master studies in Computer Science at EPF Lausanne in March 2007. During his studies, as an intern at the ABB Corporate Research Center in Baden, Switzerland, he worked on a project involving design and implementation of a real-time software application for substation automation protection and control. Later, also at ABB Corporate Research, he worked on his thesis in the domain of Adaptive Synchronization and Equalization for a DAPSK Modem. In March 2008 he joined the Pervasive Computing Group at Klagenfurt University, where he is working towards his PhD within the project Collaborative Microdrones.

Gerald Topar

System Administrator since 01.06.2007

Gerald Topar was born in 1981 in Klagenfurt, Austria. He attended the HTL in Klagenfurt for Technical Informatics and graduated in 2000. In spring 2001 he joined the company GLOCK in Ferlach, Austria as a member of the data processing department. In summer 2006 he received his Ing. degree. From July 2006 till May 2007 he was employed at the company Wernig in Unterbergen near Ferlach, Austria. In June 2007 he joined the Pervasive Computing Group at the University. He is responsible for the institute's server-infrastructure, the information and communication technology laboratory, and the IT-support for the Pervasive Computing group.

Roland Tusch

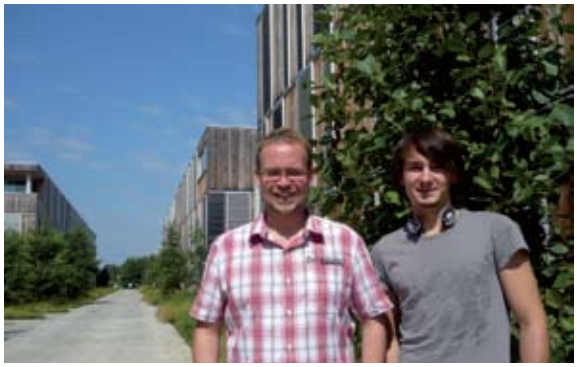
Senior Research Staff member from 01.10.2008 until 31.12.2008

Roland Tusch is a senior researcher in the cDrones project. He received both his M.Sc. and Ph.D. in Applied Computer Science from Klagenfurt University in 1999 and 2004, respectively. In 2004, he co-founded the M3-Systems research lab with the aim of transferring the research institute's multimedia know-how to the industry. Until now, a number of national projects in the area of applied and translational research have been accomplished by the lab. Roland Tusch is also author of a number of publications in the area of adaptive and context-aware multimedia services in refereed international journals and conference proceedings.

Thomas Winkler

Research and Teaching Staff member since 02.05.2007

Thomas Winkler was born in 1980 in Graz, Austria. He studied Telematics at Graz University of Technology. In 2005 he earned his Dipl.-Ing. degree with distinction, doing his thesis in the field of embedded video surveillance systems at the Institute for Technical Informatics (ITI). In fall 2005 he joined the Institute for Applied Information Processing and Communications (IAIK) as a member of the EU research project "Open Trusted Computing" working on embedded security solutions. In May 2007 he joined the Pervasive Computing Group. His research is focused on pervasive smart camera systems covering system architectures as well as operating system and middleware aspects.



IT-INTERNS SUMMER 2008: EMANUEL STEINER (LEFT PICTURE, WITH THOMAS WINKLER) AND FLORIAN SINGER (RIGHT PICTURE, WITH THOMAS SCHLECHTER)

Guest Researchers

- Univ.-Prof. Dr. Gian Luca Foresti, University of Udine, May 2008
- Univ.-Prof. Dr. Johannes Huber, University of Erlangen-Nuremberg, March-July 2008
- Dipl.-Ing. Mikhail Ivanov, Texas Instruments, March-July 2008
- FH-Prof. Dr. Mario Jungwirth, FH Wels, Nov. 2008
- Dr. Christian Micheloni, University of Udine, May 2008
- Dr. Ulrich Neffe, NXP Semiconductors Austria Gmbh Styria, Oct. 2008
- Dr. Frank Ohnhäuser, Texas Instruments, March-July 2008 and Nov. 2008
- Prof. Mubarak Shah, University of Central Florida, July-Aug. 2008

Student Assistants

- Christoph Unterrieder, bachelor student in Information Technology, 01.10.2008-31.01.2009
- Melanie Schranz, bachelor student in Information Technology, 01.10.2008-31.01.2009
- Rene Wallner, bachelor student in Information Technology, 01.10.2008-31.01.2009
- Alessandra Meyer, bachelor student in Information Technology, 15.01.2008-15.09.2008

Research Activities and Projects

The NES institute works on the design, modeling, and analysis of future networked and embedded systems. Potential application areas include telecommunications, mobile computing, and disaster management. Our project portfolio includes both long-term and short-term research. Several projects are in close cooperation with industrial and academic partners.
The following pages give an overview of our research activities and collaborators and explain in more detail some selected research topics.

Academic Partners

- Austrian Center of Competence in Mechatronics, Linz, Austria. Joint research activities and one PhD student.
- FH Oberösterreich, Austria. Joint research project.
- Georgia Tech, USA. Joint research activities.
- KAI GmbH, Villach, Austria. Joint PhD student.
- Soongsil University, Seoul, Korea. Research contract.
- TU Graz, Austria. Joint research projects and four PhD students.
- Technische Universität Wien, Austria. Joint research project and 1 PhD student.
- University of Erlangen-Nuremberg, Germany. Three external PhD students.
- University of Linz, Austria. Guest professorship.
- University of Udine, Italy. Guest professorship.
- University of Porto, Portugal. Joint research activities and joint PhD student.

Industrial Partners

- Austrian Research Centers GmbH, Wien, Austria. Joint research contract, 05/2008-05/2010 and 1 PhD student.
- Carinthian Tech Research AG, Villach, Austria. Joint research activities.
- Faller GmbH, Gmünd, Austria. Research contract, 04/2008-07/2008.
- Infineon Technologies AG Austria. Research contract, 01/2008-12/2010.
- Infineon Technologies AG, Munich, Germany. Four external PhD students.
- NXP Semiconductors Austria GmbH. Research Contract, 01/2008-12/2008.
- DICE Linz GmbH. Joint research activities and external PhD student.
- Siemens AG Munich, Germany. External PhD students and EU project RESOLUTION.
- Austrian Research Centers. Research contract, 11/2007-04/2008
- EFKON AG Graz, Austria. Research project, 05/2007-04/2010.
- EVK GmbH Grambach, Austria. Research contract, 12/2007-02/2008.
- NXP Research Eindhoven. Joint master theses and internships.
- France Telecom Group, Orange Labs, France. Research contract, 09/2006-08/2008.
- DoCoMo Communications Laboratories Europe GmbH, Munich, Germany. Research scholarship, joint PhD student.

Other Sponsors

- Texas Instruments Germany GmbH. Lab equipment.
- Altera Corporation, California, USA. Lab equipment.
- Sun Microsystems GmbH, Vienna. Lab equipment.

Main Funding

- The institute receives its main funding from the Carinthian Economic Promotion Fund (KWF).

Other Funding

- Middleware for network eccentric and mobile applications (MiNEMA), funded by the European Science Foundation (ESF), Steering board member from 01/06 until 12/08.
- Portuguese Science and Technology Fund (FCT), Portugal, Research scholarship, since 10/2006.
- FWF (Austrian Research Fund), since 2007.
- FFG (Austrian Research Promotion Agency), since 2007.

Embedded Systems and Signal Processing

Overview

The ***Embedded Systems and Signal Processing Group*** focuses on the system-, algorithmic-, architectural- and hardware-oriented aspects of embedded systems. Application areas are short range and cellular wireless systems, wireless positioning and radar systems as well as automotive applications. Our vision is to work on long term research projects as well as on short term topics, the latter in close co-operation with industry partners.

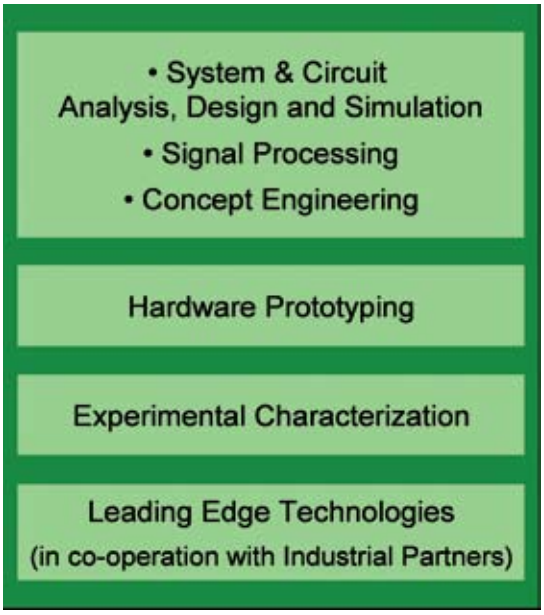
Research projects and key aspects of activities

In 2007 and 2008 we succeeded in starting projects and co-operations with excellent industry and scientific partners. The following projects are fully or partly funded by our research partners:

- Power DCDC: Power management for DC-DC converters funded by Infineon Technologies Austria and Lakeside Labs GmbH
- RELAY: Cooperative Relaying in Wireless Networks funded by Lakeside Labs GmbH
- VHD: Very High Data Rates for Contactless Smartcard Devices funded by NXP Semiconductors Austria GmbH and Austrian Research Promotion Agency within the FIT-IT framework
- Digital Signal Processing Concepts for RFICs funded by ACCM Linz and DICE Linz GmbH
- Digital Signal Processing for Radar funded by EADS, Germany

Furthermore we work on a strategic, long term fundamental research project in the field of Compressive Sampling/Compressive Sensing. Furthermore we participate in a consortium around Infineon Austria and DICE Linz, which submitted a project proposal to the FFG in the field of microelectronics. Within this project we aim at strengthening our activities in the field of Digital Signal Processing Concepts for RFICs.

The overall goal is now to focus on and strengthen the existing projects and key aspects of activity. We aim to intensify already established networks with regional, national and international industry and academic partners. Together with the neighbouring groups at Klagenfurt University and Lakeside Labs we aim to establish a unique emphasis in networked and embedded systems with international visibility, where we will contribute in the physical layer and hardware oriented research aspects.



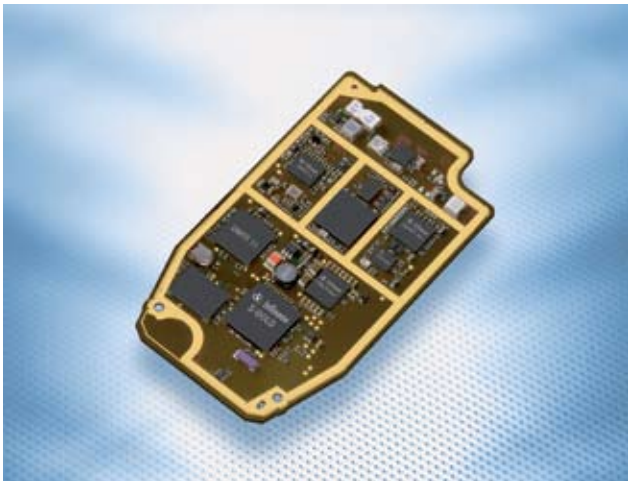
EMBEDDED SYSTEMS AND SIGNAL PROCESSING GROUP COMPETENCES

Digital Signal Processing Concepts for RFICs
Christian Lederer and Mario Huemer

Current transceivers for mobile communication devices supporting UMTS and/or HSPA are operating in full-duplex mode. That means that the transmitter and the receiver are operating at the same time, but at different frequency bands (Frequency Division Duplex).

Transmitter signals, which exhibit much more power compared to the receive signals, may leak into the receiver path because of non-linearities and/or out of band emissions. These leakage signals will be processed by the receiver path and so they will disturb the signal which should actually be received. Unfortunately, the amplitudes of the leakage signals can be much higher than the wanted signal, with the effect, that the wanted signal may be heavily distorted.

In case of homodyne receivers, which are most commonly used in modern mobile communication devices, severe problems are especially caused by second order intermodulation products. Because of second order nonlinearities in the transmitter and receiver chain and the finite isolation of the downconverting mixers, portions of the squared transmit signal will appear in the baseband. Since in homodyne receivers the RF passband signal is converted to the baseband directly, the leakage signal from the transmitter and the signal which should actually be received, cannot be separated using analog filters in the baseband.



MULTI-CHIP UMTS TRANSCEIVER
USING LARGE ANALOG FILTERS

Normally, excessive filtering (typically using Surface Acoustic Wave (SAW) filters) is already done in the RF band to avoid spurious signals after the downconverter. Such SAW filters are discrete devices that cannot be integrated into an IC, which increases the costs of the whole transceiver.

The idea is now to relax the requirements for analog filtering by digital signal processing in the digital front end (DFE). As already stated in [1], it can be shown that adaptive filtering in the baseband can relax the requirements of the filters in the analog front end. The adaptive filter estimates the influence of the squared transmit signal on the received signal. It can also be shown that the adaptive filtering after downconversion is less sensitive on the delay of the TX leakage signal than an analog adaptive filter in the RF passband. Further investigations show that the residual error after adaptive filtering is nearly independent of the leakage power, which motivates further investigations on adaptive filtering in the digital frontend.

References:
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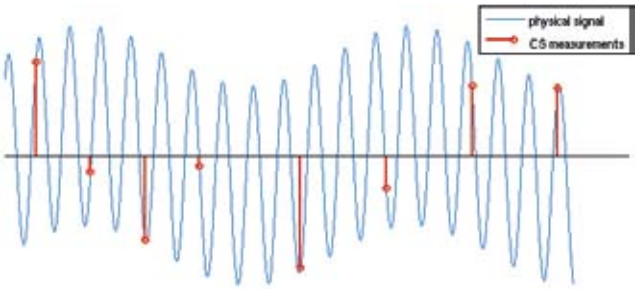
Compressive Sampling / Compressed Sensing
Alexander Onic and Mario Huemer

In order to acquire analog physical signals and all contained information the analog-to-digital-conversion needs to be designed adequately. Presently the Nyquist frequency is the mandatory minimum sampling frequency for almost every type of signal.
In recent publications a technique called Compressive Sampling or Compressed Sensing came up that allows sampling of some classes of signals far below the Nyquist frequency. The new methods allow exact signal reconstruction from sub-Nyquist sampled data with high probability [2]. Even higher is the probability of reconstructing the signal within defined error bounds. These reconstruction methods lie in the field of optimization theory and operations research.

Most signals meet the necessary preconditions for compressive sampling and so many applications can gain from the technique:

- Bajwa et al. [1] describe a wireless sensor network whose signal is acquired by a fusion center using Compressive Sampling for alleviating noise and measurement deviations.
- In decentralized sensor networks power consumption is the crucial resource for system design. A lower sampling frequency could lower power consumption significantly.
- Analog signals can be acquired in an already compressed fashion without the use of entropy coding simply by sampling below the Nyquist frequency.
- Candes mentions medical imaging applications like the MRT (magnetic resonance tomography) [2], in which incomplete frequency information needs to be dealt with on physical conditions.
- Sensing a wide spectrum used to require a very high sampling frequency. If the signal expected to be found only has a narrow bandwith, Compressive Sampling can help making the process much more efficient.



CS CAN RECONSTRUCT A NUMBER OF SINUSOIDALS BY NONEQUIDISTANT SAMPLES, EVEN WHEN THE SAMPLING THEOREM IS VIOLATED

- Technology Review also considers Compressed Sensing for image capturing devices such as cameras and medical scanners as one of the 10 Emerging Technologies 2007 [3].

The ground breaking results from recent publications in this field can have a huge impact on current `known facts' in information theory, as well as in signal processing and (multimedia) communication technologies. Since this topic startet evolving over the last few years it was mostly covered on a mathematical basis. The applicational point of view from engineering side is still underpresented and will be target for research.

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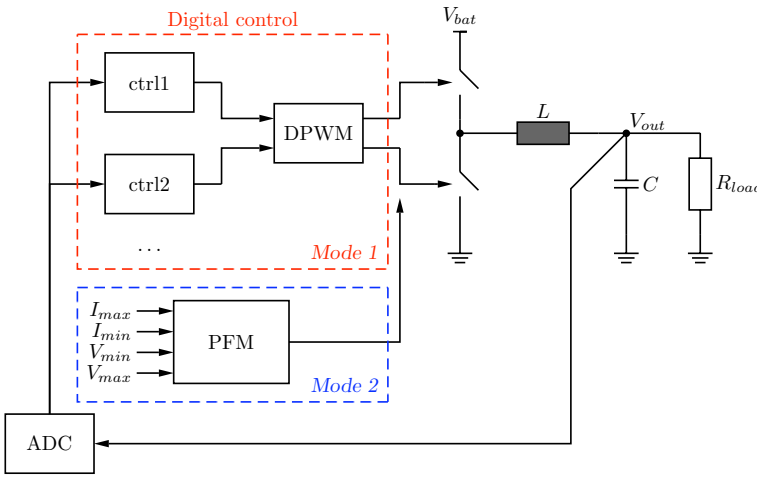
[2] E.J. Candes, J. Romberg, and T. Tao. Robust uncertainty principles: exact signal reconstruction from highly incomplete frequency information. Information Theory, IEEE Transactions on, 52(2):489{509, Feb. 2006.
[3] Kate Greene. Tr10: Digital imaging, reimagined. Technology Review, March 2007.

Power DCDC - Power management for DC-DC converters

Robert Priewasser, Matteo Agostinelli and Mario Huemer

The trend in recent hardware system designs, especially when they are battery driven (eg. notebooks, cellular phones or handhelds), is to operate the different components of the system (RF ciruits, baseband processor, etc. in case of a cellular phone) with different supply voltages, in order to achieve optimum performance and high power efficiency.

The task of a DC-DC converter is to produce this variety of required supply voltages by decreasing or increasing the voltage level offered by the source power supply (e.g. a battery). The challenging part is to perform this voltage conversions as power efficient as possible. The control scheme can be implemented both, in an analog and in a digital fashion. Digital controllers are able to offer more flexibilty and the opportunity to integrate more complex, maybe even adaptable control logic. Another possibility that has been taken into account is to apply a sliding mode control to DC-DC converters. The major advantages of the sliding mode control are its stability and robustness against large parameter, line and load variations. This is because it is designed under large-signal operating conditions. On the other hand PWM controllers are small-signal-based, so they often perform unsatisfactorily under large-signal operating condition. Sliding mode control is also relatively easy to design and implement with respect to other types of nonlinear controllers. The project funded by Infineon Villach and Lakeside Labs aims to investigate and also develop such control schemes for future DC-DC converters, with the goal to reduce the overall power consumption.



SCHEMATIC OF A DC-DC CONVERTER INCLUDING A CONTROL LOOP

The figure above depicts a high level schematic of a digitally controlled DC-DC converter. As a first step, the analog components of the DC-DC converter must be known in order to control the circuit in an optimized fashion. It might be necassary to investigate adaptable control logic, which autonomously can estimate the parameters of the external elements (tolerances of coils, capacitors, etc.). With a more accurate knowledge of the control path, the control process can be optimized. Furthermore, power savings can possibly be achieved by optimizing the transient effects when switching the circuit on and off, which is a common task in modern designs, where only active hardware blocks are powered on. The research results should be verified by simulations and by measurements on real prototype hardware.

Very High Data Rates for Near Field Communication (VHD)

Thomas Schlechter and Mario Huemer

Near Field Communication (NFC) is a new, short-range wireless connectivity technology that evolved from a combination of existing contactless identification and interconnection technologies. Products with built-in NFC will dramatically simplify the way consumer devices interact with one another.

NFC technology is currently mainly aimed at being used with mobile phones. Though, plenty of applications will be possible such as:

- Mobile ticketing in public transport: An extension of the existing contactless infrastructure.
- Mobile Payment: The mobile phone acts as a debit credit payment card.
- Smart poster: The mobile phone is used to read RFID tags on outdoor billboards in order to get info on the move.
- Bluetooth pairing: In the future pairing of Bluetooth 2.1 devices with NFC support will be as easy as bringing them close together and accepting the pairing. The process of activating Bluetooth on both sides, searching, waiting, pairing and authorization will be replaced by a simple "touch" of the mobile phones.
- Electronic passport (containing finger prints, photos, information for identification by the human iris, etc.)

Operating at 13.56 MHz and transferring data at up to 848 Kbits/second, NFC provides intuitive, simple, and safe communication between electronic devices. NFC is both a “read” and “write” technology. Communication between two NFC-compatible devices occurs when they are brought together within about 10 centimeters range. The goal of this research project is to push the transmission rates up to several Mbits/s.

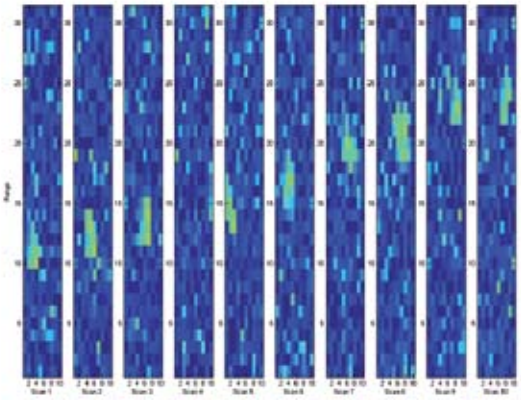
NEAR FIELD COMMUNICATION EXAMPLE

The project is done in co-operation with NXP Semiconductors Austria GmbH, Graz University of Technology and College of Higher Education of Upper Austria, and is funded by the Austrian Research Promotion Agency within the FIT-IT framework.

First system simulations results and prototype measurements show promising results up to data rates of 6.5 Mbits/s. With the help of novel signal processing techniques we aim at further increasing these results.

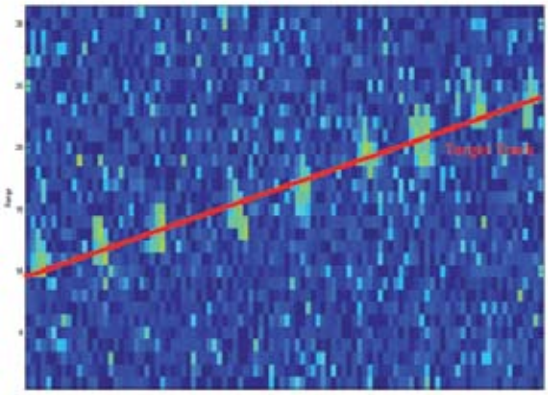
Track before Detect
Andreas Weiß and Mario Huemer

Today's Radar (Radio Detection and Ranging) systems usually incorporate a strict hierarchic signal processing pipeline: first detecting the target based on samples of one scan and than tracking the target through consecutive scans resulting in the track (trajectory) of the target.
The flaw in this "Detect before Track" sequence is the fact that weak targets are not detected based on information obtained from one scan. But the detection performance can be improved by analysing more than one scan and making a detection decision based on spatial-temporal correlation of the samples: "Track before Detect".



SEQUENCE OF SINGLE SNAPSHOTS

In this project new processing methods and algorithms based on the "Track before Detect" approach are investigated. A simplified explanation would be the analogy, that the "classical" processing chain is examining single snapshots of the scenario, while the "Track before Detect" methods are using a video consisting of several of these snapshots. The following images illustrate how the inspection of several frames reveal the



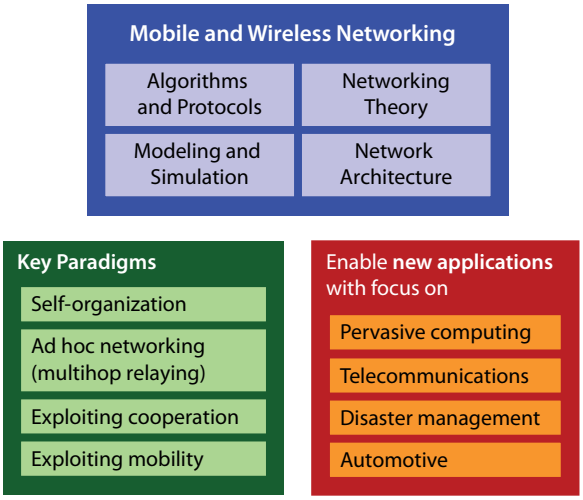
TRACK BEFORE DETECT APPROACH

track of the target, while in a single frame the target cannot be distinguished from the clutter.
With this new approach the shortcomings of the classical architecture, in noisy environments and for small targets, can be eradicated.
Putting these mathematically challenging and computation-intensive methods to practice on state of the art hardware consisting of FPGAs and microcontrollers is the second part of this project leading to a hardware/software co-design process with high demands to the system with regard to processing time, precision and adaptability. Special focus is given to the distribution of parallelisable and sequential algorithms parts to the suitable hardware components. The key challenge is to find the optimal balance between algorithmic complexity and hardware resources.

This research project is done in co-operation with EADS (European Aerospace Defense and Space Company), Ulm, Germany.

Mobile Systems

The research portfolio of the *Mobile Systems Group* is depicted on the right side. We perform research on networking issues in mobile and wireless systems. This includes the design of algorithms and protocols, contributions to networking theory, network architectures, and modelling and simulation aspects. Our goal is to enable new applications of wireless communication that go beyond classical applications of cellular networks and wireless local area networks.



RESEARCH PORTFOLIO MOBILE SYSTEMS GROUP

Current research activities and projects are as follows:

- **Distributed Slot Synchronization in Radio Networks.** We develop a distributed algorithm for slot synchronization suited for ad hoc networks. Our approach has been inspired from biology, from the synchronous flashing of fireflies. We noticed that a one-to-one transfer of the well-known firefly synchronization to wireless networks is infeasible, due to some characteristics of radio communications. We thus invented significant modifications, making the synchronization converge in multihop radio networks. Our scheme achieves high synchrony rates and a synchronization accuracy only limited by the propagation delay.
- **Cooperative Relaying in Wireless Networks.** Cooperative relaying is a new wireless communication technique promising significant gains in throughput and energy-efficiency of mobile systems. It exploits the broadcast nature of the wireless medium and benefits from a new, distributed form of spatial diversity that mitigates the negative effects of signal fading and interference. We contribute to selected areas of cooperative relaying from a networking perspective. Research work includes the following areas: protocols for relay selection, medium access issues, system and protocol architectures, and implementation and measurements on a wireless hardware platform.
- **Modeling of Sparse Networks**. Recently, the notion of "exploiting mobility" gained interest in the research community, especially in the areas of mobile ad hoc networks and delay-tolerant applications. Mobility can yield benefits in particular if the network topology is sparsely connected, i.e., it consists of several isolated clusters so that paths between nodes are only available over time. The main goal of our work in this area is to design and evaluate algorithms for information delivery that exploit the inherent mobility of nodes in sparse wireless networks. As a first and important step we have made contributions to the modeling and mathematical analysis of sparse network topologies, in particular with inhomogeneous spatial node distributions and random mobility.
- **Flooding in Random Networks.** Information dissemination in communication networks is a key function whose effectiveness depends both on the chosen dissemination algorithm and on the underlying network topology. We study information dissemination in networks modeled by different kinds of random graphs. Algorithms under investigation are probabilistic flooding, multipoint relaying, and network-coded flooding.

Emergent Slot Synchronization in Wireless Networks
Alexander Tyrrell and Christian Bettstetter

Slot synchronization is an essential building block in wireless networking. It enables time coordination between nodes necessary for various lower-layer functions, such as slotted medium access, distributed sensing, scheduling of sleep phases, and cooperative diversity.

Our approach for self-organized slot synchronization is to learn from nature. In South-East Asia, huge swarms of fireflies gather in trees and flash in perfect synchrony. A mathematical model for this interesting phenomenon was derived in the 1990s. We apply this mathematical model and adapt it to work in wireless radio environments.

Direct application of this model to wireless networks is impractical, and an adaptation was developed to address constraints of this environment. The proposed adaptation retains some key features of the original algorithm, such as high accuracy and an inherent robustness to failure and disturbances.

Work accomplished in 2008

- The behavior of the algorithm was comprehensively assessed. A metric characterizing the state of local synchronization was presented, and helps identifying the stability of the system and quantifies the level of synchrony. Furthermore the achieved accuracy was examined with regards to the network topology, and it was shown that it is limited by the propagation delay among neighboring nodes but is much often less.

- Our network synchronization concept was integrated into the system concept of the European project IST-WINNER, which aims at defining a radio interface for the fourth generation of cellular systems.

- A student completed his internship in Munich with DoCoMo Euro-Labs. During this time, he studied the robustness of the synchronization algorithm with regards to the network topology and to the introduction of malicious nodes in the network.

- Dissemination of our work spawned four peer-reviewed conference papers, including a Best Student Paper award at the First International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2008) in Aalborg, Denmark.

Outlook

In 2009, the PhD dissertation of Alexander Tyrrell will be submitted; it will summarize the last three years of research on this topic.

Modeling of Sparse Networks

Michael Gyarmati, Udo Schilcher, Christian Bettstetter and Günther Brandner

Introduction

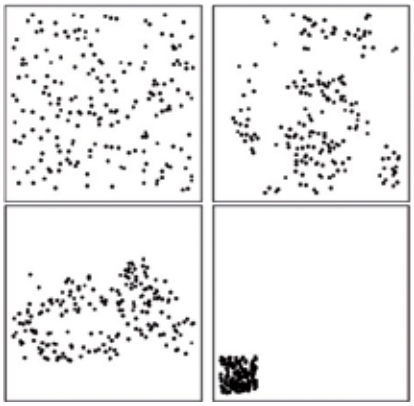
In a sparse network nodes form clusters that in general are too remote to allow any direct communication between them. Therefore, sparse networks require some mobile nodes (ferries) that carry data from one cluster to another to establish a path over time. Due to the duration of this physical mobility sparse networks need to be delay tolerant.

Problem Statement

The development of protocols for sparse networks requires an appropriate simulation framework. The inhomogeneity of the spatial distribution of nodes has impacts on various network parameters (e.g., connectivity). Nevertheless, many researchers use the uniform distribution to position the nodes. Second, the performance of the protocols highly depends on the degree and type of mobility involved. However, most traditional random mobility models converge to a uniform spatial distribution.

Work done so far

We define an objective measure for the inhomogeneity of spatial distributions [1]. Given a "real" node distribution (e.g., obtained via GPS) this measure assesses the inhomogeneity on a scale from 0 (uniform) to 1 (inhomogeneous). Using this measure, adequate randomly generated node distributions can be selected for simulations. We further investigate how random inhomogeneous node distributions can be generated [2]. For this purpose, we devise a generic method based on the thinning of a uniform distribution that can generate distributions in any shades of inhomogeneity. We further theoretically derive its most useful stochastic properties so that our algorithm may also be used by fellow researchers. We now investigate the impact of well-known random mobility models on the inhomogeneity and find that they destroy the initial inhomogeneity. Thus, we present an adapted version of the random waypoint mobility model, which guarantees to maintain the requested inhomogeneity over time [3].



UNIFORM AND INHOMOGENEOUS SPATIAL DISTRIBUTIONS

Outlook

We also find it necessary to be able to objectively measure mobility. Such a measure can help to determine if the network's mobility is sufficient to support various protocols and also to select the best message ferry. Finally, all achieved sparse network simulation building blocks will be used to devise new or improve existing protocols on sparse networks.

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[3] M. Gyarmati, U. Schilcher, G. Brandner, C. Bettstetter, Y. W. Chung, Y. H. Kim. Impact of Random Mobility on the Inhomogeneity of Spatial Distributions. In Proc. IEEE GLOBECOM, New Orleans, LA, USA, 30 Nov. - 4 Dec., 2008.

Flooding in Random Networks

Sérgio Crisóstomo, Udo Schilcher, and Christian Bettstetter

Information dissemination in communication networks is a key function whose effectiveness depends both on the chosen dissemination algorithm and on the underlying network topology. We study information dissemination in networks modeled by different kinds of random graphs. Algorithms under investigation are probabilistic flooding, multipoint relaying, and network-coded flooding.

Typically, information dissemination algorithms resort to replication based forwarding where nodes replicate and forward the information they receive, preserving message's integrity. The spectra of information dissemination algorithms was recently enlarged by the advent of the network coding (NC) paradigm where the message integrity principle is abandoned. This paradigm is based on the important observation that the act of combining different information flows in intermediate nodes can lead to faster and more robust dissemination of information. Dissemination algorithms can be further categorized in two main classes: In the probabilistic class messages are conveyed according to a set of probabilistic rules, whereas the deterministic class advocates deterministic algorithms.

Our work addresses the following aspects:

- analysis of how dissemination algorithms need to be tuned to ensure information outreach;
- analysis of how the topology of the underlying network influences the performance of the information dissemination;
- comparison between competing information dissemination paradigms and algorithms;
- design of new efficient dissemination algorithms.

In the last year, our research led to the publication of three papers in international conferences: In the first one (ICCSC 2008, Shanghai, China, May 2008), we address the following questions: (a) How does NC based flooding competes against replication based flooding? (b) What benefits may we expect from the use of NC based flooding? (c) How does the topology influences the behavior of NC based flooding? To answer these questions we performed an analytical and simulation study where we characterized the benefits of NC based flooding in terms of number of transmissions per source message and in terms of delay. Our work shows that in networks modelled by Erdös Rényi random graphs and Random Geometric graphs, the number of transmissions required to flood a message with the NC flooding algorithm under consideration is asymptotically independent of the number of nodes. The simulation results comparing NC flooding with Multipoint Relaying based flooding corroborate the benefits in terms of number of transmissions and delay that we obtain by the use of network coding.

In another paper (ICCS 2008, Guangzhou, China, Nov. 2008) we address information dissemination in broadcast environments with small-world network (SWN) topologies. We investigated how the topological properties of SWNs (in particular small network diameters and large clustering coefficients) potentiate the spread of information under distinct information dissemination paradigms (i.e. network coded and replication based paradigms). We show, both analytically and through simulation, that network coding requires a smaller number of transmissions and shorter propagation delays, conjugated with impressive steadiness under distinct topological configurations.

Finally, in a paper accepted for publication (ICC 2009, Dresden, Germany, June 2009) we address the problem of which forwarding probability must be used to ensure global information outreach with probabilistic information dissemination algorithms. We first address probabilistic flooding algorithms operating over networks modelled as Erdös Rényi random graphs. We derive a lower bound for the probability of global outreach as function of the forwarding probability and complement the analytical results with numerical simulations.

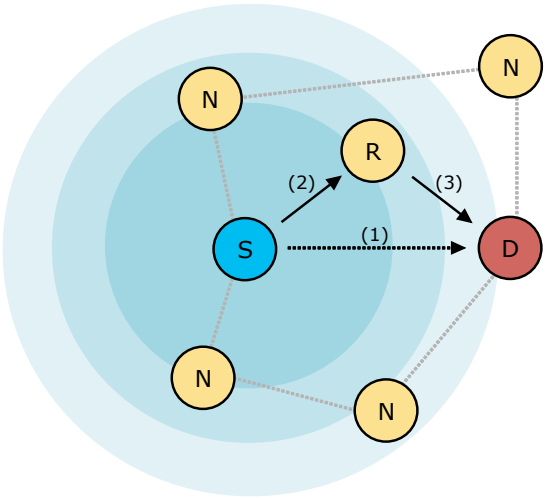
Cooperative Relaying in Wireless Networks

Helmut Adam, Christian Bettstetter, Wilfried Elmenreich, Christian Hofbauer, Nikolaj Marchenko, Udo Schilcher

The mobile radio environment is characterized by fading effects which cause an attenuation or even loss of particular links between wireless communication partners. Fading can be categorized into large-scale fading, which is caused by distance-dependent path loss and shadowing and small scale fading, which is caused by multipath propagation, i.e. when radio waves are reflected and scattered at obstacles in the environment. While the negative effects of large-scale fading can be overcome by planning for reliable communication routes between the wireless nodes, small scale fading effects change within short time that usually does not allow to react with a change of the global communication routes.

A suitable approach to counteract the effects of small scale fading is given by cooperative relaying. Cooperative relaying builds on the concept of cooperative diversity in order to increase the reliability of a communication network without increasing the transmission power (or, respectively, to keep the same reliability for a network using reduced transmission power).
Basically, cooperative relaying exploits alternative communication paths by getting assistance from other nodes in the vicinity of sender and receiver of a currently affected communication link.
These other nodes act then as relays, i.e., a dedicated or temporarily elected wireless node that assists in forwarding information from a source node to a destination node. The relayed information flow hereby establishes a communication path concurrent to the direct communication flow from source to destination or to communication via other relays. Due to spatial and time diversity, the alternative path is uncorrelated from the fading effects on the direct link. Bringing the concept of cooperative relaying into operation brings up the following research challenges:

- Real world implementations of cooperative relaying require a reconsideration of old inter-layer interfaces as well as some layers functionality to be better applied under the new paradigm of cooperative data transmission. Theoretical capacity bounds of a cooperative relaying channel are well studied in information theory and on PHY layer, but few work is done on MAC and network layers. Currently, a usual approach is to take a existing protocols and extend it with cooperative functionality. In this way, however, benefits of cooperative relaying are often nullified by performance decrease of side-effects, since standard MAC protocols are developed only with conventional point-to-point communication in mind.
- An important aspect for applying cooperative relaying strategies is how to choose the relay out of a set of potential candidates. A protocol must support the distributed decision finding while



MESSAGE EXCHANGE WITH COOPERATIVE RELAYING

coming with minimal overhead in order to preserve the expected throughput benefit.

- Cooperative relaying does not only require the design of new communications protocols, but significantly affects physical layer related system aspects as well. Hence, intensive research is required to efficiently handle the classical tasks of wireless communications, like for instance channel estimation, channel equalization or modulation, also in a cooperative and distributed system.
- As this approach may be applied to small devices like sensor nodes, energy efficiency becomes a crucial criterion for the quality of the designed algorithms. Furthermore, the robustness of the elaborated solutions with respect to synchronization related issues establishes an important and challenging task.

The main goal of this research activity is to find solutions for these challenges and to show how these solutions can be integrated into a working system. The research methodology is, therefore, multi-faceted and includes theoretic analysis, extensive simulation and evaluation on real hardware. This way, we show also how theoretic findings can be applied in a real system. In the past year, our contributions to these problems have been the following:

- Elaborating a comprehensive state-of-the-art analysis on cooperative relaying. Thereby, relay selection protocols, cooperative channel and network coding, and physical layer aspects such as cooperative modulation have been identified as promising building blocks for cooperative relaying.
- Currently, a usual approach is to take a well-known MAC protocol, for example ALOHA or 802.11 Distributed Coordination Function (DCF), and extend it with cooperative functionality. However, we show in our work that such methodology does not necessarily lead to optimal results. Instead we are investigating a more systematic approach.
- Mathematical analysis of the collision probabilities of first messages in the slotted ALOHA protocol have shown that the optimal approach is a "slow start" method where the sending probabilities of the participating nodes increase from slot to slot. As a next step, we are aiming on implementing this protocol on sensor nodes which will allow us to verify our analytical results.
- Design of extensions to IEEE 802.11 standard protocols supporting cooperative relaying. We are assuming that relaying of transmissions is an infrequent case compared to standard direct transmission. Therefore, we have designed the protocol extension with minimum overhead for the frequent case. Simulations of the protocol show an improvement of throughput over a standard, non-cooperative IEEE 802.11 network.
- Investigating cooperative beamforming techniques that do not require perfect channel knowledge, but use less accurate and therefore less amount of feedback. As such, cooperative beamforming with codebook-based feedback has been investigated more in detail. It turns out that codebook-based approaches do not perform very well in Amplify-and-Forward networks, as this kind of inaccurate channel knowledge leads to the amplification of noisy channels.
- Measurements of fading effects on a commercial-off-the-shelf sensor network platform. Therefore, sensor nodes have been deployed in indoor and outdoor environments (including some mobile nodes) while measuring the signal strength over time of transmission signals with standard power. The data gained from these experiments will be used as input for validating algorithms with respect to their applicability in real systems.

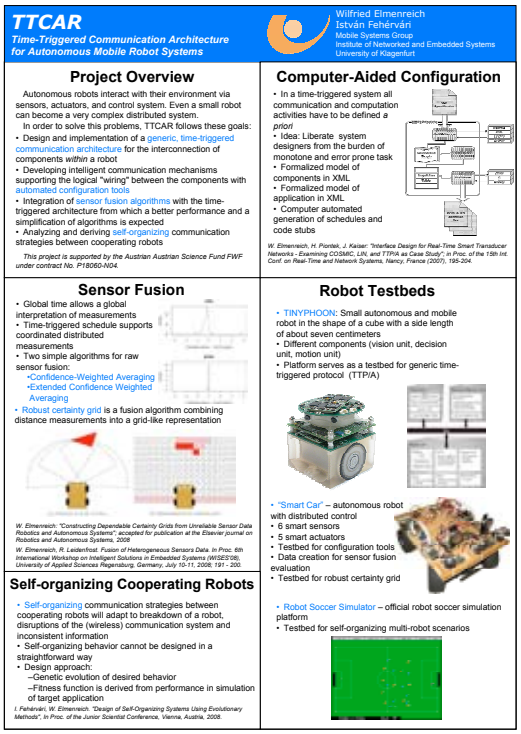
Advanced Communication Architecture for Mobile Robots

Wilfried Elmenreich, István Fehérvári

Autonomous robots interact with their environment via sensors, actuators, and a, possibly decentralized or hierarchical, control system. Even when considering a small robot, such a system can become a very complex distributed system.
Moreover, typically there exist strict real-time constraints between the components due to the existence of distributed closed control loops or important tasks such as counting odometer signals in order to infer about the robot's movement and position. Current ad-hoc implementations of communication systems, as they are present in many robot designs, do not fulfill the upcoming requirements on maintainability, manageable complexity and performance.

When considering groups of interacting robots, the communication design brings up even new challenges. Such a system will have to cope with the breakdown of a robot or the incomplete broadcast of data via wireless links between the robots. Therefore, it is required to coordinate the robots in a robust manner.

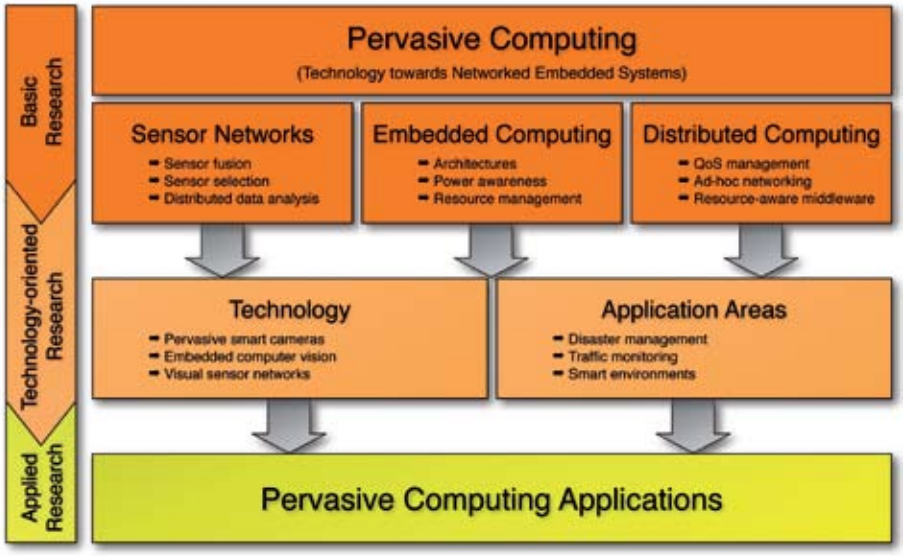
In order to address these problems, we have designed a generic, time-triggered communication architecture for the interconnection of components within a robot. As a case study we have implemented this system to internetwork components in a small but modular soccer robot. The logical "wiring" between the components is supported with automated configuration tools that release the system designer from prosy, cumbersome, and error-prone tasks which reduces the probability for configuration errors and enables a quicker change or extension of the system. Furthermore, we have identified the interface between naturally inaccurate and limited sensor data and the main application as critical for the system design.
To mitigate this, we have shown how sensor fusion algorithms can be integrated with the time-triggered communication system, which comes with the advantage of simplified and standardized interfaces for the application programmer. The time-triggered nature of the system supports a global interpretation of sensor data. Thus, the sensor fusion algorithms become simpler, easier to verify and better apt for implementation on low-cost embedded hardware. Currently, we are investigating methods for designing inter-robot behavior based on a self-organizing paradigm. These self-organizing systems are expected to show robustness against incomplete communication nets and breakdown of robots. Thus, the overall system architecture will consist of robots with a rigid time-triggered local communication system, while the cooperation between different robots is coordinated via a weaker coupling with self-organizing behavior.



POSTER FOR TTCAR

Pervasive Computing

Pervasive Computing is the trend towards increasingly ubiquitous, connected computing devices in the environment. This trend has being leveraged by a convergence of advanced technologies such as embedded computing, wireless communication and sophisticated sensing. Pervasive computing devices are not personal computers as we tend to think of them, but very tiny—even invisible —devices, either mobile or embedded in almost any type of object imaginable.



RESEARCH PORTFOLIO PERVASIVE COMPUTING GROUP

Research overview
Our research is based on the technological aspects of pervasive computing, i.e., we conduct basic and technology-oriented research towards networked and embedded systems. Within the comprehensive and interdisciplinary fields of pervasive computing we focus on the research areas sensor fusion, embedded computing and distributed systems and demonstrate the findings in application areas such as traffic monitoring and intelligent environments. Thus, our work fits very well to the research portfolio of the other research groups at our institute. The work on distributed smart cameras exemplifies very well our research activities. In this strategic research area we focus on several aspects of distributed smart cameras such as distributed resource management, collaborative image processing and sensor fusion. We develop prototypes of distributed smart camera systems and apply them in case studies such as traffic monitoring and security.

Partners and Funding
Our research is conducted in close cooperation with national and international partners both in academia as well as in industry. National partners include Graz University of Technology, the Austrian Research Centers, EFKON AG Graz, Lakeside Labs Gmbh and the Carinthian Tech Research, Villach. At the international level, we collaborate among others with Georgia Institute of Technology, Stanford University and NXP Research. Our research has been supported by companies such as Texas Instruments and Altera. We are leading research projects on "Autonomous Traffic Monitoring by Embedded Vison", and „Collaborative Microdrones" – funded by the Austrian Research Promotion Agency, and Lakeside Labs, respectively.

Pervasive Smart Camera Architectures for Distributed Vision

Wolfgang Schriebl and Bernhard Rinner

Pervasive Smart Cameras

Previous developments in the areas of communication technology and embedded systems lead to smaller, more powerful and less power-consuming system architectures. Combining these developments with the emerging technology of smart cameras leads to smaller and cheaper intelligent camera nodes. Integrating a large number of radio enabled cameras into a network, makes the idea of a pervasive smart camera realizable. The approach behind is to distribute all the processing of an image sensor network over a large number of sensors, to make the system acting more autonomously, and therefore making it usable for a wider range of applications.

WICA - WIRELESS SMART CAMERA, PROTOTYPE

Vision Sensor Architecture

Designing and developing a versatile architecture for a pervasive smart camera network in general, and an image sensor node in particular, is rather challenging. The capabilities of the nodes must range from distributed vision, self-calibration and self-organization to maintenance-free operation and wireless communication. By using different types of nodes in the network, low-level and high-level data processing can be performed on different architectures. We have proposed an architecture for a pervasive smart camera network, consisting of two layers of nodes with a well-defined scope of functions.

Distributed Embedded Vision

The main power of the pervasive smart camera approach is the large number of small and cheap vision sensors. Scene information from large areas and from different points of view can be simultaneously grabbed. One challenge in enabling vision on these sensors is to cope with the large amount of image data while taking care of the power consumption and the limited processing and communication capabilities of the embedded system. Adapting well-known vision processes to work in real-time, potentially on special-purpose hardware, and to separate between in-node and in-network processing with respect to communication overhead and information benefit, are the main goals to achieve.

Prototyping

The evaluation environment used for prototyping the vision sensor nodes involves different technologies. Besides general-purpose workstations in combination with high-level languages, special-purpose hardware is used. Digital signal processors (DSPs) are widely used in smart cameras for doing low-level image processing and analysis tasks. For evaluating both, local and distributed image processing, we use DSP developer kits provided by Texas Instruments. Currently different approaches for object classification and object tracking are implemented and evaluated.

Furthermore, the prototype of a wireless smart camera, which combines an SIMD image processor with a low-end general purpose processor, is provided by NXP Research.

The image processor can execute low-level operations on half VGA lines in a single cycle. The special character of the parallel architecture is currently evaluated by implementing methods for face detection. Further work using this platform deals with the integration of the cameras into a low-range wireless network, and with the evaluation of algorithms for distributed object classification and object tracking.

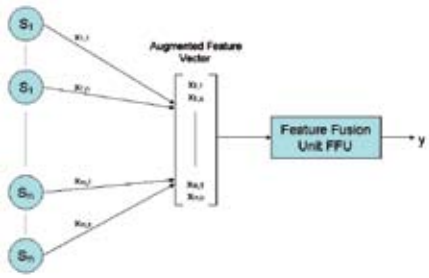
On-line Embedded Multi-Sensor Data Fusion
Andreas Starzacher and Bernhard Rinner

Motivation
The world will witness a tremendous increase in the number of vehicles in the near future. Future traffic monitoring systems will therefore play an important role to improve the throughput and safety of roads. The overall aim of this research is to improve the quality of this traffic data by fusing data captured from multiple and heterogeneous sensors.

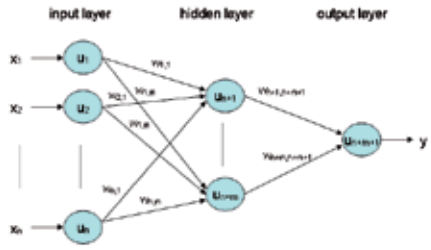
Field of Research
Multi-sensor data fusion (MSDF) is the process of combining homogeneous/heterogeneous data coming from different sensors. There are significant advantages over single source data as a result of this process such as improved overall system reliability and robustness, reduced uncertainty, extended spatial and temporal coverage, increased confidence, improved detection/classification, and many more. This research is performed as part of the "Autonomous Traffic Monitoring by Embedded Vision (EVis)" project which is a collaboration among Graz University of Technology, EFKON AG and Klagenfurt University and is funded by the FIT-IT[visual computing] program. (For more information see http://pervasive.uni-klu.ac.at/evis).

Current and Future Work
The previous year has been dominated by focusing on:

- Acoustic feature extraction algorithms: Based on the criteria of discriminability and high performance, we chose to use acoustic features in the time, spectral and cepstral domain.
- Evaluation and implementation of classification algorithms: We evaluated non-weighted k-nearest neighbor, linear and quadratic discriminant analysis for embedded online feature fusion which poses strong limitations on computing resources and timing. These algorithms are implemented on our MSDF architecture and are applied to classifying vehicles. We performed several tests on our embedded platform, such as evaluating CPU performance, memory consumption and scalability concerning number of training data and features for each algorithm [1].



FEATURE-BASED DECISION MODELING



NEURAL NETWORK REPRESENTING FFU

Additionally, a Naive Bayes classifier, support vector machine and an artificial neural network were implemented which show promising results concerning training/classification time and classification rate. Naïve Bayes will be extended for distributed fusion using a sequential Naïve Bayesian inference approach exploiting spatial and temporal relationships between sensors and sensor measurements. In order to test the algorithms on real-world data we have already recorded multisensor test data (image, audio, laser) in cooperation with EFKON AG.

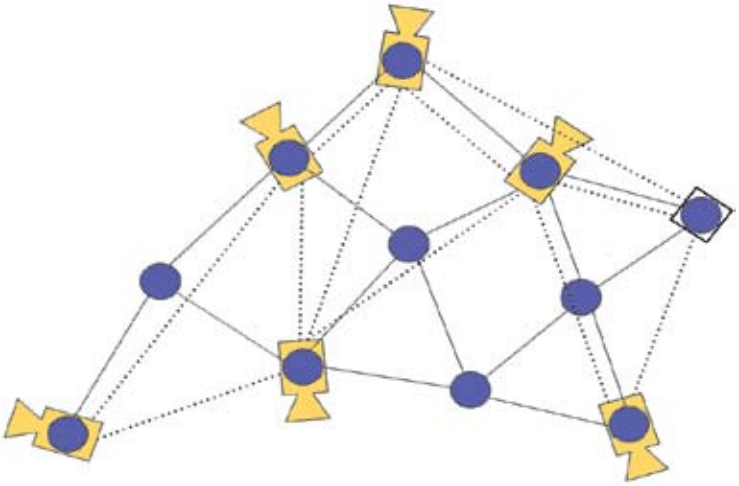
References
[1]Starzacher A., Rinner B.: Evaluating KNN, LDA and QDA Classification for Embedded Online Feature Fusion. In Proc. Internat. Conf. on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Sydney, Australia, 6 pages, Dec. 2008.

Visual Sensor Networks using multiple wireless Channels

Thomas Winkler and Bernhard Rinner

Smart Cameras

Smart cameras provide significant amounts of computational capabilities for onboard image analysis. The main benefit of this approach is that video data does not have to be streamed to a centralized processing facility but only detected events are reported. In case these events are considered important by system operators, a live video stream for visual assessment of the situation can be initiated. Most of the camera systems proposed to date rely on fixed infrastructure in terms of power supply and wired networking. Using wireless communication channels for inter-camera communication helps to reduce these requirements. Main advantages of this new class of visual sensor networks are that they are easier to deploy as less infrastructure is required and ad-hoc capabilities of wireless sensor networks can be exploited for network configuration and operation.



SYSTEM ARCHITECTURE FOR A DUAL-RADIO VISUAL SENSOR NETWORK

Architecture for Visual Sensor Networks

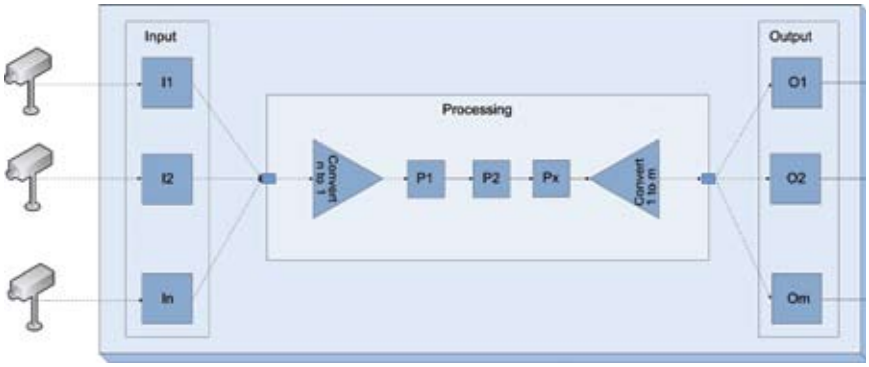
Our visual sensor network architecture consists of cameras with adjacent or overlapping fields of view as shown in the figure. Each camera node is equipped with a high bandwidth radio to facilitate delivery of video streams to a consumer. To keep installation and management as simple as possible, the high-bandwidth network does not rely on managed infrastructure like access points but uses a mesh topology for data transmission. During normal operation, the wireless network is used for system management, coordination between cameras as well as delivery of detected events to monitoring stations. In this mode, the high-performance network is not required and can be disabled to conserve power. To maintain communication links, camera nodes are equipped with an additional low-bandwidth radio represented by blue circles in the figure. They have the advantage of consuming significantly less power than the high-performance radios. Similar as for the high-bandwidth network, data between nodes of the low-performance network is routed in a multihop fashion. Since achievable communication distances for low-performance radios typically are lower than those of high-performance ones, the network is augmented with nodes only equipped with low-performance radios used for packet forwarding.

Evaluation and Future Work

To evaluate the ideas of using a heterogeneous wireless network, a prototype system was implemented based on 802.11 wireless LAN and a 802.15.4 low-bandwidth network. The feasibility of the approach has been demonstrated in a scenario where high- and low-performance radios are used in a tracking application. Power measurements have shown that the dual-radio approach can help to significantly reduce power consumption. Future work will concentrate on deploying a multi-camera testbed at our institute to facilitate extended evaluation scenarios as well as the design of a middleware layer providing a unified abstraction for the underlying heterogeneous networking technologies.

Multi-camera data aggregation and visualization
Bernhard Dieber and Bernhard Rinner

Motivation
This project aims at the application aspect of smart camera systems. Smart cameras perform image analysis onboard and deliver abstract information on the observed scene. Single-camera systems, where only one camera observes a specific scene, have limited capabilities whenever object occlusions occur. By combining data delivered from multiple cameras observing the same scene those limitations can be overcome. Therefore networks of smart cameras can be developed where objects can be detected and tracked. The resolution of object occlusion is of special importance in a multi-camera system where a certain area is monitored by two or more cameras.



A GENERIC FRAMEWORK FOR SMART MULTI-CAMERA NETWORKS

Project goals
In our research project we will develop a data aggregation and visualization system, which is able to combine the high-level output of smart cameras to form a three-dimensional model of a scene. First, the system collects the high-level frame description from each camera. Second, all objects in those descriptions are localized using the visual angles collected in the single views. By finding temporal correspondence, object tracking is performed.
Finally, the complete scene is visualized in a 3D-model. As a first step we will develop an adaptive and extendable framework to have a common evaluation platform for further development. The use of a plug-in system will enable rapid development of smart camera systems while an application performance monitoring interface will be used to evaluate and compare algorithms.
To further improve the development speed, this framework will automatically adapt to changes in data format to decrease the need for component rewriting. The framework will then be further extended to serve as a platform for smart camera networks by providing a software service interface as well as means for distributing multiple cooperating framework instances in a network.

Embedded image processing
This research is conducted in cooperation with Austrian Research Centers Seibersdorf. The ARCS Advanced Video Codec is used as an embedded smart camera platform. It delivers the high-level information, which is the input to our multi-camera aggregation.

Multi-modal visualization
The first application built on our framework will be a three-dimensional visualization of the aggregated camera data. The flexible structure of the framework, however, will enable us to quickly develop further visualization modes like Google Earth/Virtual Earth integration.

Collaborative Microdrones

Markus Quaritsch, Emil Stojanovski, Roland Tusch and Bernhard Rinner

Introduction and Motivation

Microdrones are small-scale unmanned aerial vehicles carrying payloads such as cameras and sensors. Having access to a bird's eye view over large areas through such airborne cameras is helpful in many applications, for instance, disaster management, where often only incomplete and inconsistent information is available. In such situations, aerial imagery and sensor data are valuable sources of information, helping to give an "overview" of the environment and to assess the current situation.

Project Overview

The goal of this project is to develop a system for aerial sensing based on cooperating, wirelessly networked microdrones. Several microdrones will fly in formation over a given area of interest in a self-organizing manner and deliver high-quality sensor data such as images or videos.

The idea is that a user specifies certain high-level tasks such as the areas of interest and assigns properties like observation quality or update frequency of an area. According to this high-level tasks the system generates detailed flight-routes for individual drones and groups of drones flying in formations to cover the observation areas. It is important to note that the drones fly autonomously given a sequence of waypoints and actions, without the need of a control station on the ground. During their flight, the drones sense the environment and send the acquired data to the ground station where it is analyzed in real-time and delivered to the user.

Research Focus

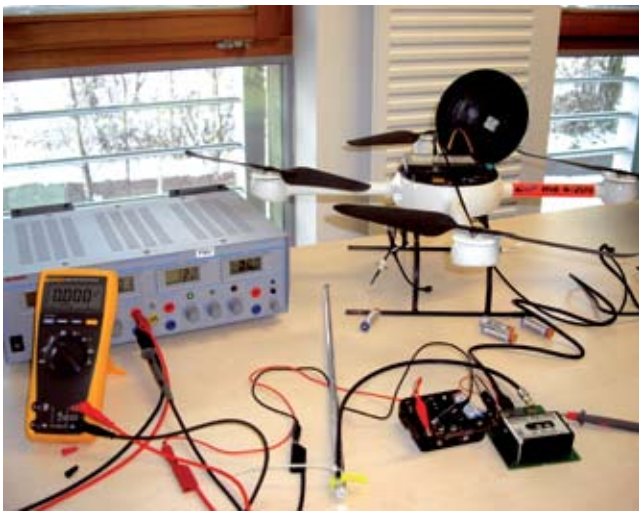
In the project we focus on three research areas:

- Flight formation and networked control
- Mission planning
- Cooperative aerial imaging

MICDRODRONE MD4-200

Flight formation and networked control investigates how to form and maintain a specific formation through distributed control via an ad-hoc network. A key challenge for the distributed control is to develop control laws that account for the non-deterministic behavior of wireless ad-hoc communication due to variable latencies and stochastic information loss. Mission planning focuses on the extension of high-level reasoning methods like first principle diagnosis and knowledge-based planning. Moreover, the integration of flight formations and the conditions under

BIRD´S EYE VIEW, TAKEN FROM THE MICRODRONE



PROGRAMMING THE MICRODRONE IN OUR LAB

which such formations improve the system behavior are addressed. The goal of cooperative aerial imaging is to advance the methods for image processing and data fusion in the area of multiple airborne cameras flying at low altitudes with significant variations in speed and orientation.

Project Partners:
This Lakeside-Labs founded project is joint work of four research groups at Klagenfurt University (Pervasive Computing, Mobile Systems, Intelligent Systems and Multimedia Communication) and Graz University of Technology with cooperation of the the Computer Vision Labs at the University of Central Florida headed by Prof. Mubarak Shah.

References
[1] Quaritsch M., Stojanovski E., Bettstetter C., Friedrich G., Hellwagner H., Rinner B., Hofbauer M., Shah M.: Collaborative Microdrones: Applications and Research Challenges. In: ACM. (Hrsg.): Proceedings of the Second International Conference on Autonomic Computing and Communication Systems. Turin, Italy, Sept. 2008, 7 pages.

Lakeside Labs

All professors of the institute were intensively involved into the development of Lakeside Labs—a new research center on information and communication technologies affiliated with the university.

Lakeside Labs in a Nutshell
Lakeside Labs is a new independent research center on information and communication technologies. Research at Lakeside Labs will develop concepts, technologies and algorithms for self-organizing networked systems. The lab is mainly funded by the European Union, funds from the region of Carinthia, and the state of Austria. The total financial resources of the lab comprise ~3.5 Million EUR/year; the human resources are 40 PY/year; both for a period of 5 years. The lab is affiliated with the University of Klagenfurt and should serve as an "incubator" for the new ICT institutes and technically-oriented INF institutes of the university, which contribute 1.5 million EUR of the resources as in-kind contributions.

Research Area
Cell phone, Internet and wireless LAN: Information and communication technology has made its mark during the past decade. Scientists at Lakeside Labs will take a further step towards the future: They are researching into 'self-organizing networked systems' and their practical usage. Mobile devices, such as cell phones and notebooks, have become our constant companions both at work and in our leisure time. We converse with our business partners whilst traveling, and send electronic photos home from our holidays. We surf the Internet via fast, wireless connections at work, on the campus and more and more frequently at home. Mobile and multimedia communication technology is all around us. However, the expectations of research and industry from this technology are considerably higher: Not only are cell phones and computers being interconnected, but more and more everyday objects of which we would

not immediately expect this. The latter form an 'Internet of things' that is intended to be of assistance to people in their daily lives. For instance, the wireless connection of cars can warn of accidents and traffic jams. For such, technically and economically extremely interesting, visions to become reality, new technologies are required that enable a spontaneous and self-organizing networking of devices – if possible, independent of a network infrastructure. Moreover, the networked devices interact actively with their environment in that they record information, for example, using sensors and cameras, and influence their environment by means of actuators. The devices are quasi embedded into their environment, where they fulfill specific tasks and form the interface between the real and virtual world. In this context, Lakeside Labs is concerned with information and communication technologies for 'self-organizing networked systems', the focal point of the research being techniques, technologies and services for such versatile, dynamic networks. For example, new algorithms and protocols for energy-saving radio transmission are being developed. "We are working on basic concepts for the design and modeling of self-organizing technical systems," explains Christian Bett-

stetter. In addition to technical development, one main aspect is human usage. Two specific application areas have been selected in which the concepts and technologies that have been developed are to be implemented as prototypes and tested. They comprise 'automotive safety' and 'disaster management'. In these two areas, the efficient implementation of the new technologies is being tested in cooperation with relevant companies and organizations.

Cars that can look around corners

'In the year 2000 alone, 40,000 people were killed and 1.7 million people injured in car accidents on the streets of the European Union. These victims and the indirect costs involved make these streets a dangerous and expensive transport route', according to Professor Kyandoghere Kyamakya, who holds the Chair in Traffic Management at the University of Klagenfurt. Driver assistance systems, such as ABS or EPS, already help to alleviate one of the causes of these accidents – human fatigue. Novel applications involve both pedestrians and traffic signs. However, these developments have their limitations. Just like people, they cannot see around corners and obstacles. 'This is where the idea of interaction and cooperation between cars via self-organizing wireless networks is effective. Cars that can receive and interpret information from their environment, and exchange this data with other cars in their vicinity, can recognize and avoid dangerous situations in advance', says Kyamakya.

Technology that saves lives

The NES institute will mainly contribute to the second application area: disaster management. For various reasons, the climate change the incidence of floods, avalanches and devastating storms is increasing. There are also earthquakes and threats by human beings, such as fires and terrorist attacks.

RESEARCH AREAS AND APPLICATION AREAS OF LAKESIDE LABS

PEOPLE BEHIND LAKESIDE LABORATORIES

Information and communication technology plays a central part in the warning and management of catastrophes. Thus areas and regions can be surveyed, for example, with the aid of wireless sensor networks, and people warned of storms, floods and avalanches in sufficient time. The emergency services also profit from spontaneous wireless networking: Firefighters are being equipped with networked cameras and displays. Earthquake relief workers communicate even when the entire network infrastructure has been destroyed.

Self-organization: a ubiquitous phenomenon

Research into self-organizing networked systems not only has technical and user-oriented aims, it also enables a high degree of interdisciplinary. We encounter self-organizing systems on an almost daily basis: In the formations of swarms of fish and migratory birds, the interplay of termites when they build their hills, or the activity of body cells during the healing of wounds. In many areas of nature, single individuals or organisms work together without central coordination, but in perfect harmony. Large areas of the economy have already been functioning for many years according to this paradigm. In self-organizing systems, the instances involved form decisions based on limited local knowledge. This leads to a desired emergent behavior of the entire system. Naturally self-organizing systems also possess many characteristics that are of value in technical systems: They are flexible and reliable, very adaptable and can be extended at any time. It is therefore no wonder that technical science has now discovered these and would like to implement them wherever centrally coordinated systems reach their limitations.

'The economic future of the area of self-organization is rated very positively', says Professor Hermann Kopetz of the Technical University of Vienna. 'At present the limitations of the complexity of centrally planned systems is visible in many places. Through the use of the principles of self-organization we hope to better control the ever-increasing complexity of large systems, and to significantly increase their reliability.'

Colloquia

Mubarak Shah (Central Florida University)
Video Surveillance and Monitoring

Recently, computer vision has gradually been making the transition away from understanding single images to analyzing image sequences, or video understanding. Video understanding deals with understanding video sequences, e.g., recognition of gestures, activities, and facial expressions. The main shift in the classic paradigm has been from the recognition of static objects in the scene to motion-based recognition of actions and events.

Since most videos are about people, this work has mainly focused on analysis of human motion. In particular, there has been a significant interest in the automated visual surveillance systems. Such systems have the advantage of providing continuous active warning capabilities and are especially useful in the areas of law enforcement, national defense, border control, and airport security. The main steps in video understanding are: detection of objects of interest in video (e.g. people, vehicles), tracking of those objects from frame to frame, and recognition of their activities and behavior. In this talk, I will present an overview of our work in video understanding.

Christian El Salloum (Vienna University of Technology)
A GENESYS-Compliant System-on-Chip Architecture

It is the objective of the GENESYS project to develop a cross-domain reference architecture for embedded systems that meets the requirements and constraints documented in the ARTEMIS SRA. These ARTEMIS requirements and contraints have been grouped under the following seven topics: composability, networking and security, robustness, diagnosis and maintenance, integrated resource management, evolvability and self-organization. Special emphasis is placed on the composability aspect of emerging architectures, such that unintended side-effects during the composition of components can be avoided. The Time-Triggered System-on-Chip architecture (TTSoC) is a GENESYS-compliant architecture with the objective of providing a predictable integrated execution environment for the component-based design of many different types of embedded applications (e.g., automotive, avionics, consumer electronics). At the core of this architecture is a time-triggered network-on-a-chip for the predictable interconnection of heterogeneous components. A component can be a self-contained computer, including system and application software, an FPGA, or a costum hardware unit. By providing a single uniform interface to all types of components for the exchange of messages, the architecture supports the component-based design of large applications and enables the massiv reuse of components. The time-triggered network-on-a-chip offers inherent fault isolation to facilitate the seamless integration of independently developed components, possibly with different criticality levels.

Klaus-D. Kohrt (Siemens AG, Munich)
Spectrum Regulation for Moblie Communication

The number of subscriptions to GSM technology worldwide increased significantly over the last couple of years and is expected to grow rapidly. Today, approximately 1 billion of people use wireless high-speed internet access. But it is predicted that the demand for wireless broadband connections continues to increase up to 5 billion people within the next few years. From a technological point of view the road towards ubiquitous wireless high-bandwidth internet access is paved, but this requires appropriate spectrum. Currently, only 5 % of the spectrum between 30 MHz and 10 GHz are reserved for mobile communication. In order to cope with the increased demand on wireless broadband access we need to rethink the spectrum assignment.

Publications

Journal, book, and magazine articles

- Aghajan H., Kleihorst R., Rinner B., Wolf W. (Ed.): Special Issue on Distributed Processing in Vision Networks. *IEEE Journal on Selected Topics in Signal Processing,* vol. 2, no. 4, pp. 445-447, Aug. 2008
- Andersson B., Pereira N., Elmenreich W., Tovar E., Pacheco F., Cruz N.: A Scalable and Efficient Approach for Obtaining Measurements in CAN-based Control Systems. *IEEE Transactions on Industrial Informatics*, vol. 4, pp 80-91, 2008.
- Elmenreich W.: Constructing Dependable Certainty Grids from Unreliable Sensor Data Robotics and Autonomous Systems. *Robotics and Autonomous Systems*, Elsevier, vol. 56, pp. 1094-1101, 2008.
- Elmenreich W., Marchenko N., Adam H., Hofbauer C., Brandner G., Bettstetter C., Huemer M.: Building Blocks of Cooperative Relaying in Wireless Systems. *e&i Journal,* vol. 125, no. 10, pp. 353-359, Oct. 2008.
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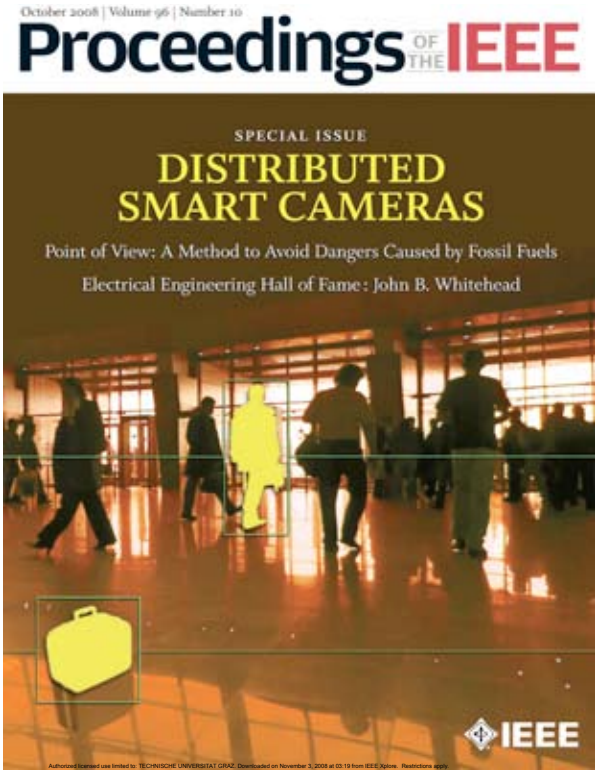
- Lunglmayr M., Berkmann J., Huemer M.: A linear programming/belief propagation decoder. *IET Electronics Letters*, vol. 44, no. 12, pp. 751-752, June 2008.
- Lunglmayr M., Krüger M., Huemer M.: Feasibility study of particle filters for mobile station receivers. *IET Journal on Circuits, Devices & Systems*, vol. 2, no. 1, pp. 81-86, Feb. 2008.

CHRISTIAN BETTSTETTER DISCUSSES RESEARCH TOPICS DURING LAKESIDE LABS RESEARCH DAYS

- Mosshammer R., Eickhoff R., Huemer M., Weigel R.: System topologies and performance evaluation of the RESOLUTION embedded local positioning system. *e&i Journal*, vol. 125, no. 10, pp. 347-352, Oct. 2008.
- Rinner B., Wolf W.: An Introduction to Distributed Smart Cameras. *Proceedings of the IEEE*, vol. 96(10) pp. 1565-1575, 2008.
- Rinner B., Wolf W. (Ed.): A Bright Future for Distributed Smart Cameras - scanning the issue. *Proceedings of the IEEE, 10*, pp. 1562-1564, Oct. 2008
- Tyrrell A., Auer G.: Decentralized slot synchronization for cellular mobile radio. *DoCoMo Technical Journal*, vol. 10, no. 1, pp. 60-67, June 2008.



SPECIAL ISSUE ON „DISTRITUBED SMART CAMERAS", EDITED BY BERNHARD RINNER AND WAYNE WOLF

Conference Papers

- Adam H., Bettstetter C., Senouci S.M.: Adaptive Relay Selection in Cooperative Wireless Networks. In *Proc. International Symposium on Personal, Indoor and Mobile Radio Communications*. Cannes, France, Sept. 2008.
- Auer G., Tyrrell A., Haas H.: Decentralized C/I power control for TDD. In *Proc. 67th IEEE Vehicular Technology Conference (VTC-Spring)*, Marina Bay, Singapore, May 2008.
- Bettstetter C., Brandner G., Vilzmann R.: On Colliding First Messages in Slotted ALOHA. In *Proc. IEEE 19th International Symposium on Personal, Indoor and Mobile Radio*. Cannes, France, 6 pp., Sept. 2008.
- Buchacher C., Zimmermann M., Huemer M.: A hybrid equalizer/Rake receiver for the Wideband CDMA Downlink in large delay spread channels. In *URSI Series on Advances in Radio Science (Kleinheubacher Berichte 2007)*, vol. 6, pp. 107-112, May 2008.
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- Crisóstomo S., Barros J., Bettstetter C.: Flooding the Network: Multipoint Relays versus Network Coding. In *Proc. 4th IEEE International Conference on Circuits and Systems for Communications*. Shanghai, China, 6 pp., May 2008.

- Crisóstomo S., Barros J., Bettstetter C.: Network Coding with Shortcuts. In *Proc. IEEE International Conference on Communication Systems (ICCS'08)*. Guangzhou, China, pp. 19-21, Nov. 2008.
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- Eickhoff R., Ellinger F., Ziroff A., Ussmüller T., Hüttner J., Gierlich R., Wehrli S., Huemer M.: Ultra Low Power Local Positioning Systems for Wireless Sensor Networks. In *Proc. 17th ICT Mobile and Wireless Communications Summit (ICT-MobileSummit 2008)*, Stockholm, Sweden, 8 pages, June 2008.
- Elmenreich W.: Time-Triggered Fieldbus Networks State of the Art and Future Applications. In *Proc. 11th IEEE Symposium on Object Oriented Real-Time Distributed Computing (ISORC'08)*. Orlando, FL, USA, pp. 436-442, May 2008.
- Elmenreich W., Leidenfrost R.: Fusion of Heterogeneous Sensors Data. In *Proc. 6th International Workshop on Intelligent Solutions in Embedded Systems (WISES'08)*. University of Applied Sciences Regensburg, Germany, July 2008, pp. 191-200.
- Elmenreich W., de Meer H.: Self-Organizing Networked Systems for Technical Applications: A Discussion on Open Issues. In *Proc. Third International Workshop on Self-Organizing Systems*. Vienna, Austria, pp. 1-9, Dec. 2008.
- Fehérvári I., Elmenreich W.: Design of Self-organizing Systems Using Evolutionary Methods. In *Proc. Junior Scientist Conference 2008*. Vienna, Austria, 2 pp., 2008
- Gierlich R., Hüttner J., Ziroff A., Huemer M.: Indoor Positioning Utilizing Fractional-N PLL Synthesizer and Multi-Channel Base Stations. In *Proc. 1st European Wireless Technology Conference (EuWiT' 2008),* Amsterdam, The Netherlands, pp. 49-52, Oct. 2008.
- Gyarmati M., Schilcher U., Brandner G., Bettstetter C., Chung Y. W., Kim Y. H.: Impact of Random Mobility on the Inhomogeneity of Spatial Distributions. In *Proc. IEEE Global Communications Conference (GLOBECOM'08)*. New Orleans, LA, USA, Nov. 2008.

NES-RESEARCHERS EMIL STOJANOVSKI AND SÉRGIO CRISÓSTOMO

- Holzer R., de Meer H., Bettstetter C.: On Autonomy and Emergence in Self-Organizing Systems. In *Proc. Third International Workshop on Self-Organizing Systems*. Vienna, Austria, pp. 157-169, Dec. 2008.
- Koplin M., Elmenreich W.: Analysis of Kalman Filter Based Approaches for Fusing Out-of-Sequence Measurements Corrupted by Systematic Errors. In *Proc. of the IEEE International Conference on Multisensor Fusion and Integration for intelligent Systems (MFI 2008)*. Korea University, Seoul, Korea, pp. 175-180, Aug. 2008.
- Lebrun Y., Hofbauer C., Ramon V., Bourdoux A., Huemer M., Horlin F., Lauwereins R.: MMSE Precoding for MIMO OFDM Systems Based on Multipaths and Spatial Correlation. In *Proc. 29th Symposium on Information Theory in the Benelux*, Leuven, Belgium, pp. 215-222, May 2008.
- Leidenfrost R., Elmenreich W.: Establishing Wireless Time-Triggered Communication using a Firefly Clock Synchronization Approach. In *Proc. 6th International Workshop on Intelligent Solutions in Embedded Systems (WISES'08)*. University of Applied Sciences Regensburg, Germany, pp. 227-244, July 2008.
- Leistner C., Roth P., Grabner H., Bischof H., Starzacher A., Rinner B.: Visual On-line Learning in Distributed Camera Networks. In *Proc. ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC-08)*. Stanford University, CA, USA. 10 pp., Sept. 2008.
- Lunglmayr M., Berkmann J., Huemer M.: LP Decoding of LDPC Codes in HARQ Systems. In *Proc. 6th Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP' 08)*, Graz, Austria, pp. 535-539, July 2008.
- Lunglmayr M., Huemer M,: LDPC codes: An Efficient Error Control Technique for Embedded Systems. In *Proc. FH Science Day 2008*, Linz, Austria, pp. 3-8, Nov. 2008.
- Ohnhäuser F., Huemer M.: Methods to Eliminate Dynamic Errors in High-Performance SAR A/D Converter. In *Proc. IEEE International Symposium on Circuits and Systems (ISCAS' 2008)*, Seattle, USA, pp. 2398-2401, May 2008.
- Priewasser R., Bougard B., Huemer M.: A Multi-Standard Instruction Set Architecture for LDPC Decoding. In *Proc. FH Science Day 2008*, Linz, Austria, pp. 9-17, Nov. 2008.
- Priewasser R., Bougard B., Huemer M.: Trade-Off Analysis of Decoding Algorithms and Ar-

12 DER STANDARD — FORSCHUNG SPEZIAL — MITTWOCH, 11. JULI 2007

Wir machen es wie die Glühwürmchen

Die Zukunft der Kommunikation ist drahtlos und vernetzt. Banal? Von wegen. Christian Bettstetter, Informationstechnik-Professor, arbeitet über dezentrale Synchronisierung und Kooperation von mobilen Geräten. Hier gehe es viel zu forschen, erklärt er Oliver Hochadel.

STANDARD: *Wieso interessiert sich ein Mobilfunk-Professor für Glühwürmchen?*
Bettstetter: In Asien treffen sich Glühwürmchen zu Tausenden in Bäumen und blinken synchron. Dies ist ein Paarungsverhalten. Wir haben versucht, diese Synchronisationsmethode auf drahtlose Kommunikationsnetze zu übertragen. Aber so einfach kann man einen Algorithmus aus der Biologie nicht in die Technik transferieren.

STANDARD: *Aber es gibt schon länger synchronisierte Geräte.*
Bettstetter: Ja, meistens gibt einer ein zentrales Gerät den Takt vor, und alle anderen, die einschalten, wird es von der Basisstation des Netzanbieters synchronisiert. Wir versuchen die Synchronisation als selbstorganisierendes Prozess dezentral zu lösen, bei dem keiner den Takt angibt.

STANDARD: *Warum ist das wichtig?*
Bettstetter: Wenn ein zentrales Gerät ausfällt, funktioniert nichts mehr – wir nennen das „single point of failure". Eine dezentrale Synchronisierung ist die Voraussetzung dafür, um mobile Geräte spontan vernetzen zu können. Solche spontanen drahtlosen Netze können in vielen Bereichen nützlich sein, zum Beispiel im Straßenverkehr. Nehmen wir an, es gibt einen Unfall, ein Airbag wird gezündet, und die Nachricht „Unfall in einem Kilometer" wird ohne Infrastruktur von einem Auto zum nächsten weitergeleitet. Daran sind die Autohersteller interessiert.

STANDARD: *Wie müssen drahtlose vernetzte Systeme noch können?*
Bettstetter: Wir arbeiten auch an kooperativen Relaying. Ein Gerät will an ein anderes Daten schicken; ein drittes Gerät hört mit und hilft den beiden, die Daten zu übertragen. Dadurch wird effizienter. Sie können mobile Geräte schneller und energiesparender kommunizieren. Ein Sensor soll ein paar Jahre halten, ohne dass man die Batterie austauschen muss.

STANDARD: *Wo liegen die Probleme?*
Bettstetter: Einen unterstützt das anderer, okay – aber wenn da zehn Geräte sind, welchen soll helfen? Hierzu brauche man Protokolle, die bestimmen, welches Gerät die Daten weiterleitet. Wir arbeiten zunächst mit Simulationen; ein wenig Informationstheorie kommt auch noch hinzu; und schließlich versuchen wir, unsere Algorithmen in Prototypen zu implementieren. Normalerweise laufen Netze nur terminweise durchs Labor, jetzt sollen sie mobil sein, sich kontaktieren und vernetzt ist Flaschenhälse und spart Energie. Wir arbeiten daran, wie man dieses „Network Coding" in drahtlosen Netzen praktisch umsetzen kann.

STANDARD: *Ist Ihre Forschung angewandt?*
Bettstetter: Es ist eigentlich beides: einerseits Grundlagenforschung – also: Wie funktioniert so ein Netzwerk? Algorithmus? – und andererseits anwendungsorientiert, da unsere Ergebnisse in konkreten Anwendungen eingesetzt werden sollen. Oft gibt es praktische Probleme, die zu ganz grundlegenden, oft mathematischen, Fragestellungen führen. Nehmen wir etwa an, wir wollen mit Sensoren die Luftfeuchtigkeit in einem Weinberg messen. Jeder Sensor hat ebenso bestimmte Funkreichweite, z. B. zehn Meter. Wie viele Sensoren brauche ich dann bei einer zufälligen Verteilung?

STANDARD: *Grundlagenforschung ist also nicht immer der Ausgangspunkt für das Neue?*
Bettstetter: Ich sehe es iterativ – man kann von beiden Punkten ausgehen, es ist ein Hin und Her. Ich würde eher unterscheiden in Forschung, bei der man große Freiheiten hat und auch Rückhalt auf neuesten Ideen und Forschungsergebnissen mitgehen kann, und Forschung, die stark in starre Projekte eingebettet ist.

STANDARD: *Unternehmen denken sich an Anwendungen?*
Bettstetter: Ja. Wir versuchen Industrieprojekte aber so aufzusetzen, dass sie uns nicht einschränken. Unsere Partner gehen uns am Anfang die Freiheiten, es so zu machen wie wir es für richtig halten. Den Druck, etwas Verwertbares zu produzieren, spüren ich nicht. Unseren Industriepartnern ist wichtig, dass wir gute Ergebnisse in angesehenen Zeitschriften publizieren und Ideengeber für Patente sind.

STANDARD: *Dann ist die Industrie weniger lästig als die öffentliche Hand?*
Bettstetter: Manche Unternehmen sind lästig, aber auch bei manchen EU-Projekten ertrinkt man angesichts des administrativen Overheads. Früher gab es noch viel mehr freie Industrieforschung. Der Druck, Ergebnisse zu produzieren hat zugenommen. Dennoch kooperieren wir mit internationalen Topfirmen aber auch mit lokalen Unternehmen – mit Letzteren noch hauptsächlich in der Lehre.

STANDARD: *Was bereift das konkret für die Lehre?*
Bettstetter: Ich organisiere etwa Exkursionen, Diskussionen mit die Vortragenden und Unternehmen vor Ort kommen und von ihren Berufsweg und ihrem Arbeitsalltag berichten. Die Studierenden erhalten somit einen Eindruck, wie ihr späteres Berufsfeld aussieht.

STANDARD: *Wie gestaltet sich die Arbeit an der Uni?*
Bettstetter: Ich war der erste Professor, der im Oktober 2005 in dem Lakeside Park gekommen ist, in dem auch IT-Firmen angesiedelt sind. Mittlerweile sind es sechs Stiftungsprofessuren. Sie erzeugen eine ganz andere Dynamik als ein einzelner Neuberufener. Für mich war das einen der Hauptargumente, hierherzukommen. Die Forschungsbereiche ergänzen einander sehr gut: Es gibt Überlappungen und Synergien, aber keine Angst unter den Kollegen, dass man sich Themen wegnehmen könnte. Wir koordinieren das.

Christian Bettstetter versucht Industrieprojekte so aufzusetzen, dass sie nicht „einschnüren". Er bevorzugt natürlich Forschung, bei der man große Freiheiten hat und flexibel agieren und reagieren kann. *Foto: Hochadel*

WISSEN

Eingebettet

Embedded Systems (Eingebettete Systeme) sind Rechnersysteme, die für den Anwender weit gehend unsichtbar in Autos, Flugzeugen, Waschmaschinen, Kühlschränken oder Geräten der Unterhaltungselektronik für bestimmte vordefinierte Funktionen verantwortlich sind. Die Forschung und Technologieentwicklung in diesem Umfeld wird hierzulande spätestens seit 2002 breit gefördert. In diesem Jahr starten

Mancher Unternehmen sind lästig, aber auch bei manchen EU-Projekten ertrinkt man angesichts des administrativen Overheads.

„STANDARD": INTERVIEW WITH PROF. BETTSTETTER

chitectures for Multi-Standard LDPC Decoder. In *Proc. IEEE Workshop on Signal Processing Systems (SIPS' 2008),* Washington DC, USA, pp. 88-93, Oct. 2008.

- Quaritsch M., Rinner B.: DSCAgents: A Lightweight Middleware for Distributed Smart Cameras. In *Proc. Workshop on Embedded Middleware on Smart Camera and Visual Sensor Networks (eMCAM-08).* Stanford University, CA, USA, 8 pages, Sept. 2008.
- Quaritsch M., Stojanovski E., Bettstetter C., Friedrich G., Hellwagner H., Rinner B., Hofbaur M., Shah M.: Collaborative Microdrones: Applications and Research Challenges. In *Proc. Second International Conference on Autonomic Computing and Communication Systems.* Turin, Italy, 7 pages, Sept. 2008.
- Quaritsch M., Wiesinger M., Strobl B., Rinner B.: An Adaptive Multi-Purpose Transmission Scheme for H.264 Encoded Video in Wireless Networks. In *Proc. IEEE 6th Symposium on Communication Systems, Networks and Digital Signal Processing.* Graz, Austria, 5 pages, July 2008.
- Rinner B., Winkler T., Schriebl W., Quaritsch M., Wolf W.: The Evolution from Single to Pervasive Smart Cameras. In *Proc. ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC-08).* Stanford University, CA, USA, 10 pp., Sept. 2008.
- Sanguinetti L., Tyrrell A., Morelli M., Auer G.: On the performance of biologically-inspired slot synchronization in multicarrier ad hoc networks. In Proc. 67th IEEE Vehicular Technology Conference (VTC-Spring), Marina Bay, Singapore, May 2008.
- Schilcher U., Gyarmati M., Bettstetter Ch., Chung Y.W., Kim Y.H.: Measuring Inhomogeneity in Spatial Distributions. In *Proc. IEEE Vehicular Technology Conference.* Marina Bay, Singapore, 5 pages, May 2008.
- Schranz M., Elmenreich W.: Approach for a Reliable Cooperative Relaying Process. In *Proc. Junior Scientist Conference 2008.* Vienna, Austria, 2 pages, Nov. 2008.
- Starzacher A., Rinner B.: Evaluating KNN, LDA and QDA Classification for Embedded Online Feature Fusion. In *Proc. International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP),* Sydney, Australia, 6 pages, Dec. 2008.

Call for Papers

Third ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC-09)

August 30 – September 2, 2009 - Como, Italy

Distributed smart cameras combine techniques from **computer vision**, **distributed processing**, **sensor networks**, and **embedded computing**. Technological advances in the design of sensors and processors have facilitated the development of efficient embedded vision−based techniques. Design of scalable, network−based applications based on high−bandwidth data such as images requires a change of paradigm in the processing methodologies, thus creating opportunities for designing distributed and collaborative vision−based techniques. As a result, novel smart environment applications can be enabled that are interpretive, context aware, and user centric in nature. After the successful meetings in Vienna (2007) and Stanford (2008), the third ACM/IEEE International Conference on Distributed Smart Cameras will be held at Como, Italy.

The conference provides an opportunity for researchers working in the areas of smart camera architectures, algorithm design, embedded vision-based processing, and smart environments to exchange their most recent results. Offering insight into the potentials and challenges of distributed vision networks and presentation of design methodologies employed by leading research groups working in these areas are also the objectives of the conference. Presentations accompanied by demonstrations and contributions based on industrial applications are also of interest.

The 2009 edition of the conference aims to also explore the practical aspects of design by introducing a **demonstration challenge** in the program. **Special sessions** covering specific topics in the participating areas will be included to explore the opportunities and challenges within each. Proposals are solicited for special sessions covering specific problems in one or more of the following areas: distributed processing, sensor networks, and embedded computing. Proposals introducing ideas and target applications for a challenge demonstrating smart camera deployment and smart cameras applications are also encouraged. Challenge ideas and special session proposals should be sent to: info@icdsc.org

http://www.icdsc.org

General chairs
Andrea Cavallaro, *Queen Mary, Univ. of London, UK*
Stefano Tubaro, *Politecnico di Milano, Italy*

Technical program chairs
Johnny Park, *Purdue University, USA*
Shuvra S. Bhattacharyya, *University of Maryland, USA*

Special sessions chair
Bernhard Rinner, *Klagenfurt University, Austria*

Industrial liason
Richard Kleihorst, *NXP Research, Netherlands*

Demos and Posters Chair
Fabio Salice, *Politecnico di Milano, Italy*

Finance chair
Augusto Sarti, *Politecnico di Milano, Italy*

Publication chair
Henry Medeiros, *Purdue University, USA*

PhD Forum Chair
Ioannis Patras, *Queen Mary, Univ. of London, UK*

Asia liaison
Akio Kosaka, *Olympus Corporation, Japan*

America liaison
Wayne Wolf, *Georgia Tech., USA*

Oceania liaison
Abbas Bigdeli, *NICTA, Australia*

Local arrangements chairs
Marco Tagliasacchi, *Politecnico di Milano, Italy*
Matteo Matteucci, *Politecnico di Milano, Italy*

Webmaster
Ioannis Tziakos, *Queen Mary, Univ. of London, UK*

Important Dates
- Challenge ideas: Nov 15, 2008
- Special session proposals: Jan 15, 2009
- **Paper submission: March 31, 2009**

LAKESIDE LABS RESEARCH DAYS

- Tyrrell A., Auer G.: Decentralized inter-base station synchronization inspired from nature. In *Proc. 68th IEEE Vehicular Technology Conference (VTC-Fall),* Calgary, Canada, Sept. 2008.
- Tyrrell A., Auer G., Bettstetter C.: A Synchronization Metric for Meshed Networks. In *Proc. 3rd International Conference on Bio-Inspired Models of Network, Information, and Computing Systems.* Brussels: Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering (ICST), Hyogo, Japan, 7 pages, Nov. 2008.
- Tyrrell A., Auer G., Bettstetter C.: On the Accuracy of Firefly Synchronization with Delays. In *Proc. International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2008).* Aalborg, Denmark, 5 pages, Oct. 2008.
- Umlauft M., Elmenreich W.: QoS-aware Ant Routing with Colored Pheromones in Wireless Networks. In *Proc. Second International Conference on Autonomic Computing and Communication Systems (AUTONOMICS '08).* Turin, Italy, 6 pages, Sept. 2008.
- Vejda T., Toegl R., Pirker M., Winkler T.: Towards Trust Services for Language-Based Virtual Machines for Grid Computing. In *Proc. First International Conference on Trusted Computing and Trust in Information Technologies (Trust 2008).* Villach, Austria, pp. 48-60, Aug. 2008.

Talks

- Bettstetter C.: *Forschung wird von Menschen gemacht (The human side of research).* Keynote speech at the event Operation Research: Research and innovation interacting with the entrepreneurial landscape, Klagenfurt, Austria, June 2, 2008.
- Bettstetter C.: *Die Vernetzung der Dinge.* Evening talk at the opening of Lakeside Labs GmbH, Klagenfurt, Austria, Feb 7, 2008.
- Elmenreich W.: *The Principle of Self-Organization.* Technische Universität Wien, Vienna, Austria, Apr. 2008.
- Elmenreich W.: *Lakeside Labs - Neues aus dem Süden.* Vienna University of Technology, Austria, Nov. 2008.
- Elmenreich W.: *Time-Triggered Transducer Networks.* Technische Universität Wien, Vienna, Austria, June 2008.
- Huemer M.: *Die drahtlose Revolution: Shannon meets Moore.* Opening ceremony of the Lakeside Labs Research Center, Klagenfurt, Austria, June, 2008.
- Priewasser R.: *A Multi-Standard Instruction Set Architecture for LDPC Decoding*, FH Science Day, Linz, Austria, Nov. 2008.
- Quaritsch M.: *Embedded Linux auf intelligenten Kameras,* LinuxDay 2008, Klagenfurt, Austria, May 2008.
- Rinner B.: *Distributed Smart Cameras.* Kolloquium, Universität Tübingen, Germany, May 2008.
- Rinner B.: *Rückblick und Ausblick der Fakultät für Technische Wissenschaften*. Eröffnung des akademischen Jahres, Alpen-Adria-Universität Klagenfurt, Oct. 2008.


KÄRNTEN

Erster Einsatz in der Nacht

Mit Mikrodrohnen ins Katastrophengebiet

INTERVIEW WITH MARKUS QUARITSCH, RESEARCH STAFF MEMBER „cDRONES“

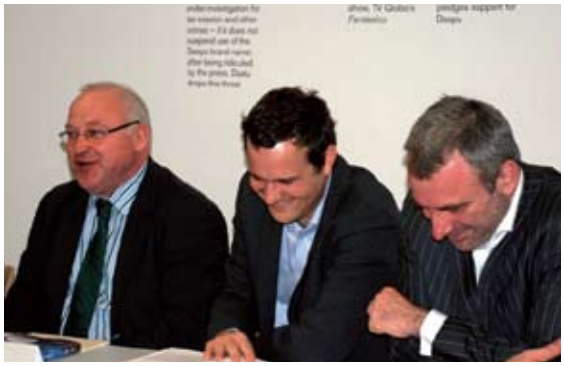

„Einige Konzerne werden nicht überleben“

INTERVIEW WITH MARIO HUEMER, CHAIR EMBEDDED SYSTEMS AND SIGNAL PROCESSING GROUP

Panel Discussions

Bettstetter C.: *Mobile Kommunikation der Zukunft. Oder: Wieviel Handy braucht der Mensch?*
Panel discussion, Lakeside Park, Klagenfurt, Austria, April 1, 2008.
Panellists:

- Hendrik Berndt; CTO & Senior Vice President, DoCoMo Euro-Labs, Munich, Germany
- Michaela Greiler; Research and Teaching Staff Member; System Security Group, Klagenfurt University, Austria
- Mario Huemer; Chair of Embedded Systems and Signal Processing Group, Klagenfurt University, Austria
- Marcus Pistauer; CEO CISC Semiconductor Design+Consulting GmbH, Klagenfurt, Austria



Bettstetter C., Elmenreich W.: *Self-Organization in Networks and Networked Systems.* Panel discussion participants at the Intern. Workshop on Self-Organizing Systems, Vienna, Austria, December 12, 2008.

Scientific Appointments


Die Zukunft beginnt im Hier und Jetzt

BERNHARD RINNER´S INTERVIEW ABOUT THE RESEARCH TOPICS OF PERVASIVE COMPUTING

MINISTER HAHN VISITS LAKESIDE LABS

Editorial Board Members

- *Christian Bettstetter* is Member of the Editorial board of "ACM Mobile Computing and Communications Review (MC2R)".

Conference Chairs

- *Bernhard Rinner* served as TPC Chair for the "Workshop on Embedded Middleware for Smart Camera and Visual Sensor Networks (eMCAM-08)", Stanford, USA, Sept. 2008.

Steering Boards

- *Christian Bettstetter* is Austrian representative and member of the steering board of the European Science Foundation (ESF)-funded project „Middleware for Network Eccentric and Mobile Applications (MiNEMA)".

Guest Editors

- *Bernhard Rinner* is chief editor of a special issue on "Distributed Smart Cameras" in the Proceedings of the IEEE, Oct. 2008.
- *Bernhard Rinner* is guest editor of a special issue on „Distributed Processing in Vision Networks" in the IEEE Journal on Selected Topics in Signal Processing, Aug. 2008.
- *Bernhard Rinner* and *Wilfried Elmenreich* are guest editors of a special issue on „Challenges on Complexity and Connectivity in Embedded Systems" in the EURASIP Journal on Embedded Systems.
- *Christian Bettstetter, Mario Huemer* and *Bernhard Rinner* are guest editors of a special issue on "Networked Embedded Systems" in the e&i Journal, Oct. 2008.

Program Committee Memberships

Christian Bettstetter

- Intern. Workshop on Self-Organizing Systems, Vienna, Dec. 2008.
- IEEE Global Communications Conf. (Globecom), New Orleans, USA, Dec 2008.
- ACM/IEEE Intern. Symposium on Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM), Vancouver, BC, Canada, Oct. 2008.
- IEEE Intern. Symp. Personal, Indoor, and Mobile Radio Communications, Cannes, France, Sept. 2008.
- Intern. Workshop on Nonlinear Dynamics and Synchronization (INDS), Klagenfurt, Austria, July 2008.
- IEEE Intern. Conf. on Communications (ICC), Beijing, China, May 2008.

Wilfried Elmenreich

- International Conf. on Soft Computing as Transdisciplinary Science and Technology (CSTST 2008) Paris, France, 2008
- Int. Workshop on Dependable Network Computing and Mobile Systems (DNCMS 08), Naples, Italy, Oct. 5th, 2008
- World Congress on Nature and Biologically Inspired Computing (NaBIC 2009), Orissa, India, 2008
- Eighth International Conference on Intelligent Systems Design and Applications (ISDA 2008), Kaohsiung, Taiwan, 2008
- 3rd International Workshop on Self-Organizing Systems, Self-Organizing Networks and Networked Systems (IWSOS), Vienna, Austria, 2008
- Second ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC), Stanford University, USA, 2008

Mario Huemer

- International Conference on Wireless Information Networks and Systems (WINSYS' 2008), Porto, Portugal, July 2008.
- Intern. Workshop on Nonlinear Dynamics and Synchronization (INDS), Klagenfurt, Austria, July 2008.

Markus Quaritsch

- Workshop on Embedded Middleware on Smart Camera and Visual Sensor Networks (eMCAM-08), Stanford University, USA, 2008.

Bernhard Rinner

- IEE International Conference on Intelligent Environments (IE), Seattle, USA, July 2008.
- IEEE Workshop on Intelligent Solutions in Embedded Systems (WISES), Regensburg, Germany, July 2008.
- International Conference on Wireless Applications and Computing (WAC 2008), Amsterdam, Netherlands, July 2008.
- IEEE Workshop on Embedded Computer Vision (ECV), Anchorage, USA, 2008.
- 6th IFIP Working Conference on Distributed and Parallel Embedded Systems 2008, Milano, Italy, Sept. 2008.
- ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC-08), Stanford University, USA, 2008.

Reviewing Activities

NES-RESEARCHER MARKUS QUARITSCH
DURING A PRESENTATION OF THE cDRONES PROJECT

Christian Bettstetter

- IEEE Transactions on Mobile Computing
- Computer Networks
- European Commission FP6 and FP7 projects

Wilfried Elmenreich

- Springer Lecture Notes on Electrical Engineering: Intelligent Technical Systems
- IEEE Journal of Selected Topics In Signal Processing
- IEEE Transactions on Industrial Electronics
- Computing and Informatics Journal

Mario Huemer

- International Journal of Electronics and Communications (AEÜ)
- Journal Proceedings of the European Microwave Association (Proceedings EUMA)
- e&i Journal (Journal of the Austrian Electrotechnical Association, ÖVE

Markus Quaritsch

- Elsevier Book chapter: Multi Camera Networks
- e&i Journal
- Proceedings of the IEEE
- John Wiley & Sons: Software: Practice and Experience

Bernhard Rinner

- IEEE Computer
- EURASIP Journal on Embedded Systems
- IEEE Transactions for Circuits and Systems
- Proceedings of the IEEE
- ACM Transactions on Embedded Computing Systems
- Machine Vision and Applications Journal
- European Commission FP7 program ARTEMIS
- IEEE Transactions on Systems, Man, and Cybernetics
- IEEE Transactions on Information Technology in Biomedicine
- Elsevier

Udo Schilcher

- Springer LNEE
- Journal on Selected Areas in Communications

PhD Examination Activities

Completed PhD Theses

- ***Andreas Klausner:*** Multi-Sensor Multi-Level Information Fusion on Embedded Systems, Graz University of Technology, Austria. April 25, 2008. Supervisor: Bernhard Rinner.
- ***Frank Ohnhäuser:*** Theory and Realization of High-End Analog-to-Digital-Converters based on the Principle of Successive Approximation, University of Erlangen-Nuremberg, Germany. Defense and Doctoral Examination: Erlangen, July 15, 2008. Supervisor: Mario Huemer.
- ***Markus Quaritsch:*** A Lightweight Agent-Oriented Middleware for Distributed Smart Cameras, Graz University of Technology, Austria. Defense and Doctoral Examination: Graz, April 18, 2008. Supervisor: Bernhard Rinner.
- ***Allan Tengg:*** A Generic, Dynamically Reconfigurable Data Fusion Architecture based on Distributed Embedded Systems, Graz University of Technology, Austria. June 23, 2008. Supervisor: Bernhard Rinner.

Evaluation of doctoral theses

- ***Mario Huemer*** served as an evaluator and examiner of the doctoral thesis "Highly Reconfigurable CMOS All Digital Phase Locked Loop for RF-Synthesis and Phase Modulation" (Christian Wicpalek) at the University of Linz, Austria. Defense: Linz, 17.01.2008.
- ***Mario Huemer*** served as an evaluator and examiner of the doctoral thesis "Investigation of the HSDPA System and its MIMO Extensions" (Klemens Freudenthaler) at the University of Linz, Austria. Defense: Linz, 03.03.2008.
- ***Bernhard Rinner*** served as an evaluator and examiner of the doctoral thesis „Visual Surveillance on DSP-Based Embedded Platforms" (Clemens Arth) at Graz University of Technology, Austria. Defense: March 20, 2008.
- ***Bernhard Rinner*** serves as an evaluator and examiner of the doctoral thesis „Privacy Sensitive Surveillance" (Sven Fleck) at University of Tübingen, Germany. Defense: May 7, 2008.

Teaching

The institute's teaching activities are aimed mainly at bachelor and master degree students in 'Information Technology'. Many compulsory courses are offered for the bachelor degree course. For master degree students mainly courses with the focus on 'Mobile and Wireless Systems', 'Embedded Systems' and 'Pervasive Computing' are offered. Guest lectures by representatives from industry and guest professors—including the esteemed Professors Foresti (Udine), Hagenauer (Munich) and Huber (Erlangen)—enhance the institute's curriculum. Assistants and professors supervise the bachelor and master degree theses individually. The teaching methodology comprises lectures, group courses of typically 15 students, laboratory courses under supervision as well as seminars and project work. An e-learning course is installed on the electronic university platform for all types of courses, on which students have access to the course handouts and which serves as a communication and organization platform (for e-mail, forums, submissions etc.). In the laboratory courses students are supervised by tutors or assistants. Free practice opportunities are offered frequently in which students can deepen their practical knowledge independently. Some lectures are supported by innovative teaching methods, such as the supplementation of lecture notes on Tablet-PC or with video podcasts.

The institute's teaching activities are centered around the bachelor and master program "Information Technology" and the master program "Informatics".

In the years 2007 and 2008, several new lectures, exercises, and lab courses have been developed and offered for the first time. The institute covered most technically-oriented mandatory courses in the bachelor program Information Technology and offered a variety of courses in the master program. The current teaching portfolio comprises the following courses as well as seminars, research seminars, and privatissima.

Bachelor Courses offered by NES in 2008

Sem	*Title*	*Lecture*	*Hours*	*Exercises/Lab*	*Hours*
1	Einführung in das Studium Informationstechnik und aktuelle Fallstudien aus der Praxis	Bettstetter	1	—	
1	Elektrotechnische und physikalische Grundlagen der Informationstechnik	Bettstetter	2	Adam	2
2	Schaltungstechnik	Huemer	2	Schlechter	2
3	Signaldarstellung und -übertragung	Huemer	2	Onic, Gyarmati	2
3	Entwurf digitaler Schaltungen	Rinner	2	Winkler	2
4	Digitale Signalverarbeitung	Huemer	2	Onic	2

Master Courses offered by NES in 2008

Title	*Lecture*	*Hours*	*Exercises/Lab*	*Hours*
Advanced Topics in Pervasive Computing	Rinner	2	Schriebl Winkler	2
Analog and Mixed Signal Design	Jungwirth Ohnhäuser	2	—	
Artificial Vision	Foresti Micheloni	2	—	
Communication Theory in Mobile Systems and Genetics	Hagenauer	2	—	
Digital Signal Processors	Rinner	2	Schriebl	2
Embedded Communications	Huemer	2	Lederer	2
Embedded Microcontroller Lab	—		Schlechter	2
High-Performance Analag- and Converter Design	Ivanov Ohnhäuser	2	—	
Information Theory and its Applications in Communication Engineering	Huber	2	—	
Information and Communication Technology Lab	—		Gyarmati Lederer Schriebl	2
Mobile and Wireless Systems I	Bettstetter	2	Schilcher	2
Mobile and Wireless Systems II	Bettstetter	2	—	
Network Simulation Lab	—		Elmenreich	2
Pervasive Computing	Rinner	2		
Pervasive Computing Lab	—		Winkler	2
RFID Topics	Neffe	2	—	
Signal Processing Architectures for Embedded Applications	Huemer	2	Onic	2

Elektrotechnische und physikalische Grundlagen der Informationstechnik

Christian Bettstetter, Helmut Adam

Diese Einführungsvorlesung vermittelt die wichtigsten elektrophysikalischen Grundlagen der Informationstechnik.

Inhalte:

0.Einführung und Überblick:
Fachliche Einführung und Überblick. Physikalische Grundbegriffe. Organisatorisches. Literatur. How to pass EPGI? Mathematische Grundlagen.

1.Elektrostatik:
Elektrische Ladung. Kräfte zwischen Ladungen. Elektrische Feldstärke. Arbeit. Spannung und Potential. Elektrische Erregung. Kontinuierliche Ladungsverteilungen. Elektrischer Fluss und eingeschlossene Ladung. Kapazität und Kondensatoren. Elektrostatik in Natur und Technik.

2.Elektrischer Strom:
Stromstärke und Stromdichte. Ladungsträgerbewegung. Widerstand und Ohm'sches Gesetz. Stromquelle: Die elektrische Batterie. Kirchhoff'sche Regeln. Schaltungen mit Quellen und Widerständen. Schaltungen mit Quellen, Widerständen und Kondensatoren.

3.Magnetisches Feld:
Magnete. Magnetisches Feld und Lorentzkraft. Magnetischer Fluss und magnetische Erregung. Ursachen von Magnetfeldern: Magnetfelder bewegter Ladungen; Magnetische Materialien. Magnetische Felder in Natur und Technik.

4.Elektromagnetische Induktion:
Erzeugt ein Magnetfeld einen elektrischen Strom? Gesetze zur elektromagnetischen Induktion. Zusammenhang zwischen E- und B-Feld. Induktivität und Spule. Schaltungen mit Spulen: Ein- und Ausschaltvorgang. Gegeninduktivität. Technische Anwendungen der Induktion.

5.Elektromagnetische Wellen:
Zusammenhang zwischen E- und B-Feld (Teil 2). Erzeugung elektromagnetischer Wellen. Eigenschaften elektromagnetischer Wellen. Form und Ausbreitungsrichtung (Ausbreitungsgeschwindigkeit, Elektromagnetisches Spektrum, Energie und Leistung). Die Maxwell'schen Gleichungen. Elektromagnetische Wellen in Natur und Technik.

Fester Bestandteil der Vorlesung sind physikalische Experimente sowie die Erläuterung von Anwendungen in Natur und Technik. Eine zweistündige Übung vertieft die eingeführten Inhalte durch Rechenaufgaben und studentische Kurzvorträge. Es wird Wert auf das Verständnis der physikalischen Phänomene und deren Zusammenhänge im Kontext einer einheitlichen Theorie des Elektromagnetismus gelegt. Zur wissenschaftlichen Beschreibung und zur Lösung praktischer Probleme werden Methoden der höheren Mathematik verwendet. Zur Veranschaulichung dient eine Vielzahl von physikalischen Experimenten.

Die Vorlesungsunterlagen bestehen aus einem ausführlichen Foliensatz ("Handouts"), dessen Inhalte in der Vorlesung mit einem TabletPC vervollständigt werden. Zur Vor- und Nachbereitung zu Hause dient insbesondere das Buch Giancoli „Physics for Scientists and Engineers“ sowie eine Videovorlesung (Podcast), die thematisch sehr gut den behandelten Stoff abdecken.

Schaltungstechnik

Mario Huemer, Thomas Schlechter

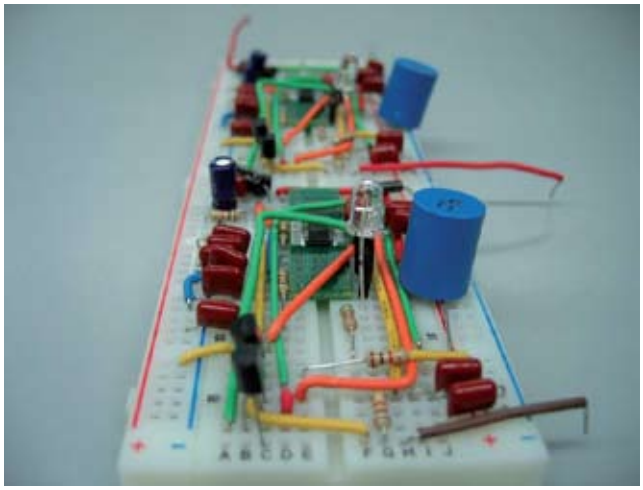
Die Vorlesung schließt nahtlos an die Veranstaltung *Elektrotechnische und Physikalische Grundlagen der Informationstechnik* an. Nach der Betrachtung von Netzwerken und Schaltungen bei Erregung mit sinusförmigen Spannungen und Strömen folgt die Beschreibung von Schaltungen mit den Methoden der Laplace-Transformation. Im Zuge dessen wird u.a. der Zusammenhang zwischen Laplace-Bereich und der (in der Technik so wichtigen) Denkweise im Frequenzbereich hergestellt.

Einer systematischen Betrachtung von Vierpolen folgen Transistorgrundschaltungen sowie die Möglichkeiten ihrer Arbeitspunkteinstellungen, die Analyse mit Hilfe von Ersatzschaltbildern und die Betrachtung ihres Frequenzverhaltens. Im nächsten Schritt werden Operationsverstärker sowie Operationsverstärker-Grundschaltungen untersucht.

Eine Anwendung von Operationsverstärkerschaltungen stellen die analogen Filter dar, die hier nicht nur analysiert sondern auch entworfen werden. Im abschließenden Kapitel werden Schaltungsvarianten für AD- und DA-Wandler für unterschiedliche Anwendungsgebiete vorgestellt.

Für Studierende des Bachelor-Studiums „Informationstechnik“ ist diese Lehrveranstaltung ein Pflichtfach im 2. Semester.

Die Vorlesung wird durch einen Kurs ergänzt, in dem die in der Vorlesung gebrachten Inhalte anhand von Rechenbeispielen weiter vertieft und ergänzt werden, darüber hinaus haben die Studenten die Möglichkeit , ihr Wissen in Laboreinheiten praktisch anzuwenden.



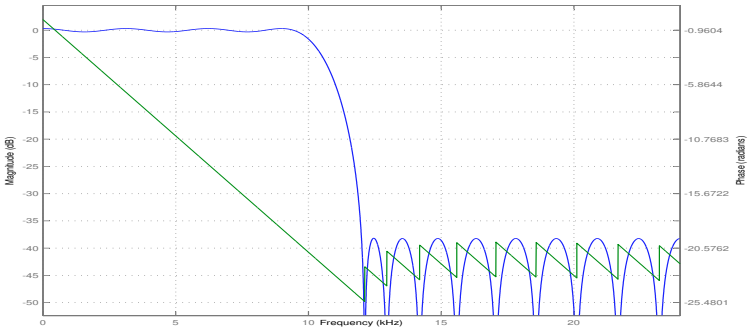
TESTAUFBAU EINER SCHALTUNG MIT STECKBOARD

Inhalte:

1. Komplexe Wechselstromrechnung (Lineare Netze im eingeschwungenen Zustand)
2. Ausgleichsvorgänge in linearen Netzen
3. Elektrische Leistung bei zeitlich veränderlichen Strömen und Spannungen
4. Lineare Vierpole
5. Transistor (Bipolar, FET) als Verstärker
6. Grundschaltungen mit mehreren Transistoren
7. Operationsverstärker und OPV-Grundschaltungen
8. Analoge Filter: Analyse und Entwurf
9. AD- und DA-Wandler

Digitale Signalverarbeitung

Mario Huemer, Alexander Onic



DARSTELLUNG DES FREQUENZGANGS EINES DIGITALEN FILTERS

Die Vorlesung schließt nahtlos an die Veranstaltung Signaldarstellung und –übertragung an und beschäftigt sich mit diskreten Signalen und deren Verarbeitung. Die Vorlesung startet mit der systemtheoretischen Behandlung der Abtastung von Signalen und dem Abtasttheorem.

Danach schließt sich die Behandlung von zeitdiskreten Signalen sowie deren Charakterisierung im Frequenzbereich an. Es werden die diskrete Fourier-Transformation (DFT) sowie die FFT (Fast Fourier Transform) eingeführt und es werden wichtige Anwendungen dieser Transformationen präsentiert.

Beschreibungsmethoden zeitdiskreter LTI-Systeme im Zeit- und Frequenzbereich (u.a. mit Hilfe der z-Transformation) sind Inhalt des nächsten Kapitels. Aufbauend darauf werden Entwurfsmethoden digitaler Filter diskutiert. Einer Einführung zeitdiskreter Zufallsprozesse folgen schließlich erste Anwendungen der statistischen Signalverarbeitung.
Im zugehörigen Kurs werden die in der Vorlesung behandelten Themengebiete mit Hilfe von Rechenbeispielen und mit Hilfe von Simulationsbeispielen in MATLAB/SIMULINK begleitet.

Für Studierende des Bachelor-Studiums „Informationstechnik“ ist diese Lehrveranstaltung ein Pflichtfach im 4. Semester. Weiterhin wird die Veranstaltung für Studierende der Studienrichtungen “Informatik” und “Technische Mathematik und Datenanalyse” empfohlen.

Inhalte:

1. Abtastung und Rekonstruktion, Abtasttheorem
2. Zeitdiskrete Signale
3. Zeitdiskrete LTI-Systeme
4. Entwurf digitaler Filter
5. Korrelation
6. Zeitdiskrete Zufallsprozesse
7. Anwendungen der statistischen Signalverarbeitung

Entwurf digitaler Schaltungen

Bernhard Rinner, Thomas Winkler

Digitale Schaltungen spielen eine zentrale Rolle in der Informationstechnik. Sie stellen die Grundkomponenten in der Elektronik dar und sind daher in vielen Geräten des Alltagslebens zu finden.

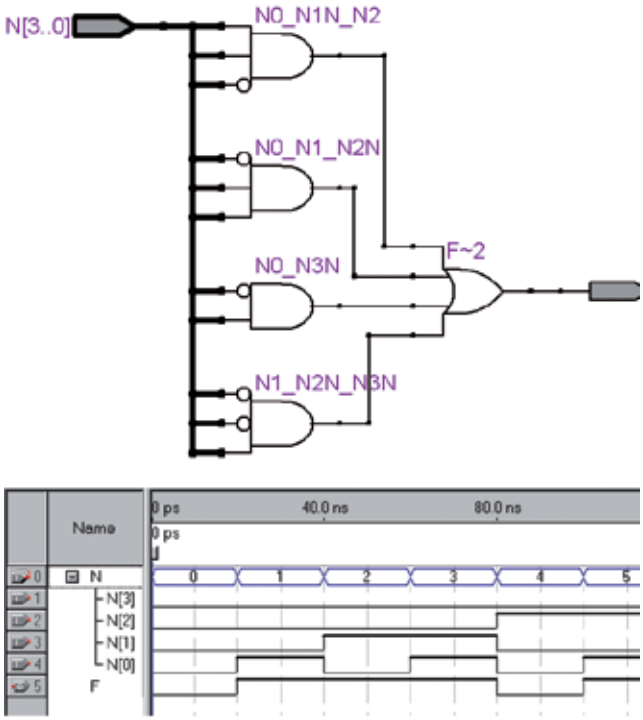
Die Lehrveranstaltung führt in die Boolsche Algebra ein und behandelt im Anschluss den Entwurf von kombinatorischen Schaltungen beispielesweise von Multiplexern, Addieren oder Multiplizieren. Die Optimierung der entworfenen logischen Schaltungen mit Hilfe von Karnaugh Diagrammen stellt einen wesentlichen Bestandteil der Lehrveranstaltung dar.

Speicher-Elemente wie Latches oder Flip-Flops bilden die Grundlage für den Entwurf sequentieller logischer Schaltungen. Nach der Einführung dieser grundlegenden Bauelemente wird auf Basis endlicher Automaten der Entwurf einfacher sequentieller Schaltungen veranschaulicht. Der praktischen Umsetzung digitaler Schaltungen auf gängigen programmierbaren Logik-Technologien wird ein eigener Abschnitt gewidmet.

Im folgenden Teil der Vorlesung werden fortgeschritten Technologien wie Register Transfers und der Aufbau von Speicherzellen besprochen. Abgeschlossen wird die Lehrveranstaltung mit der Betrachtungen des Aufbaus eines Mikroprozessors.

Die Vorlesung wird durch einen Kurs ergänzt, in dem die in der Vorlesung gebrachten Inhalte anhand von Rechenbeispielen weiter vertieft und ergänzt werden. Darüber hinaus werden die Studierenden im Rahmen des Kurses in die Grundlagen der Hardware-Beschreibungssprache VHDL eingeführt.

In Laboreinheiten haben die Studierenden die Möglichkeit dieses Wissen praktisch anzuwenden und grundlegende kombinatorische und sequentielle Schaltungen mit Hilfe von VHDL zu realisieren.



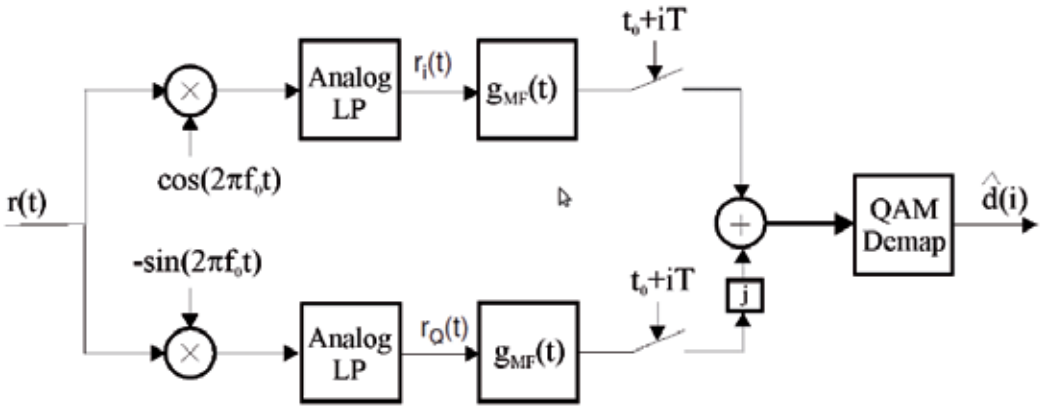
ENTWURF UND SIMULATION EINER EINFACHEN SCHALTUNG

Inhalte:

1. Boolsche Algebra
2. Kombinatorische Logik
3. Schaltungsoptimierung
4. Sequentielle Logik
5. Speicherelemente
6. Registertransfer
7. Aufbau eines Mikroprozessors
8. Einführung in VHDL

Signaldarstellung und -übertragung

Mario Huemer, Alexander Onic, Michael Gyarmati



KOHÄRENTER EMPFÄNGER FÜR DIGITALE ÜBERTRAGUNG

Die Informationstechnik beschäftigt sich mit der Übertragung, Verarbeitung und Darstellung von Informationen.
Als Träger der Informationen dienen Signale, welche mit Hilfe von Systemen manipuliert werden, z.B. in der Form einer Filterung oder Spektralzerlegung. In der Vorlesung *Signaldarstellung und –übertragung* werden die wesentlichen Grundlagen der Signal- und Systemtheorie sowie der Übertragungstechnik behandelt.

Die Vorlesung wird von einem Kurs begleitet. Im Kurs werden die in der Vorlesung behandelten Themengebiete mit Hilfe von Rechenbeispielen und mit Hilfe von Simulationsbeispielen in MATLAB/SIMULINK begleitet.

Für Studierende des Bachelor-Studiums „Informationstechnik“ ist diese Lehrveranstaltung ein Pflichtfach im 3. Semester. Weiterhin wird die Veranstaltung für Studierende der Studienrichtungen “Informatik” und “Technische Mathematik und Datenanalyse” empfohlen.

Inhalte:

1. Charakterisierung von Signalen
2. Analoge Signale (Fourier-Reihen, Fourier Transformation)
3. Analoge Systeme (Beschreibungsmethoden im Zeit- und Bildbereich)
4. Bandpasssignale- und Systeme
5. Zufallssignale und Reaktion von Systemen auf Zufallssignale
6. Analoge Modulationsverfahren (AM, FM, PM)
7. Grundlagen der digitalen Übertragung im Basisband
8. Grundlagen digitaler Modulationsverfahren (ASK, PSK, FSK, QAM, GMSK)

Mobile and Wireless Systems 1 and 2

Christian Bettstetter, Udo Schilcher

The lectures Mobile and Wireless Systems 1 and 2 give a bottom-up introduction to the area of mobile and wireless communication systems. The main goal is to give a fundamental understanding of the principles behind wireless transmission and networking. Current technologies, such as UMTS and IEEE 802.11, are used as examples to explain these principles. Moreover, a whole chapter is dedicated to ad hoc and sensor networks. The lectures are complemented by group projects, whose results are discussed in class. A tutorial course with exercises is offered for the 1st lecture.

Contents:

1. Introduction and Overview: History of wireless communications. Different kinds of mobility. Overview and classification of current wireless technologies. Key challenges in mobile and wireless systems.

2. Antennas: Antenna types. How are radio waves generated? Energy and power aspects of radio waves. Directivity and gain. How much power is received at a certain distance?

3. Radio Propagation: Path loss and shadowing (propagation in free space, generalized path loss models, shadow fading). Multipath propagation (small-scale fading, time and frequency spread, time- and frequency-variant behavior). Fading mitigation techniques (diversity, equalization, frequency hopping). Group project: "Path loss and shadowing".

4. Coding, Modulation, and Duplexing: Representation of signals. Conversion from analog to digital. Channel coding (overview, block coding, convolutional coding, coding gain, channel coding in practice). Digital modulation (overview, linear modulation, coherent demodulation, modulation in practice, spead spectrum modulation). Duplexing. Group project "Viterbi decoding".

5. Multiple Access and Cellular Concept: Ideas behind TDMA, FDMA, CDMA, SDMA. Cellular concept and channel reuse. Group project "Orthogonal Frequency Division Multiplexing (OFDM)".

6. Medium Access Control (MAC) Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CA, Performance studies.

7. Wireless LAN 802.11

8. Network Architecture and Mobility Protocols: Architecture of cellular networks (General architecture, System components in GSM and UMTS). Mobility in cellular networks (Addressing and location updating, Routing to mobile users, Roaming and handover). Mobility in the Internet (Addressing and mobility problem, Autoconfiguration, Device mobility with Mobile IP, Service discovery). Group project "Internet mobility protocols".

9. Security in Mobile Networks: Basics. Security in GSM and UMTS.

10. Ad Hoc and Sensor Networks: Introduction and Applications. Routing and Relaying. Connectivity and Capacity. Wireless Sensors. Group project "Ad hoc and sensor networks"

11. Economic, Health, and Social Aspects

Pervasive Computing

Bernhard Rinner, Thomas Winkler

The lecture ***Pervasive Computing*** provides the fundamentals of pervasive computing, dealing with the integration of computation into the environment, rather than having computers which are distinct objects. Computation is embedded into the environment and everyday objects and would enable people to interact with information-processing devices more naturally and casually than they currently do, and in ways that suit whatever location or context they find themselves in. The lecture covers spontaneous networking, localization and identification, context awareness and wearable computing.

Advanced Topics in Pervasive Computing is a lecture that focuses on selected aspects of pervasive computing and builds on the foundations of the Pervasive Computing lecture. In this course, students learn about the state-of-the-art and advances in electronics and (wireless) communication. The development of networks of low-cost, low-power, multi-functional sensors has received increasing attention. These sensor networks are a new type of networked, embedded computing system and are expected to become a key technology for many future applications. This lecture covers the fundamental concepts of sensor networks, including architectures, various networking aspects, power-awareness and sensor fusion.

To allow students to gain practical experience in different aspects of pervasive computing and sensor networking, the ***Pervasive Computing Lab*** is designed as a sensor network programming lab. The SunSPOT sensors used in this course are a wireless sensor platform developed by SUN Microsystems which are programmed with Java. Topics covered include gathering and analysis of sensor data, distributed sensor networking architectures and simple localization in sensor networks. The aim of the course is to give students the chance to get hands-on experience with wireless sensor network development. Based on predefined tasks, students train their problem solving skills as well as a problem-oriented working habit. Architecture designs and solutions of students are presented and discussed in the course.

Embedded Communications

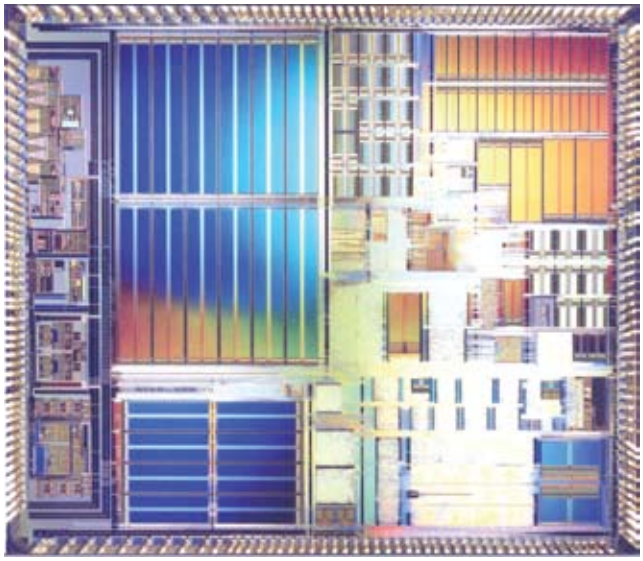
Mario Huemer, Christian Lederer

This lecture course deals with the architecture of modern wireless communication systems. All main functional blocks of a mobile phone platform including the RF transceiver and the baseband processor are addressed.

A main focus is on the board level and on the chip level architectures. In the "Digital Baseband Transceiver" chapter important baseband algorithms (equalization, channel estimation, MIMO signal processing,…), possible implementation options, and corresponding complexity considerations are discussed. The "Analog Transceiver " chapter deals with the analog signal processing tasks of a wireless device, modern transmitter and receiver architectures are discussed and future trends on the way to Software Defined Radio architectures are presented.

Contents:

1. Introductory part
   - Equivalent baseband representation of pass band signals
   - Basic principles of digital communications
   - Review of digital modulation techniques
   - The mobile radio channel
2. Abstract Hardware View on a Mobile Phone Terminal Platform (Functional Blocks, Partitioning, Technology, Power)
3. The Digital Baseband Transceiver
   - Single versus Multi Carrier Techniques (OFDM)
   - Channel Estimation
   - Equalization
   - MIMO Concepts
4. The Analog Transceiver
   - Receiver Architectures
   - Transmitter Architectures



BASEBAND CHIP FOR UMTS PHONE

Signal Processing Architectures for Embedded Applications

Mario Huemer, Alexander Onic

This lecture course deals with signal processing algorithms and with appropriate implementation architectures that focus on embedded applications.

As a consequence low power consumption and low chip area is of great importance for the regarded architectures. The course starts with a repetition of important signal processing theory and algorithms.

In the following the focus lies on implementation oriented issues like fixed point effects and architecture options. We will start with FFT architectures followed by architectures and design issues for fixed point FIR- and IIR-filters.

An old, but nowadays more and more important algorithm, the CORDIC algorithm, possible architectures and various applications of the CORDIC will be discussed in the next chapter. Next interpolation and decimation filters and possible low power implementation strategies are regarded.

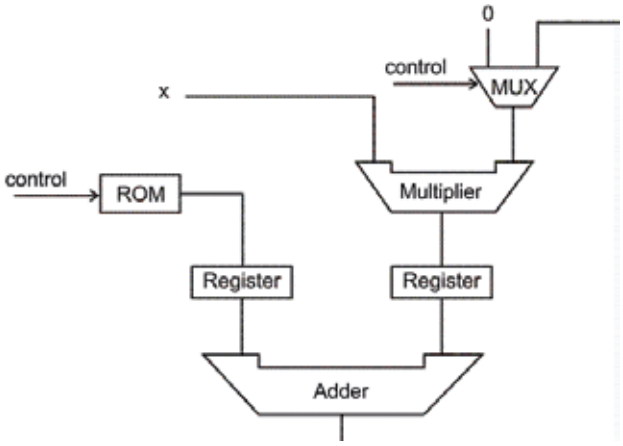
Another important issue in embedded applications is the digital signal generation. We discuss different architectures for digital signal generators like sine wave generators.

Finally we regard architectures of modern DSPs and FPGAs for embedded applications.

In parallel a practical course will be offered, where the effects and architectures are studied with the help of MATLAB/SIMULINK simulations. The course starts with an introduction in MATLAB/SIMULINK and will then focus on practical issues on the appropriate topics covered in the lecture course.

Contents:

1. Review of signal processing basics
2. Fixed point effects in digital filtering and efficient architectures
3. CORDIC-algorithm: theory, architectures and applications
4. Multirate signal processing (interpolation, decimation) : theory and low power / low area HW-architectures
5. Architectures for digital signal generators (DDS, Polynomial approximation, IIR-implementations, CORDIC)
6. Architectures for digital signal processors
7. FPGAs for signal processing
8. Applications

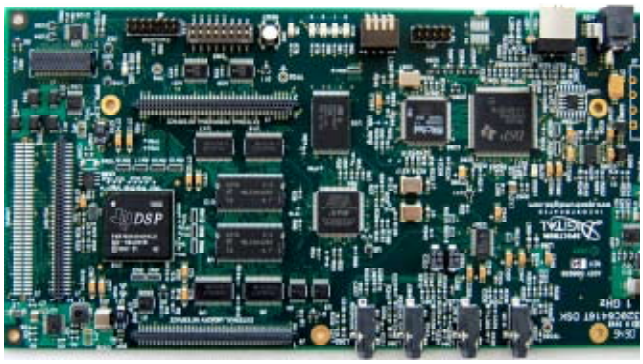


HW-ARCHITECTURE FOR POLYNOMIAL APPROXIMATION

Digital Signal Processors

Bernhard Rinner, Wolfgang Schriebl

Digital signal processors (DSPs) can be found in many devices such as mobile phones, PDAs and digital cameras.
Their fields of application are ubiquitous ranging from control and measurement to audio and video processing. This lecture deals with the concepts of modern digital signal processors. It covers main topics of micro processor architectures, focuses on the characteristic features of DSPs and presents up-to-date processors and development methods for DSP systems. Various case studies are presented during this lecture.



A C6416 DSP STARTER KIT, AS USED BY THE STUDENTS IN THE LAB

The lecture is complemented by a lab course, which applies the theoretical knowledge of digital signal processors to real-world problems. The students implement, under guidance of the lecturer, various digital filters for the C6416 DSP from Texas Instruments.

As programming a DSP implicates understanding the architecture and the concepts behind, many examples are implemented using both assembler language and C. The implementations are executed using developer starter kits, and are evaluated using the debugger and profiler. The lab is organized in units, which cover typical tasks from the areas of audio processing, image processing and optimization.

Practical Units:

- Audio processing: This unit deals with filter functions for amplification, reverberation, modulation and with FIR-filters (low-pass, band-pass, etc.). The functions are analysed using the waveform generator and music as a source, and the oscilloscope and headphones as evaluation instruments.
- Image processing: In this unit commonly used filter functions such as the threshold operation, median-filter and box-filters (Gauss and Sobel) are implemented. Furthermore, images and filters are analysed and improved by using histogram, adaptive threshold and histogram-equalization.
- Image compression: Image compressing in the frequency domain is the topic of this unit. An image compression chain using DCT/IDCT and huffman trees, similar to JPEG compression is realized and evaluated.
- Optimization: In this unit, the dot-product function is optimized step by step. Starting with sequential code the implementation is improved by filling delay slots, by using parallel instructions, by using world-wide optimization and by using software pipelining. The results of each optimization step are profiled and compared with the results of the compiler optimizations.

Contents:

1. Introduction to micro processors
2. From micro processors to DSPs
3. Development of DSP systems
4. Examples of DSPs
5. DSP programming
6. DSP applications and case studies

Networking Simulation Lab

Wilfried Elmenreich

In the "Network Simulation Lab" the students learn how to simulate mobile and wireless networks. The objectives of the course are to learn how and when simulations should be used and to learn how to apply visualization and interpretation of experimental results. Therefore, a set of different typical types of problems are modeled and evaluated in a network simulator. Therefore, the OPNET Modeler, a software for network modeling and simulation, is used.
In addition, the participating students also get a deeper knowledge in theoretical aspects of mobile and wireless networks.

The course is formally a stand-alone course, but is intended as a supplement to the lecture "Mobile and Wireless Systems II".

The course's content includes:

1. Simulation of networks in general
2. PHY and MAC layer protocols
3. WLAN
4. Mobile IP
5. Ad-hoc networks
6. Network coding
7. Network security

Information and Communication Technology Lab (ICT Lab)

Michael Gyarmati, Christian Lederer, Stefan Rass, Wolfgang Schriebl

The ICT Lab is cooperatively organized by the institutes NES and IST, and provides hands-on experience in basic areas of ICT for students doing their bachelor studies. The lab is divided into six units covering different topics, allowing students to improve their practical skills in electronics, hardware design, programming, measurements and simulation, as well as in project evaluation and documentation.

Hardware Description and Synthesis
In this unit students learn how to design and synthesize hardware. Students develop combinational and sequential circuits, describe them using VHDL, and synthesize them using the educational FPGA board Altera DE2. The final goal is to run a simple calculator on the board, which gets its input from an PS/2 keyboard, and visualizes its status using seven-segment displays and a VGA display.

Electrical Engineering and Electronics
This unit deals with the basics in measurement engineering and electronics. Students learn the correct handling of different laboratory equipments (oscilloscope, signal generator, voltage source, ...). Furthermore some circuit, which have already been taught in the course Schaltungstechnik, will be assembled and their correct function will be verified using measurement techniques.

Digital Communication
This unit deals with three different aspects of digital communication. In part one, students investigate and visualize the effects of sampling and quantization by applying them on audio signals using Matlab. In the second part, students get hands-on experience in the hardware design process by specifying, simulating, assembling and testing ADC/DAC circuits. Part three deals with well-known communication mechanisms (e.g. RS-232 and IR), which are analyzed and decoded.

Computer-aided Measurement
In this unit students learn how to build-up a temperature sensing circuit and which building blocks, as temperature sensor, amplifier, delta sigma A/D converter, are needed. The circuit is designed, simulated and measured, and as a final result, the determined temperature is transmitted to the PC via USB.

Audio Processing using Digital Signal Processors
DSPs are widely used for filtering, analyzing and processing signals in digital domain, for example for processing audio signals. In this unit, students learn how to program a DSP, how to evaluate the implementation and how to evaluate the effects of the implemented filters. As an environment, C6416 DSP starter kits, audio processing software, oscilloscope and headphones are used, the programs are implemented using C and assembler language.

Matlab and Simulink
This units introduces the numerical computing environment Matlab and the graphical simulation add-on Simulink, which are both used in many scientific disciplines. After an brief introduction into this environment, students implement and analyze a Kalman Filter using Matlab. In the second part, Simulink is used to graphically describe and simulate dynamical systems.

Embedded Microcontroller Lab

Thomas Schlechter

This course gives an introduction into the field of Embedded Microcontroller Systems. The participants of this course are expected to work on a given problem, which can be solved by a "machine".

During the course, the "machine" will, more or less completely, be implemented by the participants. The very interesting part of this course is, that circuit design skills (Hardware) as well as programming skills (C, Software) are necessary. The required knowledge will be taught during the course (basic knowledge excluded).

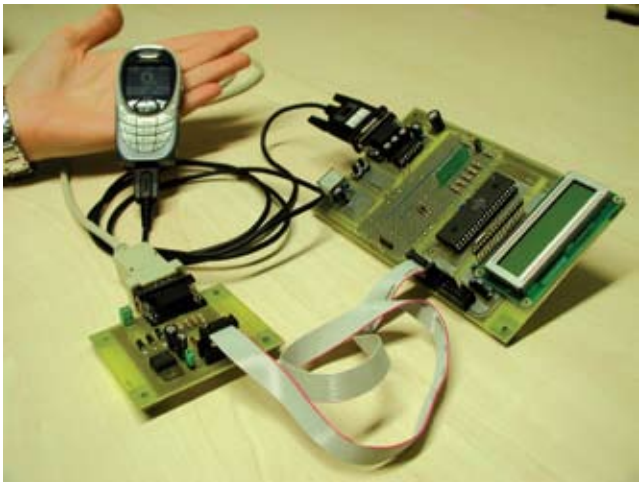
In order to keep hardware complexitiy as low as possible, a breadboard is provided to each group of the course. On this board several components of the "machine" are already implemented, only the electronic components have to be soldered in and additional peripherical circuits have to be designed. At the end of the course, the final board, built by the groups, can be taken home by the participants.

The software, implemented by each group, controls the microcontroller. C is consequently used for software implementation. Basic C-knowledge is expected from each participant at the beginning of the course.

Proceeding in the course, the participants will learn, how software and hardware work together, complement one another and build a complete system ("machine").

Contents:

1. Microcontroller ATmega32:
   - Structure
   - On-Chip-Periphery
   - Time Behaviour
   - Interaction of software and hardware
2. Development Environment:
   - Software Engineering on a Windows-System
   - Producing Code, executable on the Microcontroller
   - Programming Device, Data Transmission to the Microcontroller
3. Communications Interface:
   - Serial Asynchronous (RS232) and synchronous (PS/2) Data Exchange
   - Parallel bidirectional Data Exchange via a bus system
4. Communication Protocolls:
   - LCD Controller HD44780, PS/2 Keyboard
   - Hayes Command Set, GSM 07.07 and GSM 07.06



EMBEDDED MICROCONTROLLER

Information Theory and its Application in Communication Engineering

Johannes Huber (Guest Lecture)

Information theory from its historical development up to current methods in source and channel coding for reliable transmission are taught in this lecture as well as the necessary concepts of information, entropy, sources of information, channel models, capacity and error probabilities. A direct connection to current transmission techniques is made and proven.

Contents:

1. Basic definitions: information, entropy, mutual information.

2. Coding for data compression: source coding theorem, lossless compressing codes: Huffman-, Tunstall-, Lempel-Ziv-codes, entropy and coding for sources with memory.

3. Channel coding for reliable communications over noisy channels: channel models, capacity, channel coding theorem, bounding techniques for decoding, error probability, cut-offrate, random coding error exponent.

4. Information theory for continuous random variables: differential entropy, capacity of channels with white and coloured noise, bandlimited continuous-time channels, tradeoff between power and bandwidth efficiency. Introduction to Rate-Distortion-Theory.

Analog and Mixed Signal Design

Mario Jungwirth, Frank Ohnhäuser (Guest Lecture)

Most analog and mixed-signal circuit design today is done on a CMOS bulk process, using enhancement mode devices. This lecture will start from a basic understanding of components and circuits in analog circuit design.
A first step is to clearly delineate the difference between discrete and integrated MOSFET circuit design. Since integrated circuit design is strongly coupled with process technology the technology of devices used in analog design will be presented. Components and MOSFET amplifier configurations frequently used in analog design will be discussed using the concept of small-signal equivalent circuits. These stages serve as building blocks for more complex MOSFET amplifiers and allow the introduction of MOSFET integrated circuit design principles. Analytic calculation and numeric simulation of basic building blocks of amplifier configurations will be discussed. Finally, a deeper insight to complex circuits like oscillators, filters, mixers and phase-locked-loops will be given.
The importance of simulation in circuit design will be demonstrated by simulating the operation of several of the building block circuits using PSpice. Modifications in component parameters, loading of the input and output will emphasize the utility of simulation programs.
Single building blocks are required to design larger systems such as Analog-to-Digital converters or Digital-to-Analog converters. It is important to know the important parameters of an application, so that the right choice is done for the converter and its topology. Therefore, the parameters and causes for their degradation will be presented.
Three different converter topologies are available as catalogue products, which are the Delta-Sigma converter, the SAR ADC and the Pipeline converter. Their topology will be explained together with their advantages and disadvantages. Design and layout considerations will be introduced for the SAR and the Delta-Sigma converter.
The signal path typically includes the ADC as well as a DAC. The different DAC topologies and the Design Considerations based on a String DAC will also be presented.

Contents:

- Components in analog circuit design and its technology
- MOSFET-Transistor
- Basic building blocks in integrated amplifiers
- Operational amplifier concepts
- Signal generators / oscillators
- Filters (SC-filters, SAW-filters, etc.)
- Amplifiers (HF, CMOS, Bipolar, Wideband)
- Mixers
- PLL – Phase-Locked-Loops
- Applications
- Parameters of A/D Converter at the example of the Flash Converter
- Topologies of A/D Converter (Delta-Sigma, SAR and Pipeline)
- Design and Layout at the example of a SAR A/D Converter (Sample & Hold, DAC and Comparator)
- Design Considerations for Delta-Sigma Converter
- Topologies of D/A Converter (Current Steering, R-2R, String, Delta-Sigma)
- Design Considerations at the example of the String-DAC

Artificial Vision

Gian Luca Foresti, Christian Micheloni (Guest Lecture)

The lecture series introduces the techniques for developing advanced artificial vision based systems. From the early stages of image creation to the most advanced techniques for image and video interpretation, the course presents and discusses the more interesting algorithms for detecting objects and understanding their behaviors. During the course, real demos are presented to show the effectiveness and robustness of the artificial vision algorithms on real cases.

Contents:

1. Introduction
2. Logical architecture of an artificial vision system
3. Low level processing (object segmentation, object detection, etc.)
   - Image differencing (Frame-Background, Frame by frame, etc.)
   - Background Updating
   - Thresholding
   - Image registration (Translation, Affine, Per spective)
   - Feature-based image registration (Feature tra cking, Outlier detection, Transform Compu tation)
4. Middle level processing (object recognition, object tracking, etc.)
   - Shape analysis
   - Neural networks and Neural trees
   - Space projection (Principal Component Analysis, Linear Discriminant Analysis, etc.)
5. High level processing (behaviour analysis, event detection, etc.)
   - Explicit and probabilistic event definition
   - Simple and complex event detection
   - Feature extraction
   - Trajectory analysis and clustering
   - Scene understanding
6. Multicamera networks
   - Distributed sensor networks
   - Sensor selection
   - Data and information fusion
7. Applications
   - Human behaviour understanding
   - Face detection
   - Face recognition

RFID Topics

Ulrich Neffe (Guest Lecture)

Radio Frequency Identification Technology has got the attention of the public after the terror attacks in 2001 and the publications of the plans for the Future Store by the Metro group. The terror attacks caused the usage of RFID for securing personal documents that are used to identify persons. The future store concentrated on the identification of objects to track goods within a large retail system.

In both cases the used RFID devices are power by an electromagnetic field but they have completely different requirements on operating distance, data storage, performance, security or pricing. This lecture covers the main aspects of this technology. It will start with an introduction to RFID, an overview on the history and an outlook on this lecture. The first section describes the different RF communication technologies dependent on the carrier frequency. The second section covers the identification of objects and persons in detail. The third section describes the current RFID market with its privacy discussions and gives an outlook on new applications and required changes in technology. RF ID prototyping environments are used to demonstrate the technology during the lecture. Integrated exercises support the understanding of RFID applications.

Contents:

1. Introduction and Overview
2. RFID Technology (Low Frequency 125kHz; High Frequency 13.56 MHz; Ultra High Frequency ~960MHz)
3. RFID Applications (Identification of Objects, Identification of Persons)
4. RFID Market (Current Situation, Applications and Market Volumes, Privacy)

Guest Lectures at External Institutions

Mario Huemer:

- Gastprofessur an der Johannes Kepler Universität Linz im Wintersemester 2007/08: *Architekturen der Digitalen Signalverarbeitung.*
- Gastvorlesung *Architekturen der Digitalen Signalverarbeitung* an der Universität Erlangen-Nürnberg im Sommersemester 2008 im Rahmen des Elitestudiengangs „Systeme der Informations- und Multimediatechnik“ (SIM), der im Rahmen des Elitenetzwerkes Bayern gemeinsam von der Friedrich-Alexander-Universität Erlangen-Nürnberg und der Technischen Universität München angeboten wird .
- Gastvorlesung *Verfahren und Systeme zur drahtlosen Messdatenübertragung* an der Fachhochschule Oberösterreich im Sommersemester 2008.

Bernhard Rinner:

- Gastvorlesung an der Universität Udine im Sommersemester 2008: *Pervasive Computing.*

Events

ICDSC-08, Stanford University

The second ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC) was held at Stanford University, California, USA on September 7-11, 2008.
The conference attracted more than 150 attendees who showed a strong interest in the intersection of computer vision, embedded computing, and distributed computing.

The conference started with two tutorials on OpenCV and computer vision on the GPU from Gary Bradski and James Fung, respectively. At the main conference 24 technical papers were presented, covering a wide range of work. Two poster sessions featured the presentation of 31 papers, whereas the first session was a paperless poster presentation. The Ph.D. forum attracted presentations from 14 Ph.D. candidates. A number of demos completed the conference.

Four plenary talks were given. Alex Pentland from the MIT spoke on "Sensible Organizations: how distributed sensor data is allowing organizations to reinvent themselves." David Forsyth from the University of Illinois spoke on "Looking at People." Yiannis Aloimonos from theUniversity of Maryland spoke on "Languages of Human Activity." J. K. Aggarwal from the University of Texas spoke on "Computer Recognition of Human Activities and Objects."

Workshops
The last day was devoted to two workshops. The first workshop, organized by Tiziana D'Orazio and Mohan Trivedi, focused on Activity Monitoring by Multicamera Surveillance Systems. The second workshop chaired by Bernhard Rinner and Wayne Wolf discussed embedded middleware for smart camera and visual sensor networks.

Socializing
Stanford University, located in the San Francisco Bay Area, offered a very pleasant venue for the conference and for socializing. The social event was a guided tour to San Francisco, having the conference dinner at McCormick and Kuleto's Seafood Restaurant close to Fisherman's wharf.

Lakeside Labs Research Days

The Lakeside Research Days 2008 have been organized as a five days workshop and a previous half-day prolog. In the prolog topics for the main workshop were elaborated among a team of researchers from the University of Klagenfurt.

At the main workshop invited experts, local professors and young researchers discussed and elaborated ideas in the field of Self-Organizing Systems (SOS). The main emphasis of the workshop was on soliciting discussions and creating new ideas on the topic of self-organizing networks and their applications in the technical domain. This year, the workshop was organized for the first time. It took place at Klagenfurt University in Klagenfurt am Wörthersee, Austria. The topics treated involved definition of SOS, possible methodologies for designing SOS, showcases for SOS in the technical domain, and the role of SOS among other disciplines in science. The workshop turned out to be very fruitful for the participants.

The advances in particular have been:

- The workshop participants learned about the field of self-organizing systems first hand from the invited speakers. The presentations introduced to basic issues but also brought novel research results across.
- The guided discussions on the selected topics were further helpful to the comprehension of the field. Moreover, new knowledge was created, which, particularly, led to results in form of publications (two papers at IWSOS'08, three papers at Autonomics'08).
- In order to disseminate the results, a special session on the workshop topics has been organized at the Autonomics'08 conference in Turin, Italy.
- The local researchers could establish important contacts to the research institutions of the invited speakers. There was an oral commitment for the possibility to exchange students and researchers among the respective institutes.

A follow-up event for the Research Days is planned for 2009 to again take place in Carinthia.

NES Institute Retreat 2008

In July the scientific staff of the NES institute came together to their annual retreat. All researchers working at the institute and all external PhD students doing their research in industry met at St. Georgen am Längsee to spend 3 days together. As a special guest, Prof. Bauschert from Chemnitz University of Technology was invited to contribute his experience collected in university and industrial environment.

The intention of the retreat is twofold. On the one hand a major goal is to reflect the preceding year and to give an outlook to the upcoming, to discuss institute internal affairs, and to get an idea and understanding of the problems colleagues are working on. On the other hand the retreat stands for a social get-together, to learn more about the colleagues apart from working environment. The agenda of the retreat tried to cover the scientific and administrative demands as well as team-building and social aspirations.

The first part of the program was focused on group works and discussions. In "Internationalization: chances, dangers and problems" the international participants discussed about incoming and outgoing in research, teaching and studying from different points of views. In "The assistant as manager", heterogeneous groups of assistants and researchers reflected the topics "the own dissertation and scientific work", "working with students", "teaching" and "NES internal processes and affairs" from the assistant point-of-view. A common stand of the status quo, ideas and open questions were developed. Another point on the agenda was a structured dialog, which is a monologue talk where two persons reflect and outlook their personal and the institutes performance by answering questions. The second part of the program was dedicated to research and scientific work. Selected PhD students presented the status of their research work and already achieved results in form of oral presentation, demos and posters. Finally, our guest Prof. Bauschert, held a talk about his experience in 10 years working in industry. Beyond get-together in the evening and trips to the lake nearby, the highlight of the social program was a barbecue in the evening of day 2. We are looking forward to the retreat next year!

Guest Professor Mubarak Shah

Mubarak Shah is one of the leading specialists in computer vision – image and video analysis. Since 1986 he has been teaching at Central Florida University in Orlando, where he founded the research laboratory Computer Vision Lab. In the summer of 2008 he spent four weeks doing research at the Faculty of Technical Sciences of Alpen-Adria-Universität Klagenfurt.

Prof. Shah, why have you come to Klagenfurt?
The reason why I have come here is my personal interest in a particular field of research here. The Pervasive Computing Group led by Bernhard Rinner does research on smart cameras, which process pictures directly in cameras and which are attached to mini helicopters. I am dealing with the contents of these images and their analysis, which are required for example in medical diagnostics or in traffic control. My stay here is very interesting because we are exchanging information on the problems of evaluation and integration in smart cameras and try and come up with solutions that solve both problems.

How does image analysis work in practice?
The query you enter in the search engine is as follows: „Analyze all images and tell me how many and which incidents there have been and when they happened?" Subsequently I get only the data that have been analyzed already - without images. For this tremendous processing power and a huge number of trials are necessary.

Do you have a good team for this in Florida?
Yes, fortunately I have got an excellent team of 20 to 30 researchers: a few visitors, currently between 10 and 15 PhDs, several PostDocs and ten bachelor students per year. In addition I have got administrative staff, who look after the bureaucratic side for the researchers. The flat hierarchy leaves a lot of space for flexibility and research.

Your team is very international. You yourself are from Pakistan. Where are your team members from?
Two thirds come from Eastern Europe and Asia: Belarus, Sri Lanka, Pakistan, Thailand and China, a few from Egypt and the rest is American. We do not have anybody from Western Europe at the moment. Those who leave Europe for the US go to top institutions like Berkeley and MIT.

Your labs are barely 20 years old and your reputation is excellent. What is the reason?
Computer science was the first subject at the fast-growing UCF and we started co-operating with industry early on. That's how the labs have evolved. We work in several fields of research simultaneously and have specialised in them. We consciously try to focus on quality, in every respect.

Would you mind telling us the secret of your success?
No problem. You need three things: good research, good projects and good staff. Good funding allows for good equipment and then you can get first-class researchers. They have to be supervised well, publish well

and take part in international conferences. We organize major conferences in conjunction with ACM and IEEE.

Where do you get the projects and the funding from?
Some of our research projects we get from the National Science Fund and many come directly from industry, for example the aircraft manufacturer Lockheed Martin Cooperation. The big advantage when you work closely with industry is that you get to know their problems, you understand what direction science should take.

How do US companies commission research projects?
Companies use the Internet search engine Google to find the most qualified people: who has got the most hits, the most papers, the best website, the best reputation?

How does the university react to projects commissioned by third parties?
The university supports this trend. They match the amount, but charge high overhead costs instead. At UCL these costs are 43%. But this is still cheap; Stanford charges 70%. Private companies can charge up to 180% of overheads for third-party projects.

Is there still room for basic research?
There is, depending on the professor. Big questions always lead to other questions They often result in independent research for PhDs or PostDocs. They have to contribute as well. Our PhD students work about 70 hours per week. You cannot be successful without curiosity, ambition and commitment.

This is true for everything you do?
Yes, when you want to achieve results. And don't forget: you need patience.

Interview and picture page 84 courtesy of
Barbara Maier @ Klagenfurt University

Best Paper Award for Mobile Systems Group

At the IEEE Vehicular Technology Conference (VTC2008-Spring) Udo Schilcher, Michael Gyarmati and Christian Bettstetter received the award for the best publication of the conference.

Their paper "Measuring Inhomogeneity in Spatial Distributions" was created in a joint research activity with two colleagues from Korea toward modeling and simulating mobile wireless networks. The researchers addressed the question of how the inhomogeneity in spatial node distributions can be defined and measured. The suggested method was additionally compared to the human intuition of inhomogeneity via an online survey. The renowned conference took place for the 67th time. Out of 1,536 submissions 379 papers were selected and presented from 11-14 May 2008 in Singapore. In addition, 234 submissions were accepted and presented as posters. A second Best Paper Award was given to researchers of Massachusetts Institute of Technology (MIT) and Kyung Hee University. For Schilcher this was the first presentation at an international conference – an amazing start into the research community.

A follow-up paper that investigates how the inhomogeneity changes over time in mobile networks was presented at IEEE GLOBECOM 2008.

Lange Nacht der Forschung - cDrones project awarded

The "Lange Nacht der Forschung" is an initiative of three Federal Ministries – Transport, Innovation and Technology, Economics and Labour, Science and Research, and the Austrian Council for Research and Technology Development.

The event started at sunset and ended at midnight, showing and making it possible to experience things that normally cannot be accessed by the public. Thus, visitors had the opportunity to see laboratories, test stations and follow scientific discourse from very close up.

Throughout Austria six sites took part in this year's Night of Research, offering the possibility to visit 375 different stations. In Klagenfurt 55 different stations provided insight into the research projects of research groups from the University, the technical college and several Lakeside Park enterprises. The interest of the Carinthian public was overwhelming. Approximately 6000 people visited the University and Lakeside Park and kept researchers busy with their questions and their curiosity.

Together with the Lakeside Labs the Institute of Networked and Embedded Systems presented their "Collaborative Microdrones" project. Posters and video screenings gave the public an understanding of this research project and showed the technology behind microdrones. The flight simulator was especially popular, allowing adults as well as children to steer a microdrone. The highlight was a night flight of our microdrone, which was followed intently by hundreds of visitors.

Each site held a competition that allowed the public and a panel of experts to choose the best station. Our "Collaborative Microdrones" Project achieved second place and was awarded €1,000.

Social Events

Lakeside Labs GmbH organized and sponsored the first social event for networking between members of the NES institute, the Lakeside Labs researchers and the staff of the Lakeside Labs GmbH.

A private beach at the lake "Wörthersee" was the perfect location for the summer barbeque end of July, 2008. Almost all institute professors, researchers, staff members and Prof. Mubarak Shah (guest professor from the Central Florida University) with his family attended this casual networking event—altogether 33 persons. It was a sunny day and besides swimming there have been offered a lot of fun activities like playing table tennis, frisbee and other sports. For the barbeque a grilling area was set up and our researcher Robert Priewasser—special thanks once more—was the "barbeque boss", preparing steaks, meat, sausages and grilled vegetables. Also salads, fruits, home-made cakes and drinks have been offered. Everybody enjoyed the relaxing and casual atmosphere and the excellent barbeque. Thanks to all who have been attending our great social event, it will be continued next year in summer 2009!

BBQ-Boss Robert and Chef de Cuisine Sergio

On the 26th of September the research group "Mobile Systems" travelled to Slovenia to visit the famous caves in Postojna.

All the members of the Mobile Systems group, the members of Lakeside Labs and all our master students, 15 people joined the event. When we arrived at the caves, we had to take a small train, which carried us into the mountain. Already on the first meters, we were impressed by nice halls filled with stalagmites (growing on the ground), stalactites (growing on the ceiling) and all other kinds of dripstones, all in different colors and shapes. The halls are connected by small corridors in which the ceiling sometimes is dangerously low; the tallest visitors had to duck their heads. After the train ride we had to walk on a well prepared pathway through a vast number of rooms, corridors, along stairways and ramps. The struggle was well rewarded by the nice view of the different dripstones, some looking like spaghettis and curtains. At the end we again took the small train to come back to see daylight again. On the way back home we made a short stop in Ljubljana for lunch. We headed for a pizzeria on the Kongresni trg in the center of Ljubljana. Overall, it was a nice event to get to know each other and to discuss not only University topics but also private matters. We all look forward to hopefully enjoy such a nice event again next year.

Mobile Systems and Lakeside Labs-Staff

This year`s christmas party took place at the Salzamt – Palais Hotel Landhaushof. In the mediaval ambiente of the Renaissance arcades which were build in 1550. A dignified place to enjoy our dinner. Lakeside-Lab manager Claudia Prüggler and team joined the NES-institute for the first time.

All together we break through the 40 employes barrier. To our generally amusement the comedy duo Thomas Schlechter and Helmut Adam presented a review of this year. Istvan Fehervary presented his robotics Rudolph the red-nosed reindeer. The party lasts until the closing hour.

Like in 2005 and 2007 the Open Source Software Stammtisch organized another LinuxDay this year. The event was mainly targeted to pupils from schools in Carinthia and students from the University.

The topics were presented either in small talks or discussed off the schedule in small groups with an expert at booths. The idea was to create an exhibition like environment. Some of the major topics discussed were Embedded Operating systems on smart phones like the Android or OpenMoko, the Ubuntu Linux Distribution used as a Desktop Operating System for educational use, scientific software like LaTeX, Maxima and Octave, Server Administration and many more. The Institute of Networked and Embedded Systems presented one of their research projects - "Embedded Linux on Smart Cameras". The basic idea behind this project is to let the camera itself do some analysis and computation on the recorded pictures and transmit only the produced meta data (instead of a dump video stream). The booth included a live demonstration where visitors could see some sample transformations made in real time on the camera on an attached LC display. Future Research will include topics like embedded image processing, sensor fusion, energy aware networking and others. All in all this was a great possibility to present some of the research of the institute. For a complete overview of the discussed Topics take a look at http://eclipt.uni-klu.ac.at/ecliptwiki/LinuxDay2008.

Working as a Student at NES

Melanie Schranz, Pervasive Computing Group

My name is Melanie Schranz and I'm a student of "Information Technology" in the bachelor programme. Since the summer semester 2008 I've been working at the Pervasive Computing Group at NES.

My activities at the institute span 10 hours a week and are easily integrated with my study programme. The work comprises assistance in courses and lectures by helping to prepare lecture documents, homework corrections and working as a teaching assistant in the courses I have already completed. This way I can expand my knowledge on many topics that aren't covered in a detailed way in the lectures. Because of the permanent contact with professors, university assistants and students, good social skills are very helpful. A part of my work is also to help the assistants in their research work, so I also have a good feeling about the research which is being conducted at the institute. This is a personal advantage for me, mainly because it helps me to specify a topic for my diploma thesis on which I (will) work with the assistants, I already work with. At the start of my work I was really fascinated by the familiar climate at the institute. The feeling of being new disappeared very quickly, because all employees at NES are trying to help in a friendly way. Therefore, I can recommend to any student to take on any possibility to work at NES. With the experience I have now, I have a clearer picture of my goals and what I want to achieve regarding my education and personal career.

Melanie at her working place

Technical Infrastructure

In 2008 we could expand our research and teaching infrastructure. In addition to the laboratory used for teaching (ICT Laboratory) we equipped and maintain three more laboratories for research, the ‚Embedded Systems' laboratory, the ‚Future Networking' laboratory, and the ‚Pervasive Computing' laboratory. This expansion was necessary because of the growth of the institute. A pool of servers, workstations and software tools completes our infrastructure.

Research and Teaching Infrastructure

The 'ICT Laboratory' was set up together with the sister institute for Intelligent System Technologies and contains 16 workplaces for bachelor and master degree laboratory courses in the field of information and communication technology. The workplaces are equipped as measuring stations with signal generators, oscilloscopes, soldering stations and various measuring devices. The 'Embedded Systems' laboratory contains eight workplaces for PhD and diploma students. The equipment includes laboratory workplaces with measuring devices for the analysis of mobile radio signals, signal generators and devices for the analysis of power electronics. The laboratory 'Future Networking' offers three workplaces for development in the field of wireless sensor networks (Tmotes), four workplaces on a FPGA-based hardware platform for the development and testing of innovative mobile radio protocols as well as soldering and measuring equipment. The 'Pervasive Computing' laboratory is equipped with six workplaces for the development of pervasive computing applications on various embedded platforms and with three workplaces for developments in the field of sensor networks (SunSpots). The laboratory is also used for the testing of multi-camera applications. The software equipment comprises licenses for Matlab, Maple, Mathematica, the C++ library LEDA, Adobe Creative Suite as well as licenses for program development on various embedded platforms.

Server infrastructure

For complex computations and intensive simulations the server infrastructure comprises 7 HP ProLiant blades. Each of these blades has two Intel Xeon 3 GHz dual core processors and 10 gigabytes of RAM. To provide sufficient disk space a fibre channel storage area network is used. This results in a total storage capacity of about 18 terabytes. On all servers we use Linux as operating system. For a maximum of flexibility, scalability and resource utilization almost all of the servers have been virtualized which allows for a strict separation of services.

Promotion Activities

Neben unseren Aufgaben in der Forschung haben wir auch bei mehreren Veranstaltungen unsere Studienrichtung präsentiert. Wir setzen es uns zum Ziol, das Interesse für die technischen Wissenschaften und im besonderen unseren Studiengang zu erhöhen.

11.01.2008: Besuch des Tages der offenen Tür der HTL Mössingerstraße; Alexander Onic, Christian Lederer

21.01.2008: Vorstellung Informationstechnik am BORG Klagenfurt; Thomas Schlechter

01.02.2008: Vorstellung Informationstechnik für Besucher des BRG Lerchenfeld an der Universität; Robert Priewasser

11.02.2008: Vorlesung für den FIT-Tag; Mario Huemer

11.02.2008: Vorstellung für den FIT-Tag; Bernhard Rinner

12.02.2008: Vorlesungen für die Kinderuni; Mario Huemer

14.02.2008: Messe und Vorstellung Informationstechnik an der HTL Ferlach; Thomas Schlechter, Alexander Onic, Udo Schilcher, Michal Gurtowski

06.03.2008: Vorstellung Microcontroller Board und Diskussion mit Lehrern; Robert Priewasser, Mario Huemer

07.03.2008: Vorstellung Microcontroller Board fuer Unterstufenschüler; Robert Priewasser

13.03.2008: Vorstellung Informationstechnik in der Kaserne Klagenfurt; Christian Lederer

03.04.2008: Maturantentag; Alexander Onic, Simone Fuchs

30.05.2008: "Warum soll ich Technik studieren?"; Linux-Day Klagenfurt, Bernhard Rinner; Stand und Vortrag: Embedded Linux auf intelligenten Kameras; Markus Quaritsch, Wolfgang Schriebl, Thomas Winkler

01.06.2008: Vorstellung bei Lakeside Labs Veranstaltung; Mario Huemer, Alexander Onic, Robert Priewasser

03.06.2008: Besuch zweier Gruppen vom Gymnasium Villach, Vorstellung des Embedded Microcontroller Boards; Thomas Schlechter

17.07.2008: Vorstellung des Microcontroller Boards (Lakeside Park Führung der Ferialpraktikanten); Thomas Schlechter

Juli 2008: Betreuung Maturaprojekte der HTL Villach; Christian Lederer

Juli 2008: Betreuung der Ferialpraktikanten Emanuel Steiner und Daniel Singer in deren Projekten; Thomas Schlechter, Thomas Winkler

14.-16.10.2008: Repraesentation der Uni Klagenfurt bei der Studieninformationsmesse in Ljubljana; Christoph Unterrieder, Alexander Onic

23.10.2008: Vorstellung Microcontroller Board fuer HTL-Schueler; Thomas Schlechter

09.12.2008: Workshop, Besuch der HTL Mössingerstrasse; Wolfgang Schriebl, Christoph Unterrieder

19.12.2008: Technik Live; Thomas Schlechter

Appointments and Responsibilities at the University

Christian Bettstetter

- Head of the Institute of Networked and Embedded Systems
- Professor and Chair of Mobile Systems Group
- Elected member of the Senate
- Member of the commission for a full professorship in "Measurement and Control Systems"

Mario Huemer

- Professor and Chair of Embedded Systems and Signal Processing Group
- Vice Chairman of the Institute of Networked and Embedded Systems
- Chairman of the commission for a full professorship in “Control and Measurement Systems” at Klagenfurt University
- Member of the curricular-commission for the bachelor and master program “Information Technology”
- Member of the working group for the revision of the bachelor and master program “Information Technology”
- Member of the faculty working group for the PhD curriculum at Klagenfurt University

Bernhard Rinner

- Professor and Chair of Pervasive Computing Group
- Vice Dean of the Faculty of Technical Sciences
- Vice Chairman of Institute of Networked and Embedded Systems
- Member of the curricular-commission for the bachelor and master program “Information Technology”
- Coordinator of the double-degree program with the University of Udine

Photos


TEXAS
INSTRUMENTS
There for you

The Institute of Networked and Embedded Systems (NES) of Klagenfurt University, Austria, works on the design, modeling, and analysis of future networked and embedded systems. We are engaged in research on algorithms and protocols, architectures, networking theory, signal processing, and hardware-oriented issues, with a strong focus on wireless and mobile networks of embedded, pervasive devices and sensors. Current interests include self-organization in networks, networked cameras, cooperative wireless communications, localization and synchronization, and sensor fusion. Our project portfolio includes long-term and short-term research, both in close cooperation with industrial and academic partners. Potential application areas include telecommunications, mobile computing, automotive, and disaster management.

Our teaching activities cover bachelor, master, and PhD courses for the study programs ‚Information Technology' and ‚Informatics'. We are committed to giving high-quality lectures, seminars, labs in the areas of signals and systems, circuits and electronics, mobile and wireless systems, pervasive computing, and embedded systems.

Established in the Lakeside Science & Technology Park in January 2007, the institute consists of three research groups: Mobile Systems (Prof. Bettstetter), Embedded Systems and Signal Processing (Prof. Huemer), and Pervasive Computing (Prof. Rinner). It currently employs 34 people.