Activity Report: Automatic Control 2010

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Automatic Control 2010

Activity Report

Automatic Control 2010

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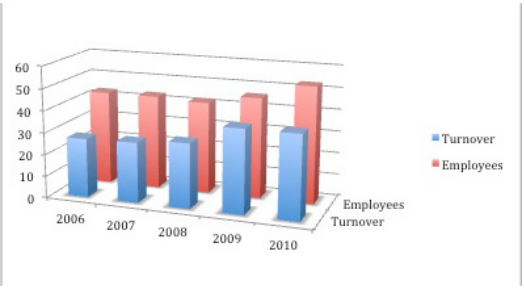
Contents

Introduction

The year 2010 was filled with many good news and interesting events for the Department of Automatic Control at Lund University. This report covers the main activities from January 1 to December 31, 2010.

The department has increased in size, both from a financial perspective and concerning personnel. The budget for 2010 was 38,1 MSEK and there are 53 people working at the department (guests not included). These figures can be compared to the corresponding number for the last 5 years in the table below. More about the financial figures can be found in the chapter General Information.



Today (year 2010) the department has 8 professors, 4 associate professors, 1 assistant professor, 5 research engineers, 4 secretaries and 31 PhD students. During the year, 10 new PhD students were admitted to the department. In September Stefan Skoog joined the department as research engineer. In addition four post-docs, one visiting professor and four long-term guests have been with the department during this year. Some of them are presented in Chapter Staff.

One licentiate thesis, by Mikael Lindberg, was published in 2010. This brings the total number of PhDs graduating from the department to 86 and the number of licentiate thesis to 60.

The people working at the department are all essential for the research and education carried out by the department. During 2010, 4 new research proposals were accepted with fundings from Swedish agencies. This year we gave 14 courses to 850 students and 45 students presented their master's thesis at the department. More about this in the Chapters Education and Research.

Every second year, the Swedish Conference in Automatic Control is organized, the location alters between the universities in Sweden. In 2010, the 3-day conference was organized by our department. June 8-9, were dedicated to the main conference. The conference program was stuffed with 5 keynote speakers, 3 tutorials, 39 presentations and 61 poster sessions, and the conference was attended by approximately 200 (197) persons – all interested in different aspects of automatic control. The conference started on June 7, though, with an informal day; the PhD-students spent

time in the city center and visited the Science center at LTH, the research engineers gathered and discussed laboratory equipement, the secretaries made a tour in the southern part of Sweden and professors and associate professors spent the day discussing education related questions. The final activity this day was a visit to the Turning Torso in Malmö and dinner at a restaurant by the sea.

The Nordic Process Control Workshop was organized by the department and held in Lund, August 25-27. In total 66 persons attended the conference. People both from academia and industry took part and tutorials were given.

Our Linnaeus Center LCCC (Lund Center for Control of Complex Engineering Systems) organized a theme semester in spring 2010 with focus on four areas within ”Distributed Decision Making and Control”. Approximately 120 internationally outstandig researchers visited the Department during various parts of this semester and we offered them both office space and accommodation. The theme semester included four intense periods, each one including a three day workshop. The proceedings from these workshops have been collected in a book. The theme semester provided valuable stimulus to the LCCC research environment, and increased the recognition of LCCC by other researchers and organizations.

During two days in October, the LCCC advisory board met at the Department. The first day was focused on LCCC presentations to the advisory board, whereas the second day was focused on discussions with and feedback from the Advisory board. The two days served as a vitamin injection to the LCCC researchers and provided valuable strategic advice for the future.

During 2010, the department hosted several international meetings; On July 7-9, two working groups of the International Standardization Organization held their meetings here with focus on standard development; ISO 22400 - Manufacturing operations management: Key performance indicators, ISO 20140 - Methodology to evaluate a manufacturing system’s energy efficiency and related factors that influence its environmental sustainability. Approximately 25 persons attended from countries all over the globe. There were also several meetings within the EU framework projects.

Charlotta Johnsson and *Eva Westin*

2. Education

2.1 Basic Level

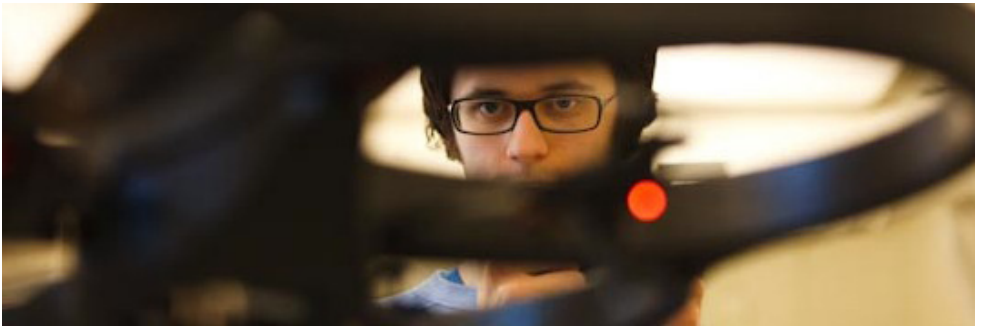
The engineering education follows the central European systems with a five year program leading up to the university degree "civilingenjör" (civ.ing.), with the international title MSc. Automatic control courses are taught as part of the engineering curriculum in Engineering Physics (F), Electrical Engineering (E), Computer Engineering (D), Mechanical Engineering (M), Information and Communication Engineering (C), Environmental Engineering (W), Engineering Mathematics (Pi), Industrial Management and Engineering (I), Biotechnology (B), Engineering Nanoscience (N) and Chemical Engineering (K).

During 2010 the department has been involved in courses given together with Lund University School of Economics and Management. Within this interdisciplinary cooperation called Technology Management, 16 future engineers have completed a master's thesis in pair with a future economist. These students have also completed different courses on the subject.

This year, 850 students passed our courses and 45 students completed their master's thesis projects. A list of the master's theses is given in the Annex. The number of registered students correspond to 123 fullyear equivalents during the year. The numbers for 2009 were 829, 40 and 118 respectively.

In the table below, our courses are listed along with the number of students who passed each course.

Each course in the engineering program has its own homepage, documentation, manuals, old exams etc. We also have information sheets about the engineering courses, the master's theses and the doctorate program. You'll find the links at www.control.lth.se/education/.



Teaching assistant and fifth year student Josefin Berner is helping Rikard Hjelm and Jimmie Hansson during a lab session.

Second year students Andrea Tollstadius and Anna Gustavsson think that the direct application from lectures is very useful.

PhD student Andreas Stolt in action during one of the lab sessions for the basic level course in Automatic Control.

Johan Falk, student on the Engineering Physics Program, enjoys the lab. His lab partner is Andreas Fransson from the same program.

2.2 PhD Studies

One licentiate theses was presented during 2010, by Mikael Lindberg (see abstract below in 2.3).

We have admitted Jonas Dürango, Martin Hast, Ola Johnsson, Anders Mannesson, Jerker Nordh, Björn Olofsson, Anders Peterson and Olof Sörnmo as PhD students during the year.

The following PhD Courses were given in 2010:

- SLAM, ht2 Group study
- Linear Systems, ht2, Bo Bernhardsson
- Feedback Control for Physicists ht2, Karl Johan Åström
- Functional Analysis in System Theory, ht1-2, Andrey Ghulchak
- A Short Course on Internet Congestion Control, August 23-24, Steven Low, Caltech
- Robotics – Kinematics, Dynamics and Control, Rolf Johansson
- Introduction to Statistical Machine Learning, April 19-27, Alex Smola, Yahoo/ ANU and S. V. N. Vishwanathan, Purdue
- A Short Course on L1-Adaptive Control, April 12-16, Naira Hovakimyan, UIUC
- A Short Course on Game-theoretical Learning and Stochastic Approximation, March 5-15, David Leslie, Bristol
- Control System Synthesis, vt1-2, Bo Bernhardsson, Karl Johan Åström

2.3 Dissertations

The licentiate thesis, of which the abstract is presented below, is available in its entirety at www.control.lth.se/publications

Adaptive Resource Management for Uncertain Execution Platforms

Embedded systems are becoming increasingly complex. At the same time, the components that make up the system grow more uncertain in their properties. For example, current developments in CPU design focuses on optimizing for average performance rather than better worst case performance. This, combined with presence of 3rd party software components with unknown properties, makes resource management using prior knowledge less and less feasible. This thesis presents results on how to model software components so that resource allocation decisions can be made on-line. Both the single and multiple resource case is considered as well as extending the models to include resource constraints based on hardware dynamics. Techniques for estimating component parameters on-line are presented. Also presented is an algorithm for computing an optimal allocation based on a set of convex utility functions. The algorithm is designed to be computationally efficient and to use simple mathematical expres- sions that are suitable for fixed point arithmetics. An implementation of the algorithm and results from experiments is presented, showing that an adaptive strategy using both estimation and optimization can outperform a static approach in cases where uncertainty is high.

2.4 Focus on PhDs

PLUME - Lund University Mentorship program for Engineering PhD students

In the fall of 2009, I came up with the idea of starting a mentorship program for PhD students. I thought there were many reasons why it would be good to have such a program at LTH: It could increase the students' awareness of and knowledge about the job market that awaits them, they could get support in their current situation, and both mentors and students could learn from each others experience of work and life. Last, but not least, I wanted to have a mentor of my own, and I couldn't come up with a simple way to find one...

Through the PhD student section, I found some other PhD students who wanted to work with this project (including Per-Ola Larsson from our department). Together, we started to market the program and look for potential mentors. The mentors were supposed to be previous PhD students, either working in the university or at a company. It turned out that there was a lot of interest, both from students and from mentors. The mentors came from everywhere: They were recent graduates, professors, developers, consultants, CEOs and directors, and one was even the Vice-Chancellor of Lund University!

We tried to match students and mentors based on their interests, so that they easily could relate to each other. There was also a lot of interest in PLUME from LTH and from Region Skåne, who agreed to help out with funding the program. Besides the invidual meetings between mentor and student, PLUME had four common events. These events had different themes (such as career choices, leadership or mingling skills) with one or more speakers to teach us about these things, followed by a nice dinner.

PLUME started in March 2010 and ended in December. There will be a new edition running in 2011 thanks to some students who thought that the program was too good to disappear after just one year. The evaluation said the same thing: Almost everyone was satisfied and would recommend others to participate. Personally, I learned a lot from this. Both from organizing the program and from the excellent mentor I got (an IT manager at IKEA who helped me realize a lot of important and useful things).

For more information about PLUME, see http://dokt.tlth.se/plume/

Erik Johannesson

Maria Henningsson
Age: 30
Family: Her husband Toivo and children Alice, one year and Arthur, two and a half.
Residence: House in Lund
Leisure activities: No passionate hobbies, just what people do most - cooking, social activities with firends etc.
Most recent book: about the global financial crisis
Most recent movie: ”cannot even remember...”

Maria – softspoken and competitive

At an age when girls want to be actresses, models or veterinarians, Maria Henningsson was an exception – she wanted to become an engineer. As an adult she seems to be a softspoken and unobtrusive character but obviously she had the guts to dare to be different even at an early age. And she was true to her words. Today she is a Ph. D. student at the Department of Automatic Control and the doctoral degree is not very far off.

Maria grew up in Falkenberg, a small town on the Swedish west coast. Chalmers University of Technology in nearby Gothenburg would have been the natural choice for her Engineering studies. However, at high school she had the fortune of being elected for a three day program called "Flickor på Teknis" at LTH, Lund Institute of Technology. The basic idea of this program is to encourage girls to go for Engineering.

- A couple of us high school kids stayed with a young woman studying Chemical Engineering. It gave me some valuable insights into what it is like to be an Engineering student. But most of all I really liked Lund, the town as well as the student life! Maria recollects.
However, after high school there were other options than joining a college or a university right away.

- A lot of kids in Falkenberg used to take a sabbatical after their exams. Some of my friends went to Norway to rinse fish in the fisheries there. It was a very popular and relatively well paid job. But it was certainly not the kind of work that attracted me. So I went to Lund instead and studied languages for a year – French, Spanish and Russian. I have always enjoyed the humanities as well. That was my sabbatical, says Maria.
She then took up her engineering studies with emphasis on Engineering Mathematics. A step into an environment dominated by males?

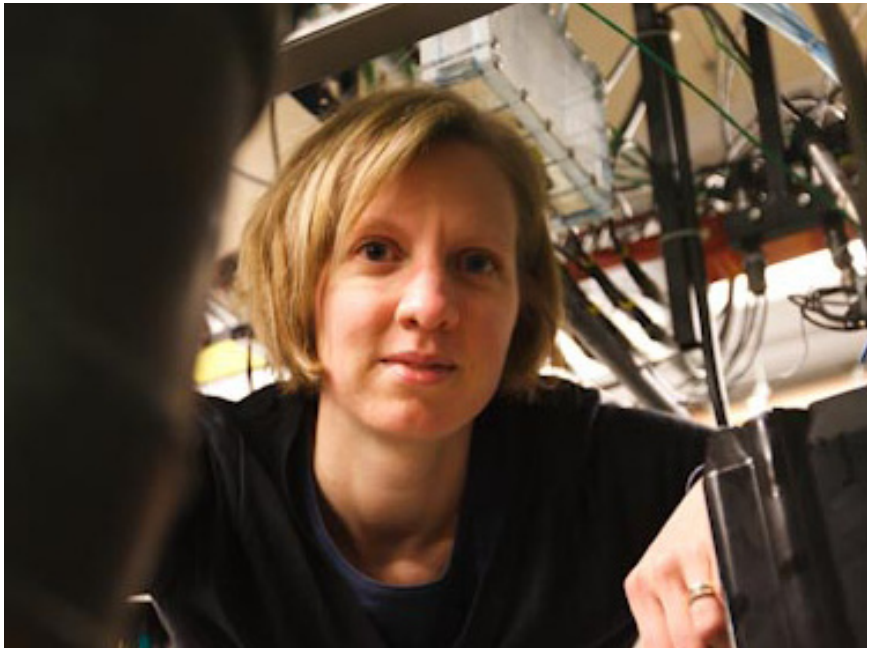
- Not really, replies Maria. One third of us were girls. And here at the Department there is also a growing number of female students and employees. But sometimes at conferences and in certain laboratories I happen to be the only woman… However, it is not a disadvantage. On the contrary, it could mean that you get more attention and support.
During her time as an engineering student she also met Toivo, her husband-to-be. Both of them are now Ph.D. students at the Department of Automatic Control. Since Maria made her Master's thesis at the Department it was an obvious choice to go for a Ph.D. position at the same place. For some time she didn't know what to specialize in. Then there was a research grant for controlling the exhausts of diesel engines. But at first Maria hesitated to go into this project.

- I had no experience of engines. Since I am more inclined towards theory it sounded too much like practical technology to me. But finally I agreed, says Maria.

- Now I am working together with a postgraduate at the Department of Combustion Engines. They have a diesel engine there and my colleague is running and handling the engine. So I can concentrate more on the theory.
Maria is working on a model by which the diesel engine can be run optimally as regards NOx- and soot particles emissions. There is a number of parameters to be considered in this kind of work like when the fuel is injected and at what pressure, acceleration, deceleration, at which load the engine is working etc. Her project started in 2005 and may take another one to one and half years.
That may sound slow but this wasn't the only project in her life at the time - during her postgraduate years she has also become the mother of two children.

- I am grateful to the Department for all the understanding and support I have got throughout my time here, she says.
And the future? Maria will be looking for industrial work, preferably in Sweden. There are many exciting possibilities. Some of her student friends have gone abroad. But with two children she wants to play it safe.
But first she has to become a doctor – something she claims to manage before her husband.

- He would never make any such claims, she says. But me, I am very competitive!



Research 2010

The Department of Automatic Control has been very successful regarding research during 2010. The department currently has four excellence centers, i.e. longterm strategic research projects and major research areas. The research spans from application-oriented projects to theory-oriented projects.

3.1 Excellence Centers

LCCC – Lund Center for Control of Complex Engineering Systems
LCCC is a Linnaeus Center at Lund University funded by the Swedish Research Council. The ten principal investigators are from the Department of Automatic Control and the Department of Electrical and Information Technology.

Process Industrial Centre at Lund University
Swedish process industry and the Foundation of Strategic Research has founded a Process Industry Centre at Lund University. PIC-LU is a collaboration between the departments of Chemical Engineering and Automatic Control at the Faculty of Engineering.

ELLIIT Strategic Research Center
ELLIIT is a network organization for Information and Communication Technology (ICT) research at the universities in Linköping, Lund, Halmstad and Blekinge, which has been created to support and enhance an internationally acknowledged research environment in these areas. The objective is scientific excellence in combination with industrial relevance and impact. It is organized within the Swedish government's strategic research support initiative.

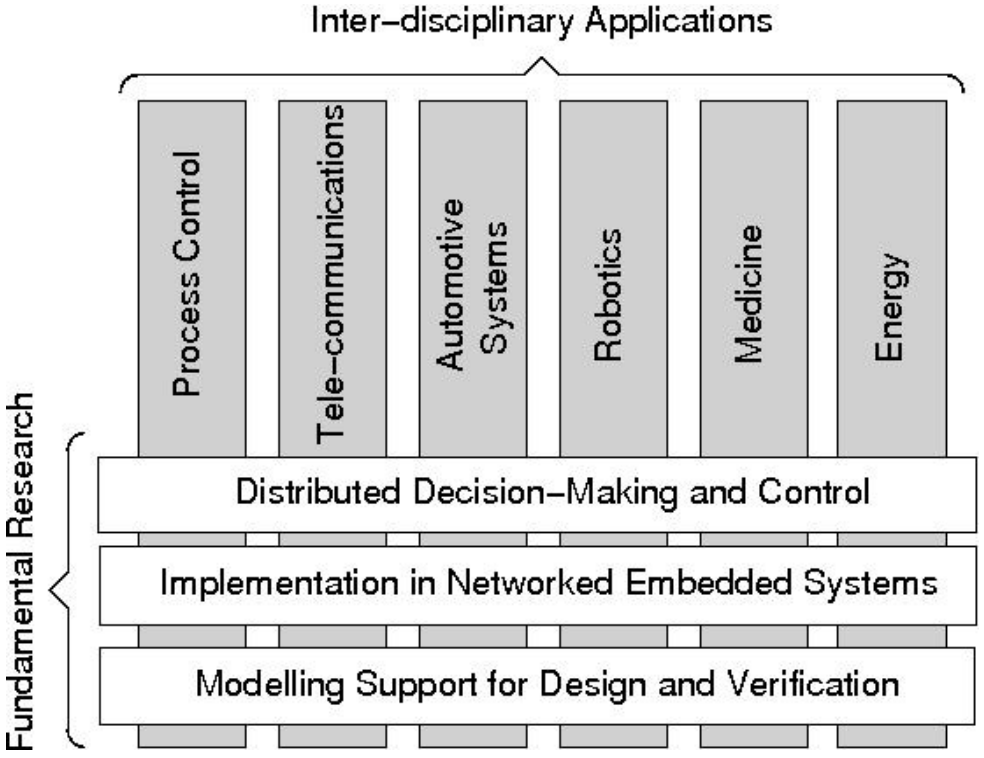
Competence Center Combustion Processes (KCFP)
The Competence Center on Combustion Processes at Lund University focuses on research on combustion processes in domain between conventional HCCI (Homogeneous Charge Compression Ignition) and classical Otto and Diesel engines.

LCCC – Lund Center for Control of Complex Engineering Systems

LCCC is a Linnaeus Center at Lund University funded by the Swedish Research Council. The ten principal investigators are from the Department of Automatic Control and the Department of Electrical and Information Technology.

LCCC official website: http://www.lccc.lth.se/

The research vision of LCCC is to make fundamental contributions to a general theory and methodology for control of complex engineering systems. This includes scalable methods and tools for modeling, analysis and control synthesis, as well as reliable implementations using networked embedded systems. Our goal is to maintain a leading role in a world-wide effort involving partners of many kinds.



LCCC coordinates complex engineering systems

How should equipment across Scandinavia be coordinated to quickly find new routes for electrical power transmission when a line is broken? How should micro-processors in a vehicle utilize brakes and engine power to recover from a dangerous situation? How can multiple applications in a cell-phone be coordinated to make optimal use of battery, memory and processing power? All these questions are examples of distributed control problems studied at LCCC, Lund Center for Control of Complex Engineering Systems. The ultimate goal is to make large-scale engineering more effective, reliable and sustainable.

LCCC is a so called Linnaeus Environment financed by the Swedish Research Council. This kind of program runs for ten years with the intent to enhance competiveness in a good environment for basic research. LCCC is coordinated from Automatic Control LTH, but involves researchers from other departments as well. At present the funding is more than 7.5 MSEK annually.

LCCC was created in 2008 but it would be misleading to characterize this as an initial stage. The research environment was already well established, but the grant made it possible to initiate new research directions and increase the international exchange. Consequently, research has been intense from the very beginning.

The LCCC is emphasizing three directions of fundamental research. One is distributed decision-making and control in large-scale engineering systems. Different technical components are often designed without complete knowledge of the total system. Hence systematic methods for distributed control and decision making will be a central tool for engineering solutions of tomorrow. Another research direction is networked embedded systems. Traffic control is a good example of this where cars on the road may create smoother and safer traffic by communicating with each other. The third direction is devoted to modelling tools and standardization for engineering design and verification.

There are all sorts of people involved in projects like these, says associate professor Charlotta Johnsson who is also deputy coordinator of LCCC.

Some are theorists. They are interested in the problems as such and want to find elegant solutions. Others are more practically inclined and want to see the applications, for instance how a solution works in an industrial process.

Since the world is full of natural and man-made automatic control systems – including our own bodies – the applications of the three fundamental research directions of LCCC are innumerable.

- There is a growing number of applications within the energy sector, explains the LCCC coordinator, professor Anders Rantzer. Consider the challenges in the use of wind power. You put turbines in a wind farm, but do they interact in an optimal way? Some of them may produce more power by shielding off the wind from others – which also means that they are more exposed to wear.

- The distribution of electricity in the power grid takes a lot of automatic control. If some of the power comes from renewable sources like wind and sun it is difficult to predict the supply. This can be solved by coupling to hydro-power. When the supply is good you may rely less on hydro-power and water levels in the water reservoirs will rise and vice versa. On the other hand, varying water levels may have an impact on the ecology near the reservoirs. Professor Rantzer also thinks that the use of communication networks might have many promising applications in traffic control:

- Today, he says, you have a sensor in the road that will affect the traffic signal. If the cars would communicate directly with each other, with varying speed limits and with traffic signals you would get a more flexible system. This could reduce congestion, while improving safety and fuel economy. It could be potentially be achieved using cell phone technology.

For a Linnaeus Center to have a good and creative research environment cooperation is needed with other disciplines. This is also true for LCCC. As Charlotta Johnsson puts it:

- Suppose that we need a compiler to translate industrial flow charts into a language a computer can understand… Well, in that case it is natural for us to seek the assistance of a computer scientist. In other cases we may need some contribution from a mathematician. So we will cooperate with these experts.

The fact that the telecommunications group is also a LCCC partner of course widens the scope of competence. One kind of problem that is dealt with by this group is communication in connection with crisis management. How should for instance the computers behind a newspaper website be organized when big news hit the world and is published on-line? The website can be blocked when too many people want too much information. Giving less information to more readers would be much better.

Exciting times are awaiting the LCCC researchers.

Charlotta Johnsson, deputy coordinator and Anders Rantzer, coordinator

ELLIIT - Excellence Center at Linköping - Lund on Information Technology

Researchers:Karl-Erik Årzén, Bo Bernhardsson, Anton Cervin, Anders Rantzer, Jerker Nordh, Anders Mannesson, Anders Robertsson in collaboration with reserachers at the Departments of Computer Science, Electrical and Information Technology, and Mathematics, Lund University, and Linköping University, Halmstad University, and Blekinge University.

Funding: VINNOVA/VR (National Strategic Research Area)

ELLIIT official homepage: http://www.elliit.liu.se/

ELLIIT is a network organization for Information and Communication Technology (ICT) research at Linköping, Lund, Halmstad and Blekinge, which has been created to support and enhance an internationally acknowledged research environment in these areas. The objective is scientific excellence in combination with industrial relevance and impact. It is organized within the Swedish government's strategic research support initiative.

The Department of Automatic Control participate in ELLIIT in the following ways:

* Karl-Erik Årzén is vice-director for the Lund part of ELLIIT and the area leader for the Embedded Systems area within ELLIIT.
* Bo Bernhardsson is an ELLIIT professor.
* The Department participate in the following projects:
  Cross-layer and cross-system design of automotive traffic safety applications
  Integrated Scheduling and Synthesis of Networked Embedded Event-Based Control Systems
  Feedback-based software project management in lean software testing
  Tools and Languages for Modeling and Optimization
  Cooperative Localization and Mapping for UAVs and UGVs
  Navigation
  Process Learning
  Optimization and Identification in Distributed Systems

Process Industrial Centre at Lund University

Researchers: Johan Åkesson, Tore Hägglund, Martin Hast, Charlotta Johnsson, Ola Johnsson, Per-Ola Larsson, Anna Lindholm, Kristian Soltesz

With support from the Swedish Foundation for Strategic Research (SSF), a new centre, PIC-LU, has been established in collaboration with the department of Chemical Engineering.

PIC-LU official hompage: www.pic.lu.se

The overall goal of PIC-LU is to establish, in cooperation with Swedish process industry, an internationally leading centre for research and professional training in process optimization and control.

In the research program, methodology and tools for modelling, optimization, and control of industrial processes will be developed, in order to improve production systems with respect to flexibility, controllability, and availability. The methodology and the tools are developed from specific solutions to process control problems suggested by the industrial partners. The goal is to make the results from PIC-LU industrially relevant, not only for the participating industries, but on a wide scale in process operation and automation. The first industrial partners are Borealis, Novo Nordisk, Perstorp, and Pfizer.

In the competence development program, the main goal is to increase the competence level of process optimization and control in industry as well as in academy. The goal will be reached in two ways; through an educational program at different levels for staff in process industry, and by directed efforts in MSc and PhD programs at the university.

KCFP, Closed-Loop Combustion Control

Researchers: Rolf Johansson and Anders Widd in cooperation with Patrick Borgqvist, Assoc. Prof. Per Tunestål and Prof. Bengt Johansson, Div. Combustion Engines, Lund University.

Competence Center Combustion Processes at Lund University focuses on research of combustion processes between conventional HCCI (Homogeneous Charge Compression Ignition) and classical Otto and Diesel engines.

Project aims:

* Reducing emissions, improving efficiency and repeatability of HCCI and PCC combustion using closed-loop control;
* Control-oriented modeling and simulation of combustion processes;
* Model-based control and optimization evaluated on test beds.

Within the project a cycle-resolved, physics-based, model of HCCI has been developed. The model includes a low-complexity model of the cylinder wall temperature dynamics in order to capture the relevant time-scales of transient HCCI when only small amounts of hot residuals are trapped in the cylinder. The temperature evolution of the gas charge is modeled as isentropic compression and expansion with three heat transfer events during each cycle.

Model predictive controllers based on linearizations of the model have been designed and evaluated experimentally. The considered control signals were the inlet valve closing and the intake temperature. The control performance was evaluated in terms of response time to set-point changes and the resulting output variance.

3.2 Modeling and Control of Complex Systems

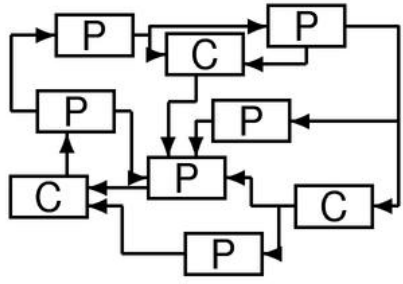
Theory and computer tools are developed to deal with fundamental complexity issues appearing in for example vehicles, power systems and communications.

Distributed Decision-Making and Control

Researchers: Anders Rantzer (area leader), Bo Bernhardsson, Andrej Ghulchak, Giacomo Como, Georgios Chasparis, Pontus Giselsson, Maxim Kristalny, Karl Mårtensson

Funding: LCCC

Most of control theory has been developed in a centralized setting, where all measurements are processed together to compute the control signals. This paradigm has conceptual advantages, but also inherent limitations. In contrast, industrial practice often relies on distributed control structures. Hence, there is a strong need for theory and methodology supporting design and verification of distributed controllers. We believe that systematic principles for control and decision-making in large-scale engineering systems can and should be developed. This is the purpose of this research area.



Topic A: Market-based Methods for Distributed Decision-making and Control
Theory for coordination of many different units is closely related to economics and game theory. The goal of this task is to exploit these links systematically. A source of inspiration is the rich set of tools from convex optimization that have found widespread use since the early 1990s. In this area, the concept of price mechanism appears naturally in the form of Lagrange multipliers and is the basis for so-called dual decomposition. Another important tool is the theory for nonnegative matrices and monotone dynamical systems.

Topic B: Distributed Validation of System Performance
For large-scale complex systems, verification of system performance cannot be performed by treating all equations of a full-scale model simultaneously. This would be too complex. Instead, it is natural to exploit the component structure and use several levels of abstraction. The objective of this task is to develop mathematical and computational tools for this purpose.

AEOLUS - Distributed Control of Large-Scale Offshore Wind Farms

Researchers: Daria Madjidian, Ahmed H. El-Shaer, Maxim Kristalny, Anders Rantzer in collaboration with project partners from Aalborg University, Industrial Systems and Control Ltd in Glasgow, University of Zagreb, Energy Research Centre of the Netherlands and Vestas Wind Systems A/S.

The project is funded by EU/IST/FP7. Duration May 2008 – April 2011.

Aeolus is an European research project funded by the European Commission under the IST framework programme 7 for Information and Communication Technology, ICT. The main goal of Aeolus is to research and develop models that allow real-time predictions of flows and incorporate measurements from a set of spatially distributed sensor devices. In Aeolus we will use the flow information as a basis for new control paradigms that acknowledge the uncertainty in the modelling and dynamically manage the flow resource in order to optimise specific control objectives.

November 14, 2008 Aeolus together with LCCC organized a Wind Power Meeting in Lund.

AEOLUS official website: www.ict-aeolus.eu

CHAT - Control of Heterogeneus Automation Systems

Researchers: Pontus Giselsson, Erik Johannesson, Mikael Lindberg, José Maestre, Karl Mårtensson, Anders Rantzer, Karl-Erik Årzén in collaboration with project partners from University of Pisa, Siemens AG, University of Trento, University College London, Elsag Datamat, Sofidel and University of Salento.

The project is funded by EU/IST/FP7.
Duration September 2008 – August 2011.

CHAT official website: www.chat.eu

Scalability, reconfigurability, and security are three aspects of paramount importance in developing efficient, predictable, and safe control architectures for large-scale networked industrial automation. At present, the state of control systems technology is such that the supervision and control of larger and more complex plants cannot be achieved without considerable costs in terms of hard infrastructure and software development.

CHAT is a research project exploring the research and engineering challenges inherent in the development of algorithms, protocols and procedures for next generation distributed control systems, in order to drastically reducing infrastructure, maintenance and reconfiguration costs.

Involvement
The Department of Automatic Control is involved in developing price mechanisms for distributed control as well as consensus and distributed estimation algorithms. Currently the focus is on using such methods for mobile robot task allocation. We have also provided simulation environments, extended to incorporate industrial network standards to our partners (FlexRay and PROFINET in Truetime).

Control with Communication Constraints

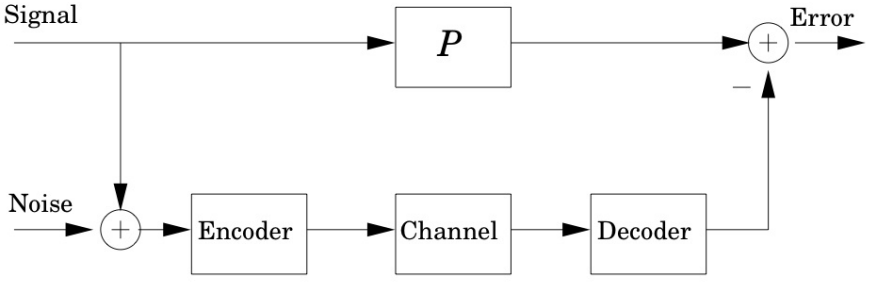
Researchers: Erik Johannesson, Anders Rantzer,
Bo Bernhardsson, Andrey Ghulchak

Funded by the Swedish Research Council.

Classical control theory assumes perfect communication, without limitations, between different parts of the control system and the process. A current trend in control systems is, however, for the systems to become more distributed and more dependent on communication over different types of networks. This makes it necessary to study the implications of the resulting communication constraints. In the control community this has spurred interest in the research of the interplay between communication and control. The results have mainly concerned fundamental limitations of control performance that arise from communication constraints.

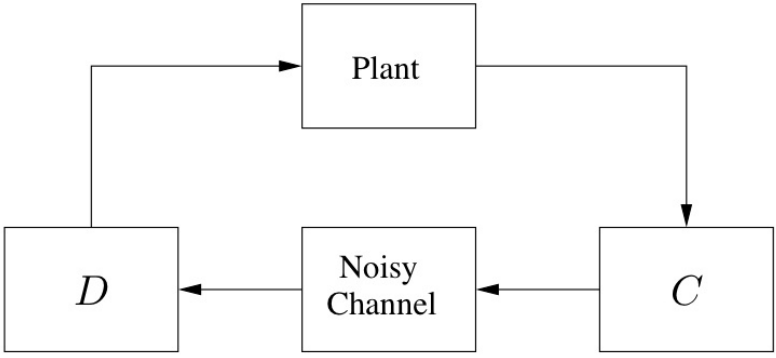
In this project, the goal is to design optimal controllers and estimators for some specific problems with limited communication. We model the communication constraints by analog communication channels with limited SNR (signal to noise ratio). These channels give an incentive to perform coding and decoding of the transmitted signal, in addition to the usual filtering and computation of control signals. The problem of designing the controller, coder and decoder simultaneously is a distributed control problem, which can be solved using tools from convex optimization. Currently, we are focusing on two specific problem structures, which represent an estimation problem and a control problem respectively.

Estimation over Channel with SNR Constraint



The objective is to design the coder and the decoder so that the estimation error is minimized. This can be interpreted as a real-time coding problem (if P is replaced by a time delay) with input noise. Another interpretation is that this concerns the design of a disturbance feedforward compensator, where the sensor and the actuator are geographically separated.

Control over Channel with SNR Constraint



In this problem, the objective is to design an observer/coder C and decoder/controller D that stabilize the plant and minimizes the effect caused by a plant disturbance (not shown).

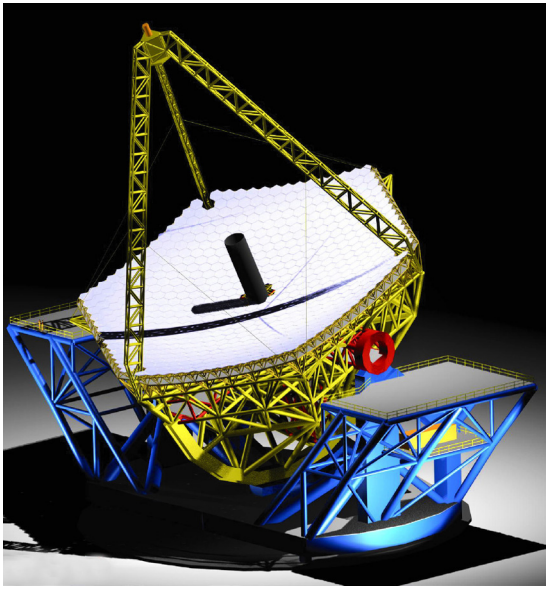
Modeling and Validation of Complex Systems

Researchers: Anders Rantzer, Kin Cheong Sou
and Aivar Sootla.

Funded by the Swedish Research Council and Toyota Motor Corporation.

Large complex mathematical models are regularly used for simulation and prediction. However, in control design it is a common practice to work with as simple process models as possible. This makes it easier to analyze and evaluate the model, or to use it as a component for efficient system-wise evaluation. On the other hand, models are typically dependent on some adjustable parameters, which allow system design. Therefore, the capability of simplifying parameter dependent models is important from an efficient design point of view. One objective of this project is to develop methods for parameterized model reduction, where a single parameter dependent reduced model is an accurate simplification of the original complex model for all the parameter values of interest. In this project, a semidefinite programming based parameterized model reduction method is being developed.

Another aspect of this project is to develop model reduction tools that take into account the properties and restrictions of large scale distributed networked systems. Model reduction schemes guaranteeing overall system stability is being developed. In addition, structure preserving model reduction and network topology simplification methods are also being investigated.



As an academic case study of the developed reduction tools a model of deformable telescope mirror is considered. The initial full order model is obtained using finite-element modeling approach, which yields a high order system. The telescope model was developed within the Euro50 modeling project (see, http://www.astro.lu.se/~torben/euro50/).

Language Support for Dynamic Optimization

Researchers: Johan Åkesson, Karl-Erik Årzén
and Görel Hedin (Comp. Sci.)

Overview
Efficient development and operation of control systems is essential in industry today. Optimization is increasingly used as a standard tool to improve operation, both in on-line and off-line applications. Examples are calculation of operating points, grade change trajectories and production schedules that maximize production while minimizing raw material, energy and other resources. Similar issues arise in the design of embedded control systems for e.g., the automotive, avionics, and mobile telecom areas, where efficient utilization of computing, communication, and/or battery resources is required in order to meet market demands. This can also often be formulated as optimization problems.

Due to the ever increasing complexity of plants, a model-driven approach is required. At the heart of this project is a language-based approach for developing a high-level description framework targeted at unified modeling of physical systems and associated optimization problems. This also includes development of prototype software, which transforms a high-level description into a canonical mathematical model representation. This canonical representation may then be used as a basis for code generation for the above mentioned applications. The main topic of the project is the formulation of large-scale optimization problems. Associated with this topic is also code generation for numerical solvers.

Optimica
A key issue is the definition of syntax and semantics of the Modelica extension, Optimica. Optimica provides the user with language constructs that enable formulation of a wide range of optimization problems, such as parameter estimation, optimal control and state estimation based on Modelica models.

At the core of Optimica are the basic optimization elements such as cost functions and constraints. It is also possible to specify bounds on variables in the Modelica model as well as to mark variables and parameters as optimization quantities, i.e., to express what to optimize over. While this type of information represents a canonical optimization formulation, the user is often required to supply additional information, related to the numerical method which is used to solve the problem. In this category we have e.g., specification of transcription method, discretization of

control variables and initial guesses. Optimica also enables convenient specification of these quantities.

The first version of Optimica was published in 2007. Current research focuses on extending Optimica to support specification of Model Predictive Controllers (MPC) and multistage problems.

Software Tools - the JModelica.org platform

One of the results of the research project is an open source project entitled JModelica.org. JModelica.org is an extensible Modelica-based open source platform for optimization, simulation and analysis of complex dynamic systems. The main objective of the project is to create an industrially viable open source platform for optimization of Modelica models, while offering a flexible platform serving as a virtual lab for algorithm development and research. As such, JModelica.org is intended to provide a platform for technology transfer where industrially relevant problems can inspire new research and where state of the art algorithms can be propagated form academia into industrial use. JModelica.org is currently managed by the Lund-based company Modelon AB and continues to evolve in close collaboration with several departments at Lund University, including Automatic Control, Mathematics and Computer Science.

JModelica.org features compilers supporting code generation of Modelica models to C, a C API for evaluating model equations and their derivatives and optimization algorithms. The compilers and the model C API has also been interfaced with Python in order to enable scripting and custom application development. In order to support formulation of dynamic optimization of Modelica models, JModelica.org supports the Optimica extension. Solution of dynamic optimization problems is supported by an implementation of a simultaneous collocation algorithm based on the NLP solver IPOPT.

Applications and related projects

JModelica.org, and prototypes thereof, have been used in a number of industrial size applications. These include start-up optimization of a plate reactor, lap time optimization for racing cars, CO_2 post combustion separation systems, polyethylene reactors and optimal robot control. In a recent project, JModelica.org is used to compute optimal grade change profiles in collaboration with plastics manufacturer Borealis. For details, see the corresponding research home page (www.control.lth.se/Research/ProcessControl/gradechanges.html). The project is also related research on parallel methods for dynamic optimization.

Parallel Methods for Dynamic Optimization

Researchers: Johan Åkesson, Carl Laird
(Texas A&M University, TX, USA)

Optimization is used extensively in many contexts in control engineering. Applications include design optimization to develop optimal processes, set-point optimization to minimize raw material and energy consumption, and on-line optimal control strategies such as Model Predictive Control (MPC). As systems are becoming increasingly complex, the need for efficient computational methods is put into focus. The proposed research project is motivated by Moore's law, which states that the maximum number of transistors that be fit into an Integrated Circuit to a reasonable cost is doubled every other year. For decades, Moore's law has been closely related to important performance measures, for example the computational power of processors found in desktop computers. During the last 3-4 years this situation has changed, however. While the number of transistors on an Integrated Circuit continues to increase rapidly, many software applications does not run at correspondingly higher execution speeds. The explanation is that modern processors are equipped with multiple cores. Also, the clock frequency, which directly affect execution speed, is increasing only moderately. Many applications are capable of utilizing only one core, and cannot benefit from the availability of multi-core architectures.

In order to utilize more than one core, new methods and/or application of known methods in new contexts are needed. Such methods are typically specific for different application areas. In the field of dynamic optimization, development of parallel and distributed methods is essential in order to efficiently meet the challenges outlined above. In principle, there are two different scenarios that require attention. In the first scenario, the main challenge is the complexity of the problem. In this case, decomposition and parallelization is important in order to obtain manageable subproblems to distribute amongst the available cores. In the second scenario, the complexity of the problem may be moderate, but the computation time is critical. For example, MPC falls into this category. In this case, parallel algorithms are needed in order to fully explore the computational power of multi-core architectures and thereby reduce computation times.

Active Control of Compressor Systems Based on New Methods of Nonlinear Dynamic Feedback Stabilization

Researchers: Rolf Johansson, Anders Robertsson, Alina Rubanova in cooperation with Prof. Anton Shiriaev, Umeå University & NTNU, Trondheim

Funding: Swedish Research Council 2007-2009, Ref. 2006-5243; VR 2007-2009, VR 2009-3178)

This project deals with a number of facts related to the output feedback stabilization of the Moore-Greitzer compressor model. We show that quadratic feedback stabilization of the surge subsystem of the three-state Moore-Greitzer compressor model, which ensures an absence of additional equilibria in the augmented with stall dynamics closed loop system, implies convergence of all solutions to the unique equilibrium at the origin. Then some steps in developing such output feedback controller for surge subsystem are discussed, and a family of controllers is presented. Based on our new theoretical results on integrability, stability, nonlinear dynamic output feedback control, we wish to pursue active control application to compressor systems and experimental verification.

Adaptive Control in Flying Vehicles

Researchers: Anders Pettersson, Rolf Johansson, Anders Robertsson,
Karl Johan Åström

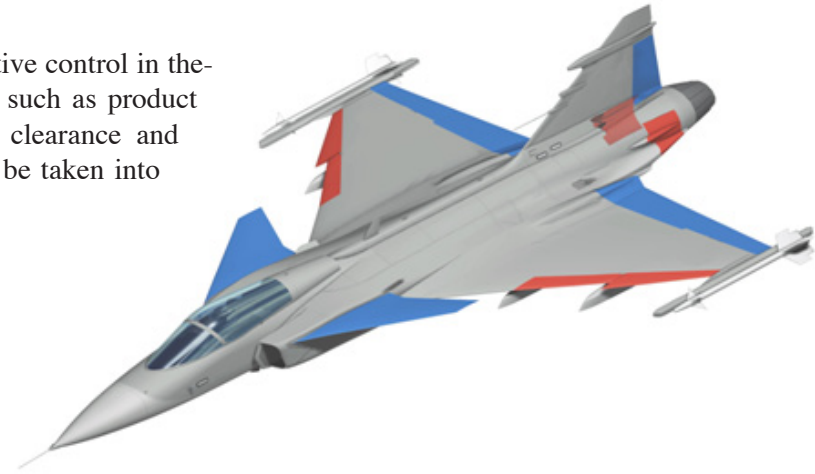
The goal of this project is to address the question whether adaptive control can be used in products that SAAB are developing today or in the future.

There are two fundamentally different ways of controlling systems with dynamics that change over time: adaptive or robust control. The industrial baseline for flying applications today is to use robust control, which caters for the effect of parametric uncertainties, but this baseline comes with an associated loss of performance. On the other hand, with an adaptive controller it is possible to boost the performance of the closed-loop system, but then the inherent robustness may be insufficient.

Questions to be addressed:
Can better performance be achieved for a fully/partly adaptive controller compared to a robust controller, especially with uncertain dynamics in the plant and its subsystems?

When in product development cycle, can adaptive steering be used? In what applications can adaptive techniques be used? Subsystems such as actuators perhaps, as well as at the top level?

For the use of adaptive control in these systems, aspects such as product safety, control law clearance and certification should be taken into account.



3.3 Control and Real-Time Computing

In the Control and Real-Time Computing area and work is performed in two main directions:

*** Implementation of control systems on resource-constrained implementation platforms, e.g., small embedded processors or networked controllers with limited communication bandwidth. This also includes event-based control.**
*** Applications of control to computing and communication systems. This includes control of server systems and adaptive resource management of embedded systems.**

Adaptivity and Control of Resources in Embedded Systems (ACTORS)

Researchers: Mikael Lindberg, Vanessa Romero Segovia, Anton Cervin, andaKarl-Erik Årzén in collaboration with the other 6 core partners.

Funding: EU/IST/FP6 STREP
Duration: February 2008 - January 2011

ACTORS is an EU/IST FP7 STREP on feedback-based resource manageACTORS is an EU/IST FP7 STREP on feedback-based resource management and data-flow modeling in embedded systems. The other partners in the project are

* Ericsson (Coordinator) – Johan Eker
* Scuola Superiore Sant'Anna di Pisa – Giorgio Buttazzo
* TU Kaiserslautern – Gerhard Fohler
* Ecole Polytechnique Fédérale de Lausanne – Marco Mattavelli
* Evidence Srl – Paolo Gai
* AKAtech SA – Vincent Noel
* Xilinx – Jörn W. Janneck

For more detailed information, see www.actors-project.eu.

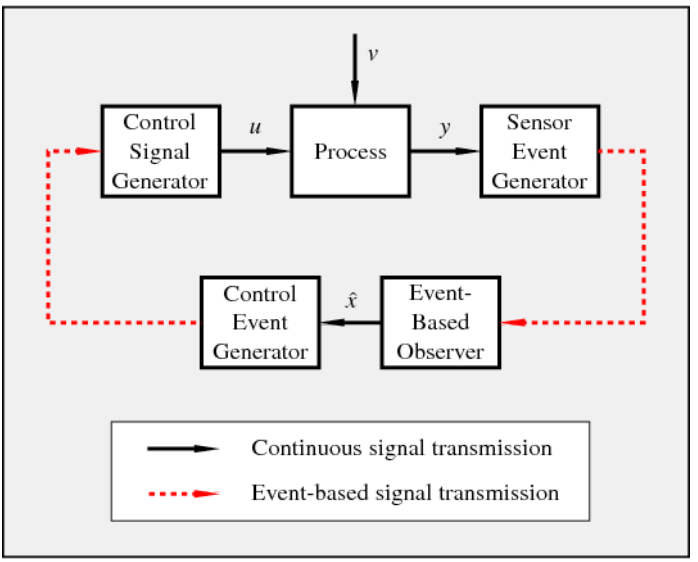
Event-Based Control

Researchers: Anton Cervin, Toivo Henningsson,
Erik Johannesson, Bo Bernhardsson and
Karl Johan Åström

Funding: Swedish Research Council, LCCC

The vast majority of all feedback controllers today are implemented using digital computers, relying on periodic sampling, computation, and actuation. For linear systems, sampled-data control theory provides powerful tools for direct digital design, while implementations of nonlinear control designs tend to rely on discretization combined with fast periodic sampling. In recent years, there has been a growing research interest in event-based control, in particular in connection to distributed and networked control systems. The basic idea is to communicate, compute, or control only when something significant has occurred in the system. The motivation for abandoning the time-triggered paradigm is to better cope with various constraints or bottlenecks in the system, such as sensors with limited resolution, limited communication or computation bandwidth, energy constraints, or constraints on the number of actuations.

In this project we are currently developing theory and design methodology for suboptimal event-based state feedback and comparing the achievable performance to the linear time-invariant case. We are also developing theory and design methodology for suboptimal event-based observers and comparing the achievable performance to the linear time-invariant case. Th project is investigating scheduling policies for multiple event-based controllers or observers on a shared local network.



Integrated Scheduling and Synthesis of Networked Embedded Event-Based Control Systems

Researchers: Anton Cervin, Karl-Erik Årzén, in collaboration with
the Embedded Systems Lab at Linköping University.

Funding: ELLIIT and LCCC

Modern embedded control systems comprise periodic and sporadic software tasks that control several physical processes and execute on platforms with multiple computation and communication components. The project will focus on the complex system timing induced by resource sharing among the tasks, which is one of the main characterizations of the control quality. This control quality, which is affected negatively by long and varying computation and communication delays in the control loop, will be considered during system-level scheduling and optimization, as well as during controller synthesis by delay-compensation techniques.

Many control systems have time-varying resource demands, implying that scheduling policies and control strategies must be adapted at runtime to provide high control quality and efficient resource usage. Such variations are inherent in event-based control, which is an emerging technology in resource-constrained systems, but also occur depending on the states of the controlled processes or as a result of process disturbances and mode changes. The project will therefore also consider runtime optimization techniques to address such variations.

The project aims to push the state of the art of integrated control and computer systems design in several directions. We shall develop design methods for control-quality optimization of embedded control applications running on distributed execution platforms, which, for example, are very common in the automotive systems domain. Our subsequent aim is to develop design-time and runtime optimization methods that trade off control quality with the varying resource requirements present in multi-mode and event-based control systems. The long-term objective of the project is to develop an optimization and resource-management framework to be used for the design and implementation of future resource- constrained and adaptive embedded control systems.

ArtistDesign - Design of Embedded Systems

Researchers: Toivo Henningsson, Mikael Lindberg, Vanessa Romero Segovia, Anton Cervin, Anders Robertsson, and Karl-Erik Årzén in collaboration with the other 31 core partners of the EU IST FP7 ArtistDesign Network of Excellence.

Funding: EU IST FP7 NoE. Duration 2008-2011.

ArtistDesign is an EU/IST FP7 network of excellence on design of embedded systems. It is a follow-up project to the FP6 NoE Artist2. The objective of ArtistDesign is to strengthen European research in Embedded Systems Design, and promote the emergence of this new multi-disciplinary area. ArtistDesign gathers together the best European teams from the composing disciplines, and will work to forge a scientific community.

Internally ARTIST2 is divided into four thematic clusters (Modeling and Validation; SW Synthesis, Code Generation and Timing Analysis; Operating Systems and Networks, and Hardware Platforms and MPSoC Design) and one tranversal integration cluster. Lund is a member of the Operating Systems and Networks cluster. Karl-Erik Årzén is also the leader of the Design for Adaptivity activity within the integration cluster.

ArtistDesign official homepage: http://www.artist-embedded.org/artist/

LUCAS - Lund Center for Applied Software Research

Researchers: Karl-Erik Årzén, Rolf Johansson, Anders Robertsson, Anton Cervin, and Anders Blomdell in collaboration with Dept. of Computer Science, Lund University

The Center for Applied Software Research (LUCAS) is a collaboration between the software-oriented parts of the Departments of Automatic Control and Computer Science at LTH. In total around 15 faculty members and 20 PhD students are involved in LUCAS. The focus of LUCAS is industrially-oriented and motivated software research. This includes research on software engineering, software technology, and software applications. Special focus is put on real-time systems, in particular embedded systems, networked systems, and control systems.

LUCAS started in 1999 and its status has changed over the years. Currently its main role is to act as an umbrella organization. The main activity is the annual LUCAS workshop.

LUCAS official homepage: http://www.lth.se/programvaruportalen/

Performance Modelling and Control of Server Systems

Researchers: Anders Robertsson, Karl-Erik Årzén, Karl Johan Åström and Björn Wittenmark in collaboration with Maria Kihl and Payam Amani at Dept. of Electrical and Information Technology, LTH, Lund University

Funding: LCCC and the Swedish Research Council.

In the last couple of years ”Communication and Control” has gained large attention and a lot of new research has focused on control of and over networks. However, the admission control problem, which is important for the utilization and the robustness of the network still remains as an rather unexplored area. Here, we believe the interaction of queuing theory and nonlinear control play a major role. The research is aimed at advancing the state of the art in control oriented modeling and control design of server systems by combining the scientific expertise from the telecommunication and the control communities. Important components in this research field are queuing theory, system identification, real-time systems and non-linear control theory. These fields have since long been well established research areas. However, the integration of this research with application to control of server systems gives raise to fundamental and challenging questions on how to e.g., combine and analyse discrete-event and continuous time flow models. The problems are of large theoretical as well as practical relevance in control of computing systems.

The main objectives of the research are:

* To use system identification and control theoretic methods to find good stochastic models and reliable state estimators for traffic and server systems
* Analyse the fundamental mechanisms in the combination of discrete-event based server systems and real-time control algorithms.
* To develop an experimental platform for experimental evaluation of control mechanisms

3.4 Process Control

The department has always had an active collaboration with the process industry as well as suppliers of process control instrumentation. Most of the research projects are formed together with the process industry, and several of them are performed with active participation by staff from industry. Many of the research results are also transfered to instrument and system suppliers, and implemented and used in process industry.

PID Control

Researchers: Karl Johan Åström, Tore Hägglund and Per-Ola Larsson

This project has been in progress since the beginning of the eighties, and resulted in industrial products as well as several PhD theses. Three monographs on PID control that are based on experiences obtained in the project have also been published. The last is ”Advanced PID Control”, published in 2005. It is also translated to Spanish 2009: ”Control PID avanzado”. The research is currently focused on the following topics:

A simple dead-time compensator
In this part of the project we are considering an ordinary PI(D) controller extended with a dead time compensator structure similar to a Smith predictor. The motivation for the project is that this new controller structure may be as easy to tune as a PI(D) controller, provided that model-based tuning rules are used. The performance of the new controller will be compared with the performance of the PID controller. The closed loops will be required to fulfill certain degrees of robust stability and performance and have a limit on control signal variance induced by measurement noise. The minimization criteria at the controller design is the integrated absolute error (IAE).

Filter order selection for PI and PID controllers
Measurements often have small amount of noise since sensors are not perfect. This will be reflected in the control signal behaviour in e.g. high variance or large inter-sample jumps if considering a discrete time setting. Previous work on PI and PID controllers often focus on proportional-, integral- and derivative gains at design but the filter action is added afterwords such that a resonable sensitivity to noise is given. However, the filter changes phase and gain of the controller and the initial tuning may not give satisfying results. In this project, we have developed a software optimization routine in Matlab that calculates controller settings (PI and PID) and filter settings simultaneously that minimizes the Integrated Absolute Error (IAE)

with robustness and meausrement noise sensitivity constraints. The filter may be chosen to have order 1-4. For filters of orders higher than 1, all time constants are equal and the damping must be lower than 0.7, i.e., no amplification of measurements.

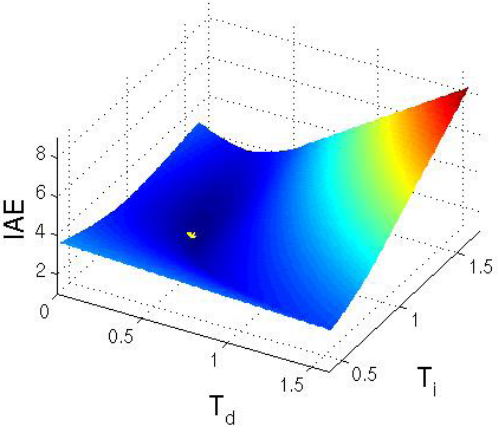
Relation between control signal properties and robustness measures

In a realistic setting, fast response to load upsets are restricted by e.g. limitations on actuator devices, noise characteristics of measured signals, and process variations. Thus, this should be incorporated in the design of a controller. An analysis concering the optimization constraint in the PID design in this project and in the project ”Decentralized Structures for Industrial Control” has been performed. It has shown that analytical expressions relating the M_S and M_T circles and the control signal magnitude and activity exist to a certain extent. Large robustness margins give small control signal activities and the opposite holds for small robustness margins. Thus, the proposed PID parameter optimization do take required control signal properties into consideration.

Software tools for design of PID controllers

A new, interactive and easily modifiable software tool for robust PID design has been developed at the department. The tool has been programmed in Matlab and the goal is to find the controller that minimizes the IAE value during a load disturbance, while applying robustness constraints in terms of M-circles. The figure on this page shows a plot from the program, depicting the IAE cost as a function of the integral time and the derivative time in a PID controller. The minimum is shown by the yellow mark in the figure.

The software is free to download. The Matlab files contained in the zip-file will make it possible to design a robust, optimal PID (or PI) controller. The software has been tested on Matlab 7 and may need some changes if it is not run under that version.



Surface plot from the PID design tool

Interacting learning modules for PID control

We are also developing interactive learning modules for PID control. The modules are designed to speed up learning and to enhance understanding of the behaviour of loops with PID controllers. The modules are implemented in SysQuake, and the work is done in collaboration with professor Sebastián Dormido at UNED, Madrid, and José Luis Guzmán at Universidad de Almería.

Automatic Tuning

Researchers: Kristian Soltesz, Tore Hägglund, Karl Johan Åström
The project is part of the Process Industrial Centre at Lund University, PIC-LU.

Within process industry, a large number of processes can be accurately modeled using simple models, i.e. SISO FOTD or SOTD. In order to control FOTD or SOTD processes, it is often sufficient to use the PID controller. It is desired to choose PID parameters yielding a closed loop system with robustness towards load and measurement disturbances. We aim at developing a methodology for automatic tuning of PID controllers, using nonlinear feedback for idenfication input generation and optimization based methods for both process parameter identification and controller synthesis.

The main components of the auto-tuning alogorithm are the following:

1. Generate identification input with little or none a priori system information
2. Transfer function parameter identification through optimization
3. Model verification
4. PID synthesis
5. Performance evaluation

As a case study, a modified version of the method has been applied in simulated anesthesia. Depth of hypnosis was successfully controlled in individuals of a test group with pharmacodynamics unknown a priori. This work was done in co-operation with the ECEM group at the University of British Columbia.

Upset Management

Researchers: Anna Lindholm, Charlotta Johnsson

Plant-wide disturbance management in the process industry

The fraction of time a plant produces, the availability, is an important measure of the efficiency of a plant. High availability implies a possibility for large production volume and thereby increased profit for the company.

One way of improving the availability of a plant is by minimizing the effects of disturbances. The focus in this research project is on plant-wide disturbances, disturbances that could affect several production areas at an industrial site. Currently, disturbances int hte supply of utilities, such as steam and cooling water, are investigated, since these disturbances are typically plant-wide disturbances that lead to large revenue losses at industrial sites.

A generic method for minimizing the effects of disturbances in utilities has been developed, which requires a model of the site. Different production modeling approaches have been suggested and the objective has been to start with simple and quickly obtained models, and step by step move towards more elaborate models.

The research is part of the Process Industrial Centre at Lund University, PIC-LU, and is performed in close collaboration with Perstorp AB. The generic method has during 2010 been applied to the company's site in Stenungsund using a simple model of the site. Currently, approaches for obtaining more advanced site models are investigated, where the goal is to capture the relationship between disturbances in utilities and production of different areas at the site more accurately.

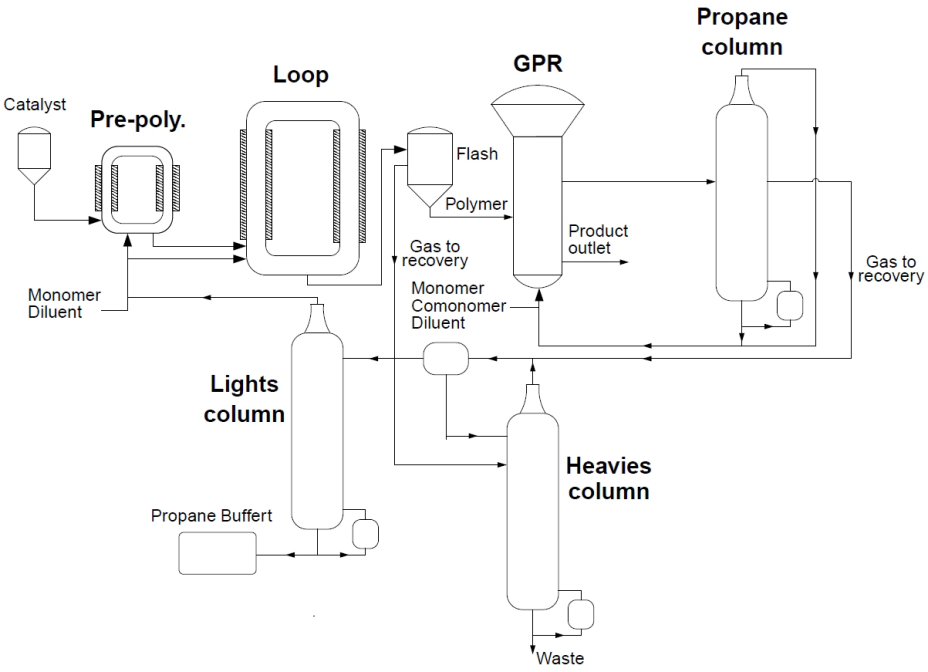
Modeling and Optimization of Grade Changes for Polyethylene Reactors

Researchers: Per-Ola Larsson, Niklas Andersson (Chem. Eng), Johan Åkesson, Tore Hägglund, Bernt Nilsson (Chem. Eng)

In collaboration with Borealis AB.

In this project, which is a collaboration with Borealis AB, we are considering grade changes for a chain of three polyethylene reactors and a gas recycle system consisting of three distillation columns. In chemical industry today, the market is changing rapidly both in raw material pricing but also in product demand. To have the ability to perform fast and safe grade changes and thus adapting to the market is highly advantageous.

One part of the project is to develop physical models of the three polyethylene reactors and recycle system at Borealis' Stenungsund site, see Figure 1. Using both well known physical laws and empirical relations, together with models derived for a non-linear MPC controller used at site today, a model library has been initiated. The library is developed in the Modelica language and includes both reactor and distillation column models and framework models for optimization and validation. The second part of this project is optimization of grade changes using the models



in the library. In the optimization, which is non-convex, both limitations of the reactors and columns, but also economics, safety, time, and parameters defining the desired grade needs to be considered. Using JModelica.org, which is a framework for dynamic optimization of Modelica models, grade change optimization problems can be solved. JModelica.org incorporates Optimica, which extends the Modelica language with constructs to encode optimization problems.

2009

During 2009, the core of the library has been built. A first optimization of a grade change for a single reactor has been performed successfully and submitted for publication. Model calibration using measurements has been initiated at the Chemical Engineering Department using a computer cluster.

2010

The work performed during 2010 mainly includes three parts. First, optimization of grade change with all three reactors has been performed with success and submitted for publications. Secondly, modeling of the recycle part, i.e., the distillation columns, has begun with support from measurement data from Borealis AB. Grade change optimization with both reactors and recycle system is under ongoing work. Thirdly, static model calibration using measurement data has been performed successfully at the Chemical Engineering Department.

2011

Plans for 2011 are to develop a cost function for the dynamic optimization of reactors and recycle system such that economical profit is maximized during grade changes and to perform model calibration using dynamical data recorded from previously completed grade changes.

Decentralized Control Structures

Researchers: Martin Hast and Tore Hägglund

There is an unfortunate gap between the centralized computational approaches of multi-variable control theory and the common practice to design local control loops disregarding couplings and interaction. Today it appears that both approaches has reached a point of refinement where the gap can be reduced from both sides. This project aims to revise and improve the basic modules for decentralized control, and to develop new. The ideas to be investigated in this project are relevant not only for process control but is also of interest for general classes of multi-variable systems.

TITO control
We will develop a new module building on experiences from PID control: a TITO controller, i.e. a controller with two inputs and two outputs. To be accepted in process control, the TITO controller must be fully automatic without any parameters to be set by the user. It means that an automatic tuning procedure has to be developed. Anti-windup can e.g. be handled conveniently.

In this project, we have established collaboration with University of Córdoba in Spain. An alternative decoupling structure, inverted decoupling, has been investigated. This structure has several important advantages compared with conventional decouplers, especially when it comes to implementation of the TITO controller. Using inverted decoupling, it is possible to implement the decoupling using standard blocks in most DCS systems just by adding feedforward signals to the two PID controllers. Industrial collaboration has also been initiated in the project.

Feedforward from load disturbances
Feedforward is a powerful method to improve the performance of feedback loops. Feedforward can be made both from setpoint and measurable load disturbances. In this project, the goal is to improve both structures and design methods for feeforward control from load disturbances.

The basic idea for design of feedforward compensators is simple. The ideal compensator is formed as the dynamics between the load disturbance and the process output, divided by the dynamics between the control signal and the process output, with reversed sign. However this ideal compensator is seldom realizable. Therefore, there is a need for design methods. There are surprisingly few such methods presented in the literature, and the methods do normally not take the feedback control into account in the design.

In a first phase, new simple tuning rules for feedforward compensators have been derived. The design objective is to minimize IAE without getting any overshoot in step load disturbance responses. This work has been done in collaboration with University of Almeria in Spain. In a second phase, the design project will continue, as well as investigations of improved feedforward structures.

Performance Monitoring and Diagnosis

Researcher: Tore Hägglund

Stiction and backlash in control valves are the major problem at the loop level in process control plants. There are two aspects of the problem. First of all, the nonlinearities deteriorate the control performance. Secondly, the loops facing these problems often remain undiscovered by the personnel in process control plants. These are the motives for research in the area of automatic performance monitoring and diagnosis.

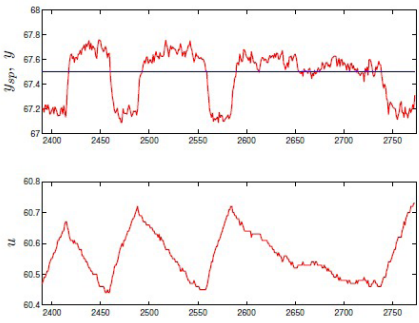
Backlash estimation

A new method for detection and estimation of backlash in control loops has been developed. The detection procedure is based on normal operating data. It is not assumed that the output from the backlash is measured. The procedure is automatic in the sense that no information has to be provided from the user to run the procedure. Since an estimate of the dead band caused by the backlash is provided by the procedure, the procedure gives all information needed to compensate for the backlash. The procedure has been tested in industry and a MS project has been performed in collaboration with ABB to prepare for implementation in an industrial DCS system. The method is patented.

Valve Stiction Diagnosis

Valves with a high level of static friction (stiction) generates stick-slip motion that causes the control loops to oscillate. There are several efficient methods for automatic oscillation detection available. There may, however, be several causes of oscillations in control loops. Besides sticky valves, bad controller tuning and external load disturbances may cause oscillations. Therefore, there is an interest in procedures for automatic diagnosis of oscillations.

In this project, a method for automatic diagnosis of stiction in control valves has been derived. The diagnosis is performed using a shape analysis of the wave form of the oscillations that appear in the process output. In case of stick-slip motion, a rectangular form is obtained, whereas external load disturbances and bad controller tuning gives a sinusoidal wave form. The procedure is automatic in the sense that no process information is assumed except the one that is already available in the controllers. The procedure can be used both on line and off line. It has been tested on industrial data with good results.



Stick-slip motion in a recirculation flow loop in a distillation column

Optimizing fermentation control for B. licheniformis

Researchers: Ola Johnsson, Charlotta Johnsson, and Tore Hägglund

This project is performed in collaboration with Novozymes AS and Department of Chemical Engineering within the PICLU centre.

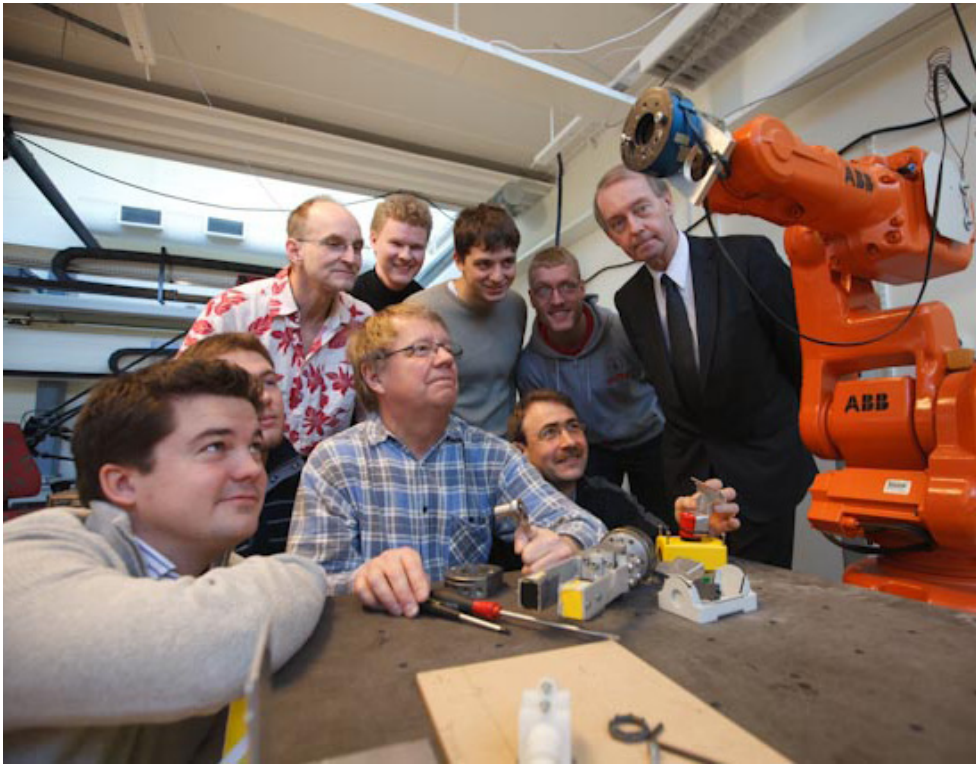
The project focuses on developing, improving and optimizing fermentation control strategies for the B. licheniformis fed batch processes. This process can produce vast amounts of protein but is sensitive to overdosing and process disturbances which lead to process variations and possibly crashed fermentations. There is thus a strong motivation for developing more robust control strategies for this process. The project aim is to develop a general method for finding optimal control strategies for various B. licheniformis production strains.

In addition to developing and evaluating bioprocess control strategies which can improve robustness and yield of specific B. licheniformis processes, it is also of interest that the developed methods are general enough to allow for implementation on various enzyme-producing processes utilising different B. licheniformis strains. This will require the identification of key physiological variables in the strains and an understanding of the interaction between these properties and the way the process is controlled.

More information is given on www.pic.lu.se

3.5 Robotics

Robotics offer both theoretical and practical challenges. Our main research are in motion and compliance control, force control, control system architectures and different sensor fusion problems.



The majority of the robotics group considering one of the robots.

In front, from the left: Karl Berntorp, Stefan Skoog, Rolf Braun and Anders Robertsson. In the back, from the left: Anders Blomdell, Björn Olofsson, Andreas Stolt, Magnus Linderoth and Rolf Johansson.

Productive Robotics @ LTH

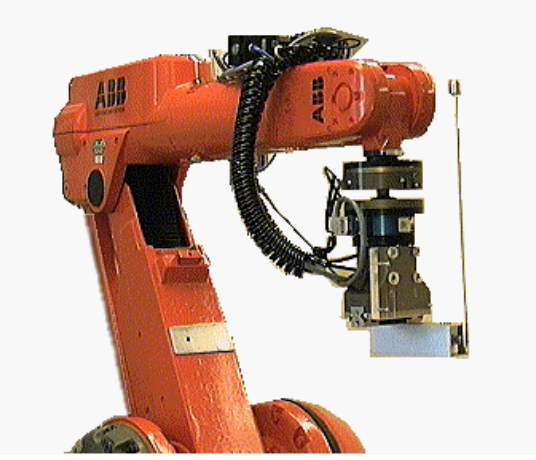
Research responsibles: Klas Nilsson (Dept. of Computer Science), Rolf Johansson (Dept. of Automatic Control), Anders Robertsson (Dept. of Automatic Control), Gunnar Bolmsjö (Dept. of Mechanical Engineering), Kalle Åström (Dept. of Mathematics) and Mats Alaküla (Dept. of Industrial Engineering and Automation)

Several research interests are represented in Robotics Lab:

* Open Control Software Architectures
* Exteroceptive Robots
* Force Control
* Robot Vision
* Sensor Fusion
* Adaptive and Iterative Learning Control
* Task-level Programming

Robot control systems and other manufacturing equipment are traditionally closed. This circumstance has hampered system integration of manipulators, sensors and other equipment. As a result, such system integration has often been made at an unsuitably high hierarchical level.

The purpose of past and present projects is to show how to organize open robot control systems and to verify these ideas by means of experimental verification.



As a part of this research, we have developed several experimental open robot control systems. The systems are built around industrially available robots that have been reconfigured for experimental purposes.

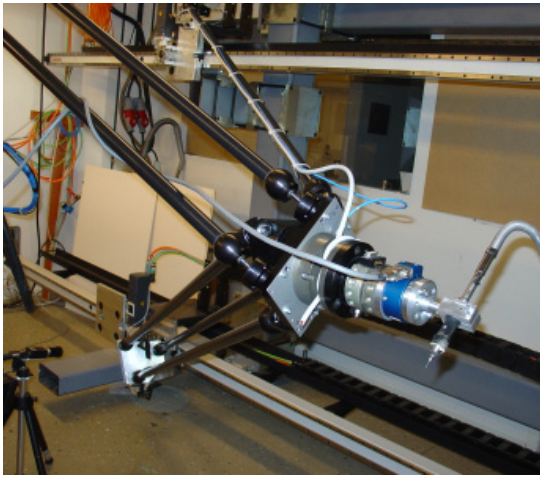
The developed specific robot interfaces and the integration of the robots into a complete system forms a unique environment for testing and development of algorithms for improvement of performance, sensor integration, programming automation and autonomous operation.

Robotics Research

Researchers: Rolf Johansson, Anders Robertsson, Isolde Dressler, Magnus Linderoth, Andreas Stolt, Olof Sörnmo, Björn Olofsson, Karl Berntorp, Karl-Erik Årzén and Anders Blomdell in close cooperation with colleagues from neighbor departments at the Robotics lab at LTH, Lund University, and ABB Robotics, Västerås, Sweden.

Robotics offers both theoretical and practical challenges with a multi-disciplinary topics. We collaborate with both national and international robotics colleagues regarding different aspects of robotics and we also have a close cooperation with industrial partners. Our main research are in motion and compliance control, control system architectures and different sensor fusion problems with application mainly to industrial manipulators. We use mainly modified and extended ABB robot control systems as experimental platforms.

The laboratory for robotics and real-time systems is centered around industrial manipulators with open control system architectures. In the lab we have several generations of robots from an elderly ABB IRB6 robot, an ABB IRB2000 robot, an ABB Irb2400 (S4C+) to the more modern ABB IRB140 (IRC5), Gantry-Tau robot (IRC5). Hardware interfaces have been developed to create an open system suitable for control experiments (Orca/Orcinus). The computer hardware is either PCI-based with both microprocessors and signal processors integrated into an embedded system for hard realtime control in one of the labs and integrated with an additional PCI-based G4 PowerPC for the new Open Control system based on S4CPlus and the newly developed networked architecture running on Linux/Xenomai-platforms.

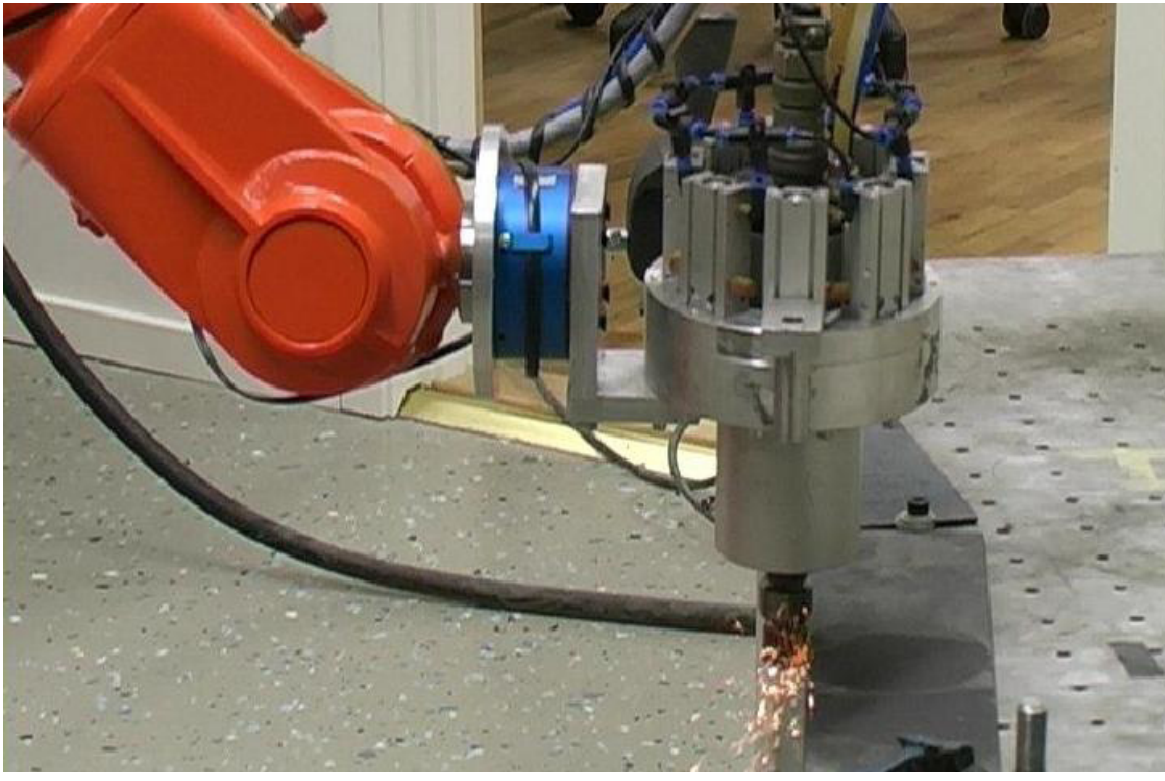


The systems are connected to a network with workstations, which are used for program development and control design. A purpose of the current project is to show how to organize open robot control systems and to verify these ideas by means of experiments.

One goal is to permit efficient specification and generation of fast robot motions along a geometric path which requires coordinated adjustment of the individual joint motions.

Another aspect of robot motion control is how to to integrate simultaneous control of force and position according to ideas of impedance control in which stability is an important theoretical issue. A major topic in this project is to integrate aspects of control, sensor fusion and application demands using robot vision and force sensing. Another project is on the structure and programming of control systems for industrial robots. The problem addressed is how the software architecture and the realtime structure of a robot control system should be designed to allow easy and flexible incorporation of additional sensors and new control algorithms.

A software layer between a supervisory sequence control layer and the basic control level has been proposed. Case studies and prototype experiments show promising results and further implementation is going on. The project Autofett aimed towards use of force control in manufacturing operations such as robotized fettling and is now continued in the SMErobot and FlexAA-projects. New sensor interfaces with modification of hardware and realtime software architectures have been developed to accommodate the use of force control algorithms based on workspace sensing. to accommodate the use of force control algorithms based on workspace sensing.



ProFlexA — Productive Flexible Automation

Researchers: Rolf Johansson, Anders Robertsson, Olof Sörnmo, Björn Olofsson and Anders Blomdell in cooperation with Dept. of Computer Science, Lund University and Div. of Assembly Technology, Linköping University, and several industrial partners.

This project is financially supported by the Swedish Foundation for Strategic Research (SSF) under the programme ProViking. Duration: 2009-2012

Description

The Swedish casting and foundry industry is under high pressure to reduce its production cost in order to maintain its competitiveness and avoid moving its activities to low cost countries. This means that there is a need to improve efficiency, product quality and consistency and to reduce costs and lead-time. The project focuses on achieving productive and profitable robotized automation of the fettling for small and medium sized volumes.

The project has the following work packages that also reflects the expected results and deliverables.

* WP1: Development of components and methods for handling of castings, inclu ding development of modular, configurable, simple and inexpensive grippers.
* WP2: Development of technology and configurators for flexibility and quick start-up of new products or product changes.
* WP3: Development of methods for measurement of excess material and compen sation of gripper errors.
* WP4: Build-up of database of process parameters for optimal material removal rate.
* WP5: Development of a Lead-through programming concept.
* WP6: Development of the Off-Line programming concept.
* WP7: Development of physical demonstrator.
* WP8: Exploration of the potential for the developed technology in other industry branches.

All of these benefits strengthen Swedish foundry industry and deliver important knowledge to other adjoining industry sectors.

Members
* Swerea SWECAST AB
* Artech Automation AB
* SVIA — Svensk Industriautomation AB
* Smålands Stålgjuteri AB
* Saab Aerosystems
* DELFOi
* Combi Wear Parts AB
* AB Bruzaholms Bruk AB
* Linköping University
* Lund University

ProFlexA official homepage: www.iei.liu.se/mt/research/proflexa?l=sv

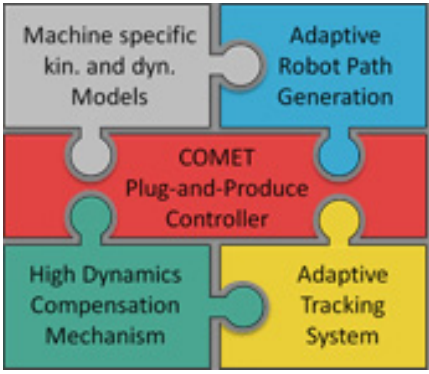
COMET — Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future

Researchers: Rolf Johansson, Anders Robertsson, Björn Olofsson and Olof Sörnmo in cooperation with Dept. of Computer Science, Lund University and several academic and industrial partners.

This project is financially supported by the European Union's Seventh Framework Programme FP7 under the programme "Factories of the Future", ref. #258769 COMET. Duration: 2010-2013

Description

The COMET project aims at creating solutions enabling the use of industrial robots for high-end machining tasks in industry. The goal of the project is to develop a Plug-and-Produce platform, which will fulfill the needs from the manufacturing industry for cost effective, flexible and reliable manufacturing solutions. The components of the project are described by the figure:



The four pieces of the puzzle in the figure above define the different parts of the project, which also constitute the technical work packages:

WP1: In this work package, a methodology for describing kinematic and dynamic models of an industrial robot will be developed. Those models will accurately define the static and dynamic behavior of any industrial robot, which then is represented by its unique signature.

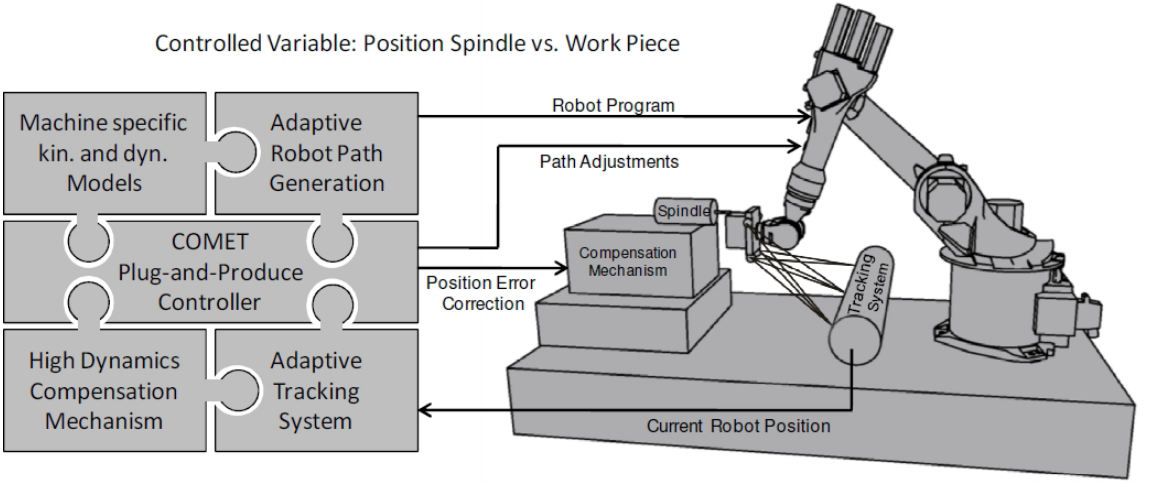
* WP2: An integrated programming and simulation environment for adaptive robot path generation will be developed in the second work package. The path generation system will utilize the models of the robot obtained in WP1 for accurate path generation.

* WP3: The third work package is to develop an adaptive tracking system for industrial robots to detect deviations from the programmed robot path and to adaptively initiate real-time corrections via the robot controller to ensure the necessary machining accuracy.

* WP4: For high-precision machining, a high-dynamic compensation mechanism

will be developed. By utilizing this mechanism, the aim is to accomplish an absolute accuracy better than 50 um in machining tasks. This is significantly below the structural capability of the robot system on its own, due to the limited stiffness and positioning accuracy of the robot.

* WP4: For high-precision machining, a high-dynamic compensation mechanism will be developed. By utilizing this mechanism, the aim is to accomplish an absolute accuracy better than 50 um in machining tasks. This is significantly below the structural capability of the robot system on its own, due to the limited stiffness and positioning accuracy of the robot.



Members

* AMRC Manufacturing Ltd, United Kingdom
* ARTIS, Germany
* BTU Cottbus, Germany
* Delcam, United Kingdom
* DemoCenter-Sipe, Italy
* Fraunhofer IPA, Germany
* Gizelis Robotics, Greece
* Lund University, Sweden
* N. Bazigos S.A., Greece
* Nikon Metrology, Belgium
* Nisaform s.r.o., Czech Republic
* SIR SpA, Italy
* TEKS, France
* University of Patras, Greece

COMET official webpage: www.cometproject.eu

ROSETTA—RObot control for Skilled ExecuTion of Tasks in natural interaction with humans; based on Autonomy, cumulative knowledge and learning

Researchers: Rolf Johansson, Anders Robertsson, Magnus Linderoth, Andreas Stolt

Integrated project funded under the European Union's Seventh Framework Programme (FP7), (Ref. FP7 ICT-230902 ROSETTA).

The ROSETTA research project develops technology for industrial robots that will not only appear more human-like, but also cooperate naturally with human workers. This project is funded by the European Union under the FP7 grant 230902.

The following 4 **objectives** are set forth:

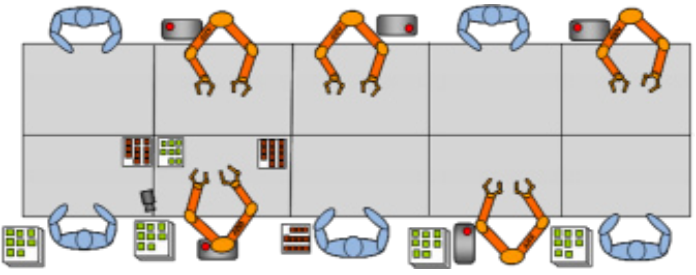
* to enable robots to be used in complex tasks with high flexibility and robustness
* to ease the deployment effort to allow fast production changeover from product A to product B
* to produce an easy-to-use programming system to access ROSETTA robot fun ctionality without the need for highly skilled robot programmers
* to provide new sensing, control and decision making methods for safe physical human-robot interaction.

Members (in alphabetical order):

* ABB AB (Sweden, Coordinator)
* ABB AG (Germany)
* Dynamore GmbH (Germany)
* Fraunhofer IPA (Germany)
* K.U. Leuven (Belgium)
* Ludwig-Maximilians-Universität Munich (Germany)
* Lunds Universitet (Sweden)
* Politecnico di Milano (Italy)

Project information

ROSETTA is the acronym for a new European Large-Scale Integrating Research Project "RObot control for Skilled ExecuTion of Tasks in natural interaction with humans; based on Autonomy, cumulative knowledge and learning". The 4-year project started March 1, 2009, and has a total budget of 10 MEUR.



Goals

ROSETTA develops "human-centric" technology for industrial robots that will not only appear more human-like, but also cooperate with workers in ways that are safe and perceived as natural. Such robots will be programmed in an intuitive and efficient manner, making it easier to adapt them to new tasks when a production line is changed to manufacture a new product.

Key Issues

The need for such robot systems stems from analyses showing that future factories will produce more and more goods with high volumes, but with many variants and limited product lifetime. This requires a flexible manufacturing system allowing for frequent production changes. Robot systems are the automation method of choice to meet these demands, but they need the ability to adapt even more quickly to new tasks, and to obtain full production output faster than today. Also, it is mandatory to easily integrate robots into manufacturing lines with human workers, as the combination of manufacturing by humans and robots promises highest flexibility. Tasks difficult to automate will in this scenario remain the domain of humans, whereas operations with low automation threshold or high quality requirements will be performed by these robots.

Scientific/Technical Approach

The project will address the challenges by developing methods to engineer and program robot systems in ways that are more intuitive, more related to the task, and less specific to the installation. This will require robots to be able to execute tasks more autonomously, without the need for detailed description of every step, and will lead to a significant reduction in programming effort. Once programmed, the robots will use sensor-based learning to autonomously improve their abilities ("skills") to perform the task quickly, quite like a human worker. When the operation is optimized in this way, the robot shares the knowledge of how to best perform the operation with other robots by sending the parameters over a network to a cen-

tral server. Other robots do the same, which results in a quick build-up of production knowledge ("cumulative learning").

Storing and sharing production-related data will make use of latest techniques developed for the Web 2.0, representing such data as form of "knowledge" that can be accumulated, enhanced and re-used by a population of robots.

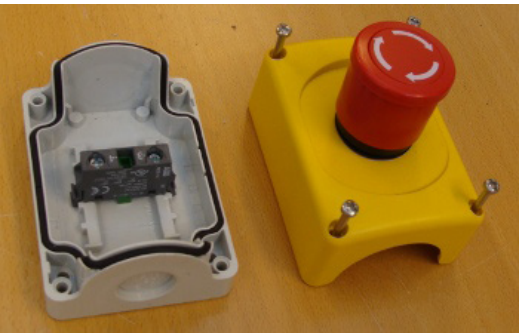
The production scenario that involves robots and humans working side-by-side and interacting safely requires that design, control and supervision devices and methods are found for robots to be harmless, and to act in a way that humans anticipate and feel comfortable with. This involves developing human-like motion patterns, speech interaction as well as avoidance of any situation that may pose a hazard or uncomfortable situation to human workers or operators. The human-machine cooperation will be supervised by a multi-level sensor system involving different sensor types and a reasoning unit that will analyse the robot environment and give the robot instructions in real-time how to adjust to changing environments and to human presence.

Expected Impact

The engineering and production methods will make robot automation accessible for a variety of new applications, in particular where production is frequently adapted to new product lines. This will enable the European industry to increase its competitiveness by reducing production cost and by increasing production quality. A thorough understanding and modelling of the human/robot contact and interaction in a production scenario are major efforts of ROSETTA. The theoretical and experimental investigations will lead to injury risk classifications with the goal of creating future safety standards for human-robot cooperation, helping the industry to better utilise the potential of robots working in human environments.

Work Packages

WP	*Title*	*WP Leader*
1	Knowledge and skill representation	Lund University
2	Knowledge transformation and learning	K.U. Leuven
3	Robust task execution	Lund University
4	Injury risk knowledge	Fraunhofer
5	Safe human-robot interaction control	Politecnico di Milano
6	Application and engineering principles	ABB
7	Demonstration platform for validation	ABB
8	Exploitation and dissemination	ABB
9	Management of consortium activities	ABB



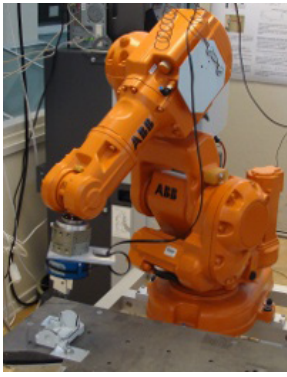
The emergency stop button used as the main scenario.

Research in Lund @Control

Research so far has been focused on force controlled assembly. The implementation has been based on iTaSC, instantaneous Task Specification using Constraints. The main scenario has been the assembly of an emergency stop button.

Snapfit assembly

A switch should be snapped into one of many available slots. It has been assumed that the location of the bottom box as well as the gripping of the switch has been uncertain to some extent. These uncertainties have been resolved using a 6 DOF force/torque sensor. A method for detecting the transient from the snap, when the switch is inserted into the slot, has been designed and a learning strategy has been used to increase the assembly speed.



Execution of the snapfit assembly.

Execution of the red button assembly.

Red button assembly

The red button should be inserted into the yellow case. This is a typical peg-in-hole assembly task. Location of the yellow case and the gripping of the button is uncertain, and the uncertainty is resolved using force sensing. The button has further on been assumed to be rotationally symmetric. This introduced a redundant degree of freedom, which has been used to optimize the task.

Dual robot leadthrough

A dual arm leadthrough demo has been developed. Each robot is equipped with a force/torque sensor and is given a virtual mass and damping through an impedance control scheme. The robots are further on connected to move simultaneously, as if being rigidly connected. This is a demonstration of sensor fusion and coordinated control of two robots.

Dual robot assembly

The snapfit assembly has been implemented in a dual robot setup. Previously the bottom box was placed in a fixture, but in this setup a second robot is used to hold it. Different kinds of motions have been superimposed onto the motions required for the assembly.

ENGROSS - Enabling Growing Software Systems

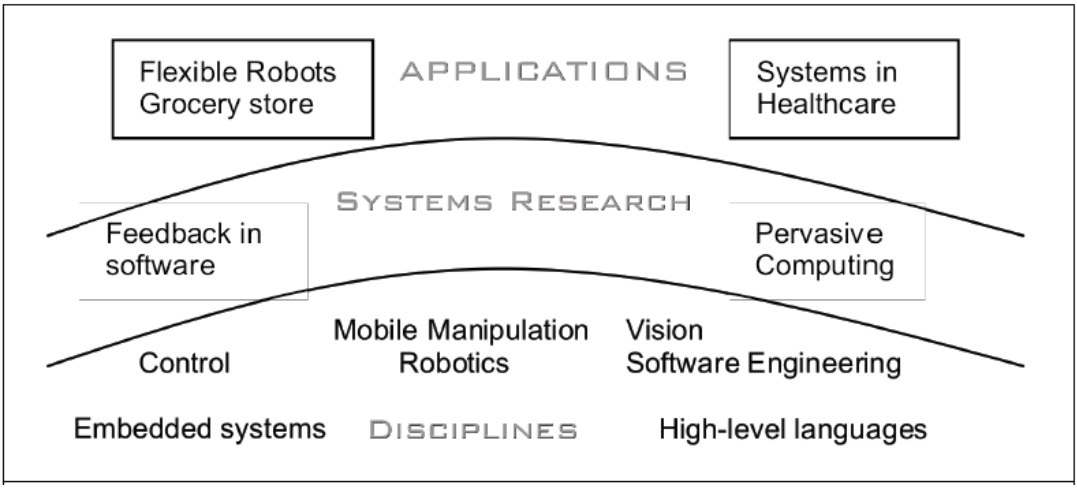
Researchers: Karl Berntorp, Anders Robertsson, and Karl-Erik Årzén, in collaboration with the Department of Computer Science, Lund University and the Department of Mathematics, Lund University.

The project is funded by SSF, the Swedish Foundation for Strategic Research.
Duration: 2009 - 2013

ENGROSS official homepage: www.engross.lth.se

The ENGROSS project is an SSF framework project on software-intensive systems. This project is focused on the central problems of complex software systems; how such systems can be built in order to be more flexible, robust and possible to compose at the same time. The project is structured in three layers:

* Systems Research
* Demonstrator
* Disciplinary Research



The systems research is based on previous work at Department of Computer Science in the form of the Palcom middleware for loosely interconnected systems. In ENGROSS Palcom is extended to support real-time applications and safety-critical applications.

The main demonstrator in ENGROSS is a grocery-store mobile service robot and surrounding IT systems, sensing, and communication. The primary task for a grocery robot is to put arriving items on shelves in the shop. The robot demonstrator gives rise to many situations where systems need to be integrated in new ways. The current version of the demonstrator is based on the Frida two-armed bobot from ABB (see the picture) and a mobile service robot platform from the Fraunhofer Institute for Manufacturing Engineering And Automation (IPA).

The robot demonstrator also serves as a platform for the disciplinary research in the project:

* Mobile manipulation
* Vision
* Localization and navigation
* Resource-constrained embedded systems
* Safety

INROSY—Intelligent Networked RObotics SYstems with reconfigurable exogenous system sensing

Researchers: Klas Nilsson, Dept. Computer Science, Rolf Johansson and Anders Robertsson in cooperation with Prof. Il Hong Suh, Hanyang University, Seoul, Korea.

Funding: STINT-KOSEF Institutional Grant for cooperation with Hanyang University (Prof. Il Hong Suh), Seoul, Korea.

Nowadays, we are living with automation systems that have intelligence such as cleaning robot, human care robot and guiding robot within everyday life. These robots will be key components of our daily life. It is true that quality of our life can be improved by these robots. Unlike the industrial robots that continuously repeat their given jobs in a fixed environment, service robots have to provide event-driven services, while keeping natural human-robot interaction in dynamic changing environment. Therefore, intelligence including sensory-motor coordination is thought as a core element of everyday life robot. The intelligence of a robot depends on the cognitive ability for environment, and how the robot acts properly with cognitive results.

In this project, we address research issues on software architectures for reactive, cognitive behavior in robotics work spaces.

Robots adapting to a messy world

When nothing ever changes and you are doing the same operation over and over again you might as well be a robot. And that's what industrial robots have been best at: working in a large scale industry, e.g., spot-welding the skeleton of car which is always there, exactly in the right position. But there is every reason to believe that industrial robots soon will be useful even in small- and medium-sized industries. Promising research is in progress.

Anders Robertsson

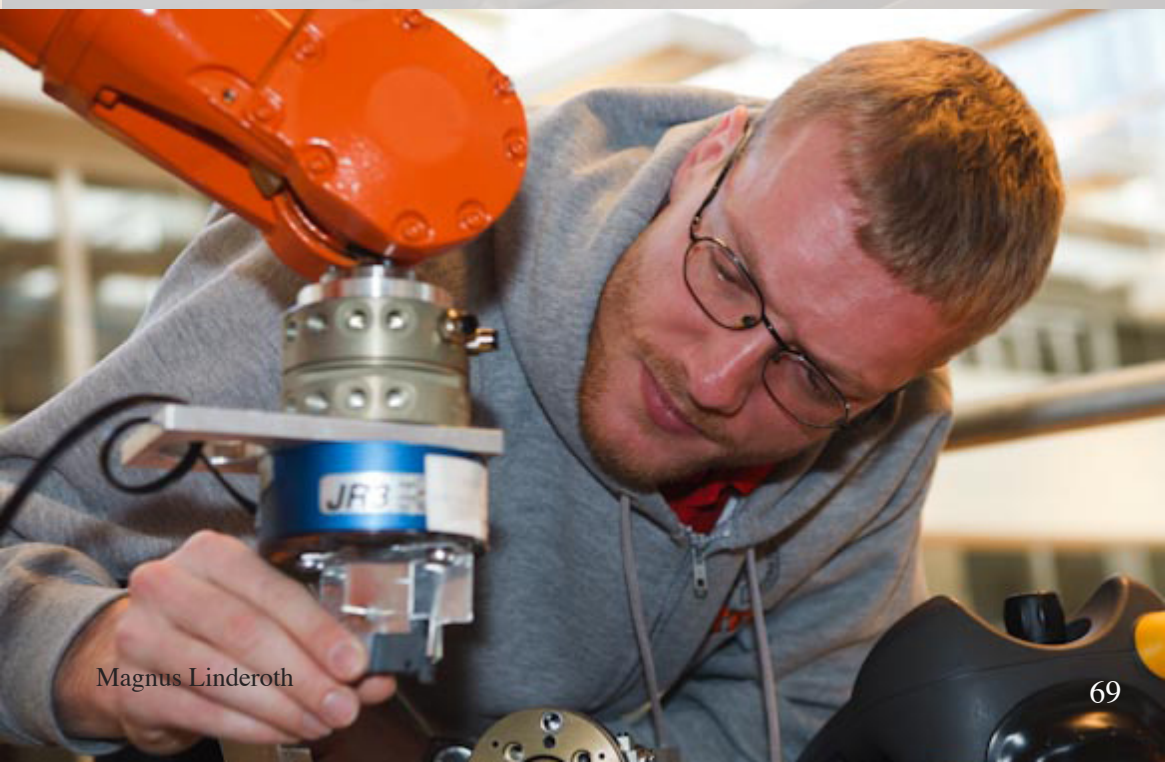
For an industrial robot to function in such an environment it needs to be even more flexible than today's models. It must be easier to handle for somebody who is not a robotics expert - you may, for instance, have to reprogram the robot because you work with different kinds of short production series. There could also be more uncertainties in how objects are placed on the production line. The new generation of industrial robots must be smarter and more adaptable. Anders Robertsson, associate professor at the Robotics lab, is full of confidence:

- Some of our research is focused on contact force control, he says. The robots are equipped with piezoelectric sensors and it is possible to teach them the position of an object by stroking the sensor or the tool to be applied along the object´s outlines. Even if such a movement is not a perfect fit the sensors will measure enough positions to make out the shape of the object. You can also calculate with a zone of uncertainty and within that zone the robot can slow down its movements to make soft contact.

The project is known as SMErobot and is funded by EU FP6. SME stands for Small and Medium Enterprises. The project is expected to make Europe more competitive.

Robotics represent multi-disciplinary fields. The laboratory is run in collaboration with the Department of Computer Science. Thus there are two directors, associate professor Klas Nilsson, Computer Science, and professor Rolf Johansson, Automatic Control. A team of mathematicians working with image processing is also contributing because robots do not only use sensors but also cameras to find their bearings. It is a tricky business to make a robot interpret what it "sees". A robot may for instance use two cameras to capture its target zone but will also need contact force data to know the distance.

Recent work in the robotics laboratory demonstrated playfully how to achieve a lot with a minimum of sensors. Magnus Linderoth constructed a dart- and ball-catching robot. If you threw a ball the robot would move a container to adjust to the trajectory and catch the ball trough a hole only slighter bigger than the ball – or there could be a target board so that you always scored tens when throwing darts. Two cameras were used to track the ball. The trajectory would be measured at a number of positions so the rest of trajectory could be calculated. Later on Linderoth showed that the tracking could be achieved with only one camera, but with much worse performance.



Magnus Linderoth

3.6 Automotive Systems

Projects devoted to vehicle dynamics and combustion control run in cooperation with major car manufacturers.

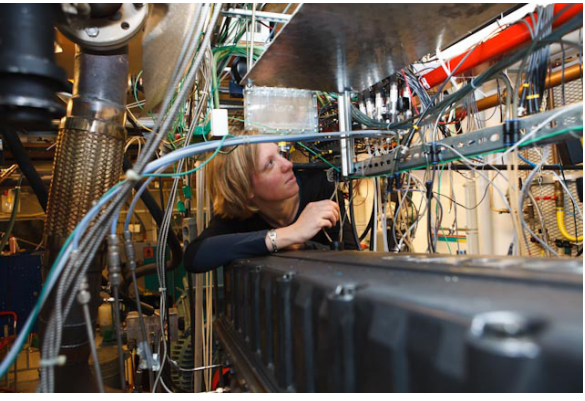
Diesel Combustion with Low Environmental Impact

Researchers: Maria Henningsson and Rolf Johansson in cooperation with Kent Ekholm, Prof. Bengt Johansson, Dr. Per Tunestål, Div. Combustion Engines, Lund University, Petter Strandh, Johan Dahl, Stefan Strömberg, Volvo Powertrain, Urban Carlson, Anders Höglund, Cargine.

This project is financially supported by Volvo Powertrain, Inc., Cargine, and the Swedish Energy Agency (program FFI P32067-1).

The heavy-duty engine market is dominated by compression-ignition diesel engines because of their high energy conversion efficiency. High efficiency is essential both in terms of fuel economy and the impact on global warming through CO2 emissions. Besides the goal of energy efficiency, diesel engines must fulfill numerous other requirements, such as legal constraints on emissions of NOx, soot particles, and hydrocarbons. There are also legal restrictions on the audible noise from the engine, and market demands for reliability, durability, and competitive pricing.

To steer the combustion process to the optimal trade-off between emissions, fuel economy, and audible noise, a number of sensors and actuators are available. We work on optimal control methods to manage the trade-off between emissions and fuel economy on-line. Among control methods successfully applied, linear quadratic Gaussian control and model-predictive control have been implemented and tested. Our current focus is to integrate the control of the gas flow and fuel injection processes in the engine. We also investigate dual-fuel operation, combining direct injection and port injection of different fuels to improve fuel economy.



During 2010, work focused on upgrading our laboratory facilities. As part of this, we are preparing to integrate the Cargine free valve system into our laboratory engine. We also started to develop a simulation model of the engine based on physical modelling in cooperation with Modelon.

DIAdvisor™-Personal mobile short-term blood glucose predictor and treatment advisor

Project leader: Rolf Johansson.
Researchers: Marzia Cescon, Fredrik Ståhl, Meike Stemmann and Dawn Tilbury.

This project is financially supported by the European Commision through the Information Society Technologies (IST) programme under the Seventh Framework Programme (FP7) n° 216592.

Partners

Novo Nordisk A/S, Bagsværd, Denmark, www.novonordisk.com, Coordinator
Johannes Kepler University, Linz, Austria, www.jku.at, Control & advisory algorithms
Lunds University, Lund, Sweden, www.lu.se, Data based models
University of Padova, Padova, Italy, www.unipd.it, Physiological models and clinical trials
Centre Hospitalier Universitaire de Montpellier, Montpellier, France, www.chu-montpellier.fr, Clinical trials
Toumaz Technology Ltd, Abingdon, UK, www.toumaz.com, Device integration
Sensor Technology and Devices Ltd, Belfast, UK, www.stnd.com, Vital sign sensors
Ondalys, Montpellier, France, www.ondalys.fr, Non invasive glucose measurement
RomSoft, Iasi, Romania, www.rms.ro, Software
Institute for Clinical and Experimental Medicine, Prague, Czech Republic, www.ikem.cz, Clinical trials
RICAM, Linz, Austria, www.ricam.oeaw.ac.at, Mathematics
Ramboll, Virum, Denmark, www.ramboll.com, Risk management
Federation Internationale du Diabete Region Europe, Brussels, Belgium, www.idf-europe.org, Validation and Dissemination

Background

Diabetes Mellitus is a chronic disease of disordered glucose metabolism due to defects in either insulin secretion from the pancreatic beta-cells or insulin action. Type-1 diabetes (T1DM), also called insulin-dependent diabetes mellitus (IDDM) is characterized by no production of insulin what so ever, whereas type-2 diabetes is caused by decreased sensitivity of the tissues to the metabolic effect of insulin. The basic effect of insulin lack or insulin resistance is to prevent the efficient uptake and

utilization of glucose by most cells of the body, resulting in abnormally high blood sugar levels (hyperglycemia). Sustained hyperglycemia is associated with acute ketoacidosis, nephropaty, rethinopaty,neuropathy and damages to the cardio-vascular system, therefore intensive insulin therapy aiming at near-normoglycemia(80-100 mg/dL) has been strongly promoted during the last decade, following the results of the major Diabetes Control and ComplicationsTrial (DCCT) and follow-up Epidemiology of Diabetes Interventions and Complications (EDIC) studies. Focusing on tight blood glucose targets, the strategy comprises test of blood glucose levels at least four times a day, taking insulin at least three times a day by injections or using a pump and patient assistance by healthcare team through visits and phone calls. Meanwhile, the lack of improved quality of life and above all, the occurence of induced hypoglycemic events which may result in seizure, coma and eventually death preclude the feasibilityof such a DCCT-like intensive therapy.

The problem of maintaining glucose levels within a predefined range by acting on insulin delivery is a control poblem, whose controlled variable is glucose utilization, measured output is either the subcutaneous glucose provided by the CGMS or the capillary glucose provided by the fingerprick, control input is the insulin intake, and the clinical criterion for success is plasma glucose. The system is subject to disturbances, the most important one being the meals. Control strategies involving the regulation of blood glucose levels in type 1 diabetes subjects range from classic PID feedback controller, run-to-run strategies to MPC algorithms.

The DIAdvisor™ project

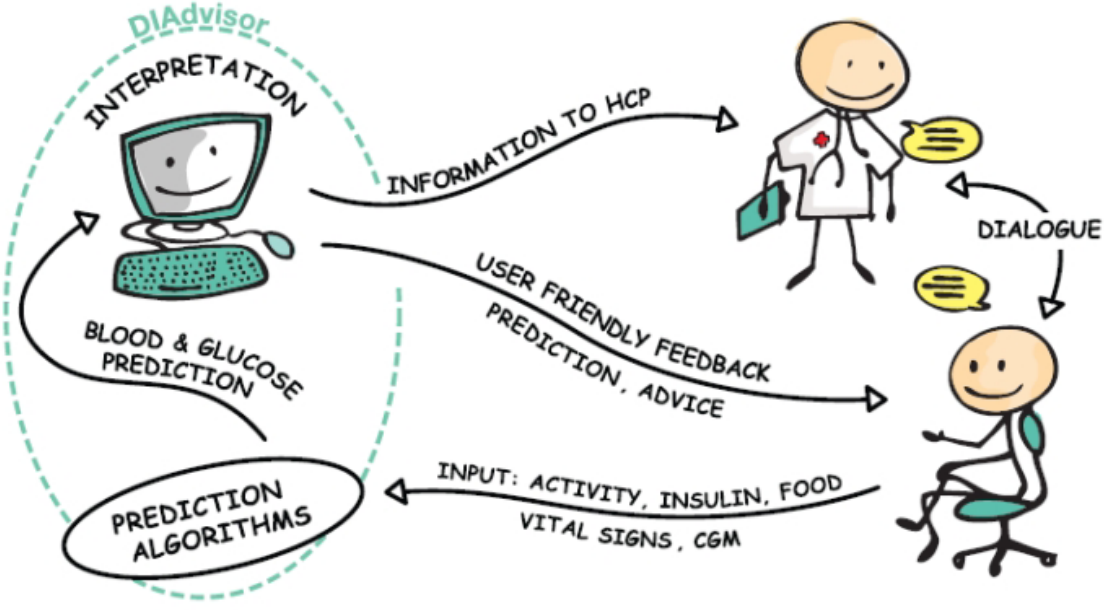
The DIAdvisor™ is a large-scale integrating project (IP) aiming at the development of a prediction based tool which uses past and easily available information to optimise the therapy of type 1 and developed type 2 diabetes. The DIAdvisor™ is not dependent on specific sensor technologies and can be adapted to technologies like standard strip sensing, minimally-invasive continuous glucose sensors and emerging non-invasive methods.

For safety reason, the DIAdvisor™ system will be able to self-assess the confidence of its proposed decisions. For safety reasons as well as for the sake of therapy improvements, the system connects and provides information and trends to the Health Care Provider.

Glucose prediction is difficult and requires advanced science within the fields of physiological modelling, identification theory, control theory, medical device technology, risk management theory, sensor science and user understanding. It can be achieved only by a well balanced group of eminent experts, including academics, clinicians, user representatives and leading companies.

The expected impact of DIAdvisor™ will be improved diabetes control and quality of life in large populations of insulin treated patients, leading to fewer diabetic complications and lower Health Care costs. Moreover, the project will constitute a valuable opportunity for European companies to build up a special know-how leading to products that profoundly and positively have an impact on the lives of millions of people with other indications than diabetes.

Official Website: www.diadvisor.eu



Cerebellar Control and Adaptation

Researchers: Jonas Dürango, Anders Rantzer and Rolf Johansson in collaboration with Dr. Henrik Jörntell (Div. Neurophysiology, Dept. Experimental Medical Science, Lund University).
Project Leader: Rolf Johansson

Funding: LCCC, Swedish Research Council; Ref. VR 2007-8646.

Cerebellar contribution to motor control and motor learning

The cerebellum is a structural unit of the central nervous system that plays a significant role in motor control and coordination, motor adaptation and the acquisition of new motor skills. It also provides large contributions to cognitive functions such as speech. Rather than initiating movement, the cerebellum influences movement control by integrating sensory signals and cerebral cortical signals related to the movement task at hand, and projecting it back to the motor areas of the cerebral cortex and brainstem. This is evident from studies where cerebellar lesions won't cause paralysis, but rather by leaving the patient with poorly controlled movements and unable to learn new motor skills or adapt existing movement patterns to new conditions.

The cerebellar cortex is built up from networks of different types of neurons. Purkinje cells act the main output of the cerebellar cortex, and each of these cells recombines information from a vast amount (~200 000) of other cerebellar cells. Each Purkinje cell is also contacted by a single climbing fiber, which is thought to encode information signalling to the cerebellum that an erroneous output is being made, and from this error the connection strengths between the Purkinje cell and the innervating cells are altered. This highly plastic and modular wiring of the cerebellar cortex allows for the cerebellum to adapt its output to better control and coordinate complex movement tasks.

From a control theory point of view the cerebellum can be viewed as an adaptive element contributing to motor control tasks in a larger decentralized control scheme. The aim of this project is to combine recent experimental findings with control theory to gain better insight of how the mechanisms of cerebellar contributions function.

3.8 Tools

A large number of software tools for analysis, design, and simulation of control systems have been developed at the department since the 1970's. Below we list tools that are being actively developed or maintained at the current time. The tools are free software and can be downloaded from the department web page.

TrueTime
TrueTime is a Matlab/Simulink-based simulator for networked and embedded control systems. It facilitates detailed co-simulation of plants, controllers, real-time scheduling algorithms and network transmissions. During 2010, the work on a new major release, TrueTime 2.0, has continued. Also, TrueTime Network for Modelica was released. Two versions have been developed - one based on an external C code implementation and one based on native Modelica. The development has been done within the ITEA 2 project EUROSYSLIB.

Jitterbug
Jitterbug is a Matlab toolbox that facilitates stochastic analysis of control loops with random delays. The toolbox can evaluate a quadratic cost function for a linear control system with Gaussian noise under various timing conditions. Using Jitterbug, it is easy to assert how sensitive a given control loop is to sampling jitter, input-output delay, output jitter, and lost samples, without resorting to simulation. During 2010, functions for jitter-robust LQG design and LQG control design with integral action has been added to the toolbox.

MPCtools
MPCtools is a freely available MATLAB/Simulink toolbox for simulation of MPC controllers. MPCtools provides functions to create and simulate basic MPC controllers based on linear state space models.
The toolbox provides support for quadratic cost functions, linear inequality constraints on states and controls, integral action by means of disturbance estimation and two different QP solvers for solving the optimization problem. MPCtools is primarily intended for research and teaching but is free to use for all purposes. During 2010, mainly maintenance and bug-fixing was done.

JModelica.org
JModelica.org is an open source software for optimization, simulation and analysis of complex dynamic systems. The software provides algorithms for solving optimal control and parameter estimation problems based on large-scale DAE systems expressed in the Modelica and Optimica modeling languages. The software also supports open standards specifying model exchange formats in C and XML, in order to

facilitate integration with other tools.The software is developed in a collaboration between the Lund-based company Modelon AB and the departments of Automatic control, Mathematics and Computer science at the faculty of Engineering, Lund university. During 2010, the department of Automatic control supported the development of the JModelica.org compiler. The software was also used in the research project PIC-LU and in a master's thesis on optimal robotic control.

Grafchart

The following people have contributed to JGrafchart:
Karl-Erik Årzén, Gert-Ola Carlsson,
Rasmus Olsson, Alfred Theorin.

Grafchart is a language for supervisory level sequence control and procedure handling that is based on ideas from Grafcet/Sequential Function Charts, Petri nets, Statecharts, and object-oriented programming.

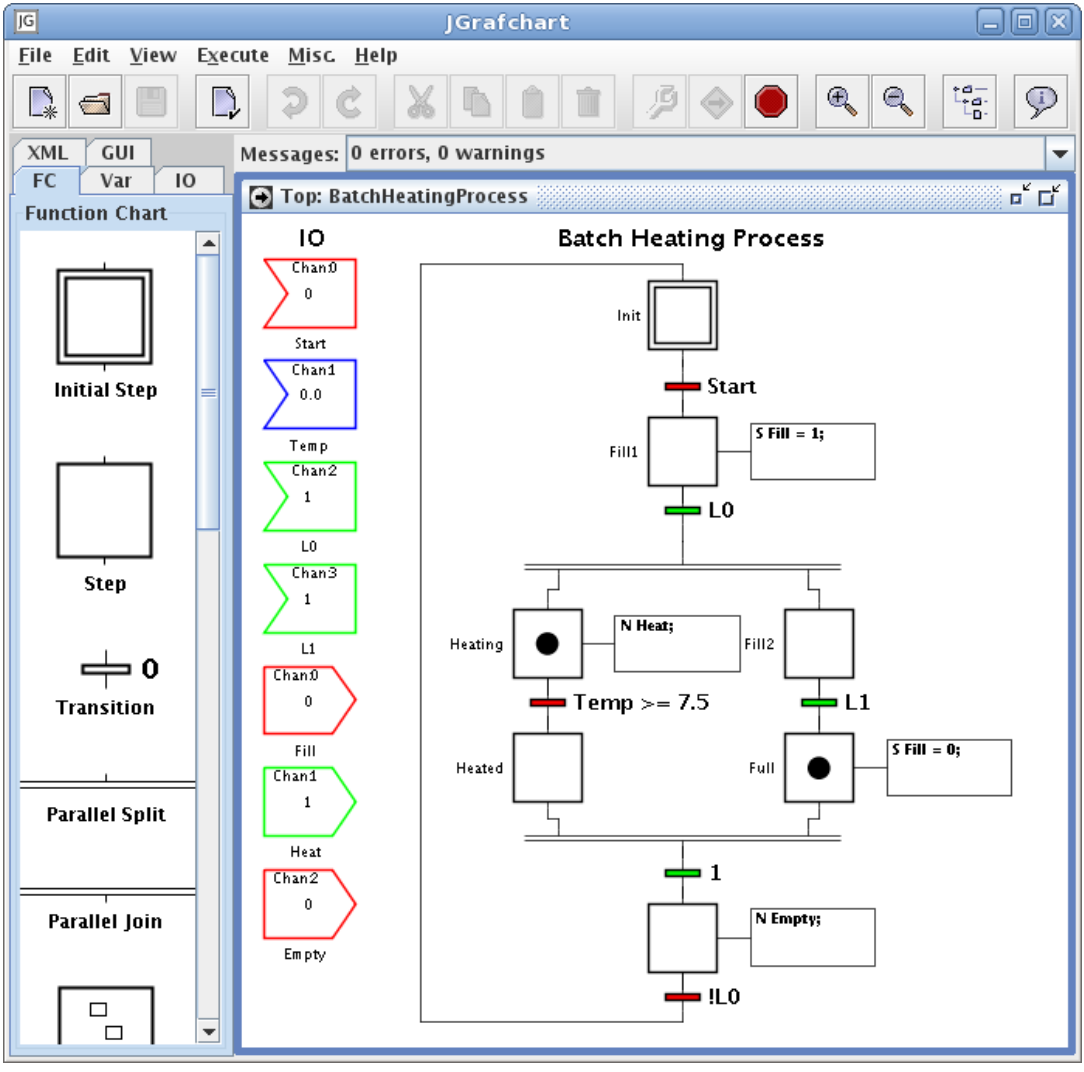
The original implementation of Grafchart had the same name and was developed in G2 from Gensym Corporation. Using this platform Grafchart was used for batch recipe control, diagnosis of mode-changning processes, alarm filtering, implementation of operator decision support systems, and implementation of robot cells.

JGrafchart
In the beginning of 2001 a decision was made to create a new implementation of Grafchart in Java. It is called JGrafchart and is used in our laboratory exercises on logical sequence control and batch control. It has also been used within the EU/GROWTH project CHEM. It currently supports the following features:

* Steps and transitions with parallel and alternative branches
* Hierarchically structured workspaces
* Procedures
* Macro steps and Procedure Steps with exception handling
* Process Steps
* Digital IO, analog IO, socket-based IO, and XML-based IO.
* Simple and complex variables
* Graphical objects
* XML-based storage on file
* Printing

During 2010, the compilers for the textual languages were rewritten using ReRAGs (Rewritable Reference Attribute Grammars). A new public release including these changes is planned for the next year.

JGrafchart is avaiable for download as freeware. The included documentation for the latest version is also available online.
http://www.control.lth.se/Research/tools/grafchart.html



Example

A usual example is the Batch Heating Process which is a process where a tank is to be filled up to a certain level and heated to a certain temperature. Heating is only allowed when the level is above a certain threshold. Once the correct level and temperature are reached, the tank shall be emptied. An implementation of this can be seen in the screenshot above.

4. External Contacts

A healthy mix of fundamental and applied work is a cornerstone of our activities. In the applications projects the goal is to solve real control problems together with external partners. In these projects the problems are approached with an open mind without glancing at particular methods. One purpose is to learn about real problems, another is to learn about new problems that are suitable for theoretical research. An important role for universities is to organize knowledge in such a way that the results can easily be digested by engineers in industry. There is naturally a strong symbiosis with teaching in this activity. A good mechanism is thus to introduce new research material into existing and new courses. A related form of technology transfer is to write books and monographs and to develop software. Exchange of personnel between industry and university is another very effective vehicle for technology transfer.

4.1 Academic Contacts

We have very good and fruitful relations and cooperations with a number of universities and academic institutions throughout the world. This year we have had important contacts with:

- Department of Computer Science, Lund University, Sweden
- Department of Electrical Engineering and Information Technology, Lund University, Sweden
- Department of Mathematics, Lund University, Sweden
- Department of Heat and Power Engineering, Lund University, Sweden
- Department of Mechanical Engineering, Lund University, Sweden
- Department of Cardiology, Lund University Hospital, Sweden
- Department of Clinical Sciences, Lund University Hospital, Sweden
- Department of Logistics, Lund University, Sweden
- Universidad Politecnica de Valencia, Spain
- Umeå University, Sweden
- Jaen University, Spain
- Norwegian University of Science and Technology, Norway
- Universidad de Valladolid, Spain
- Universidad de Almeria, Spain
- Universita di Roma, La Sapienza, Italy
- Universita di Siena, Italy
- Parades, Rome, Italy
- Herlev University Hospital, Copenhagen, Denmark

- Tsinghua University, Bejing, China
- Hanyang University, Korea
- Sung Kyun Kwan University, Korea
- Linköping University, Sweden
- EPFL, Switzerland
- Scuola Superiore St'Anna, Pisa, Italy
- KU Leuven, Belgium
- Texas A&M University, Texas, USA
- Politecnico di Milano, Italy
- TU Kaiserslautern, Germany
- Caltech, USA

4.2 Industrial Contacts

We have very good working relations with many companies and organizations The interactions are at different levels and of different intensities, from visits and discussions to joint projects. Master's theses and education are also important ingredients. During the year we have had major projects with:

- ABB Automation Technologies/Robotics
- ABB CRC Västerås
- ABB Corporate Research Sweden/Germany
- ABB Robotics Products, Västerås
- Boeing R&D
- Borealis AB
- Castings Technology International, England
- Ericsson
- Güdel AG, Switzerland
- KPS Rinas, Denmark
- Novo Nordisk AS
- Perstorp AB
- Pidab AB
- SKB Oskarshamn
- TetraPak
- Toumaz Technology Ltd, Abingdon, UK
- Volvo Powertrain, Inc
- Novozymes AS
- Evidence, Italy
- Akatech, Switzerland
- Modelon AB
- Rockwell Automation, Lund

4.3 European Collaboration

During 2010 the department was involved in the 6th and 7th Framework Program of the European Commission.

FP6 Projects:

- ARTIST2 – Embedded Systems Design
- HYCON – Hybrid Control: Taming heterogeneity and complexity of networked embedded systems
- EURON-II – European Robot Research Network
- SMErobot™

FP7 Projects:

- ACTORS
- AEOLUS
- ArtistDesign
- CHAT
- DIAdvisor™
- ROSETTA

5. Staff

During 2010 the staff at Automatic Control has grown appreciably. Several new PhD students have been employed, one new associate professor and two new post docs. We have also had the pleasure of hosting several international guests for shorter or longer periods.

In the coming parts the personnel and its activities will be described.

5.1 Personnel and Visitors

Professors

Karl-Erik Årzén
Bo Bernhardsson
Tore Hägglund
Rolf Johansson
Anders Rantzer, prefekt
Dawn Tilbury, visiting professor (from September)
Björn Wittenmark (until March)
Karl Johan Åström, senior professor
Per Hagander, senior professor

Associate Professors

Anton Cervin
Andrey Gulchak, 50%
Charlotta Johnsson
Anders Robertsson

Assistant Professor

Johan Åkesson (on leave 50%)

Research Engineers

Leif Andersson
Anders Blomdell
Rolf Braun
Anders Nilsson (from October)
Stefan Skoog (from September)

Secretaries

Britt-Marie Mårtensson
Ingrid Nilsson
Eva Schildt
Eva Westin

Postdoctors

Georgios Chasparis (from December)
Ahmed El-Shaer (until September)
Maxim Kristalny (from August)
Kin Cheong Sou (until August)
Vladimeros Vladimerou (until December)

PhD Students

Karl Berntorp
Marzia Cescon
Isolde Dressler
Jonas Dürango (from July)
Pontus Giselsson
Martin Hast (from February)
Maria Henningsson
Toivo Henningsson
Erik Johannesson
Ola Johnsson (from August)
Per-Ola Larsson
Mikael Lindberg
Magnus Linderoth
Anna Lindholm
Daria Madjidian
Anders Mannesson (from June)
Karl Mårtensson
Jerker Nordh (from August)
Björn Olofsson (from August)
Anders Pettersson (from March)
Philip Reuterswärd
Vanessa Romero Segovia
Alina Rubanova
Kristian Soltesz
Aivar Sootla
Olof Sörnmo (from May)
Meike Stemmann
Andreas Stolt (from January)
Fredrik Ståhl
Alfred Theorin (from January)
Anders Widd

Project Assistants

Mikael Kralmark (from September)
Jesper Mattsson (until April)

Guests and visitors

Jörn Janneck, University of California Berkeley, USA (until June)
Dragoljub Gajic, Univ. of Belgrade, Serbia (from August)
Joel Andersson, Univ. of Leuwen, Belgium (from October)

Yongxin Liu, Univ. of Inner Mongolia (from March)
Steven Low, Caltech USA (August)
Lennart Ljung, Linköping Univ. (from September)
Roberto Parrotto, Univ. of Pisa, Italy (until March)
Felix Farias, UNICAMP Brazil (until January)
Maasaki Hioki, Gifu Univ., Japan (from December)
Andrea Zanchettin, Politecnico di Milano, Italy (April - July)
José Pepe Maestre, Univ. of Seville, Spain (until January)
Ling Zhong, Shanghai Jia Tong Univ., China (until January)

Visiting Scholars within the LCCC Theme Semester

Patrick Kreidl, Massachusetts Institute of Technology
Ather Gattami, KTH, Stockholm
Henrik Sandberg, KTH, Stockholm
Maben Rabi, University of Cambridge
Mihailo Jovanovic, University of Minnesota
Luca Scardovi, Technische Universität München
Alain Sarlette, University of Liège, Belgium
Stacy Patterson, University of California at Santa Barbara
Puduru Viswanadha Reddy, Tilburg University
Gunn K. H. Larsen, University of Groningen
Natalia Akchurina, University of Paderborn
Paulo Frasca, Politecnico di Torino
Dario Bauso, University of Palermo
Alexander Skopalik, Aachen University
Toru Namerikawa, Keio University
Georgios C. Chasparis, Georgia Inst. of Technology
Yakov Babichenko, Hebrew University of Jerusalem
Johan Ugander, Cornell University
Archie Chapman, University of Southamton
Wei Ren, Utah State University, Logan, UT
Ulf von Lilienfeld-Toal, Stockholm School of Economics
Paolo Frasca, Politecnico di Torino
Angela Schoellig, Institute of Dynamic Systems and Control, ETH Zurich
S V N Vishwanathan, Purdue University
Colin Jones, ETH Zurich
João Tasso de Figueiredo Borges de Sousa, Porto University
Karl Worthmann, University of Bayreuth
Ion Necoara, University Politehnica Bucharest
Sorin Olaru, Supelec
Erjen Lefeber, Eindhoven University of Technology
Marcello Farina, Politecnico di Milano
Carlo Savorgnan, Katholieke Universiteit Leuven
Mikael Schönlein, University of Würzburg
Noortje Groot, Delft University of Technology

5.2 Staff Activities

Åkesson, Johan
Assistant Professor, PhD (2007); joined the department in 2001. Johan's main research interest is in the field of languages and tools for dynamic optimization of large scale systems, including language design, compiler design and implementation, numerical algorithms, and industrial applications. He is currently leading the JModelica.org project aimed at developing a Modelica-based open source platform for optimization of dynamic systems. Within the PIC-LU project, he is part of the management team and he is leading an associated project dealing with grade change optimization in cooperation with the plastics manufacturer Borealis. During the year, Johan took part in the supervision of four master's thesis projects and two PhD students. He served as the course responsible for the course Project in Automatic Control (FRT090). Johan is also associated with Modelon AB, where he works part time.

Andersson, Leif
MSc, Research Engineer since 1970. Leif started at the department with a responsibility for the teaching laboratory. He designed some lab equipment, notably an analog computer. In 1976 he started in ernest with digital computers, and has been responsible for the department computing facilities since then. The main computer systems have been RT11, VAX/VMS, Sun Solaris, Linux and lately MacOSX. He has also been forced to handle Microsoft Windows. His professional activities, apart from computer system maintenance, have ranged from computer typesetting (TeX and LaTeX) via Real Time Programming to using Java as a tool for writing educational software.

During the last few years he has been involved in converting the department web server from the 'Roxen Webserver', used for about ten years, to the more common 'Apache Webserver'. In that connection the creation of web pages has been moved from direct editing of HTML code to the use of a Content Management System. The particular system chosen has been 'CMS Made Simple', an open source package. This has given the department web pages a much more unified style than before, but has also meant quite a lot of conversion work.

Årzén, Karl-Erik
Professor (2000), PhD (1987): Joined the department in 1981. His research interests are real-time and embedded control, real-time systems, programming languages for control, Petri nets and Grafcet, and monitoring and diagnosis.
Leader of the Design for Adaptivity activity in the EU/IST FP7 network of excellence ArtistDesign. During the year he has primarily been involved in the EU/IST

FP7 STREP project ACTORS (Adaptivity and Control of Resources in Embedded Systems), in the EU/IST FP7 STREP project CHAT, and in the SSF project ENGROSS. He has been responsible for and taught the undergraduate course Real-Time Systems. He is partly or fully involved in the supervision of four PhD students.

Åström, Karl Johan
Professor in Automaic Control since 1965, founder of the department, emeritus form 2000, senior professor. This year he has been Member of Examination Committee of the thesis on Low-Cost Navigation Systems A Study of Four Problems by Isaac Skog from KTH. He has participated in LCCC workshops. Participated in KHWeek Stockholm where he presented the dinner speech jointly with Shankar Saastry: Intelligent Women and Renaissance Men. Member of Advisory Board for EU-project FeedNetBack: Feedback design for wireless networked controlled systems. Participated in NeCSYS'10 2nd IFAC Workshop on Distributed Estimation and Control in Networked Systems, Annecy France Sept 13-14. FeedNetBack Advisory Board, Sept 15 Annecy France.

Bernhardsson, Bo
PhD 1992, Professor 1999. Bo is working full-time from May 2010 again and is now "Studierektor för forskarutbildningen" at the department of Automatic Control. Bo's research interests are in linear systems, practical applications of control theory, and the connection between communication and control theory. He has been co-directing the thesis of Erik Johannesson. He has been responsible for and taught the PhD courses Linear Systems and Linear Systems II.

Berntorp, Karl
MSc in Engineering Physics, graduate student since February 2009. Karl is part of the ENabling GROwing Software Systems (ENGROSS) project, currently focusing on control and navigation of mobile manipulators. During the year he has been involved in teaching the courses Nonlinear Control and Real-Time Systems. He has also been attending PhD courses.

Blomdell, Anders
Research Engineer at the department since 1988. Heavily involved in almost all aspects of Robotics Research at the department, also responsible for the department network and lab computers for teaching and research. The frst half of 2009 was in a large part dedicated to finishing touches of the SMErobot project. The second half focus was shifted to the run-time architecture in the Actors project, but also managed to get a preliminary version of open Powerlink and B&R feld-bus modules interfaced to the software used for our teaching activities in China.

Braun, Rolf
Research Engineer at the department since 1969. Designs and builds equipment for education and research, and handles hardware maintenance of computers and equipment. He also plans and supervises maintenance and rebuilding of offices and labs.

Chasparis, Georgios
PhD 2008. Georgios has been a post-doctoral scholar in LCCC since December 2010. His research interests lie in the general area of distributed control and optimization. He is currently working on the distributed optimization of power flow in electricity markets.

Cervin, Anton
Associate professor, PhD (2003); joined the department in 1998. Anton's research interests include real-time systems, event-based and networked control, and computer tools for analysis and simulation of controller timing. During 2010, he has been leader of the research projects "Suboptimal methods for event-based control and estimation" and "Integrated scheduling and synthesis of networked embedded event-based control systems", funded by the Swedish Research Council and ELLIIT. He was also involved in the EU/FP7 projects ArtistDesign and ACTORS. He has been coordinator and lecturer in the basic-level course FRT110 Systems Engineering. He also gave some lectures on Simulation of Networked Embedded Systems at the Technical University of Denmark. He is program director for the China Profile and deputy member of the Academic Appointments Board 2 at LTH. During 2010, he was on parental leave in February and September-December.

Cescon, Marzia
BSc, MSc, graduate student since July 2008. Main research interests involve subspace-based identifcation techniques with application to biomedical systems. Currently working on the DIAdvisor project within the European FP7-ICT program, pursuing research on prediction and predictive control of blood glucose concentration in diabetic subjects. Her teaching activities during the spring were related to the System Identifcation Course, and during the fall to the Basic Course in Automatic Control and the Predictive Control Course.

Dressler, Isolde
Msc, graduate student since September 2004. Isolde is interested in modeling, calibration and control of parallel kinematic robots. She was working on dynamic identification and observer-based iterative learning control applied to the parallel kinematic Gantry-Tau robot. The work was done within the ELLIIT project together with Johanna Wallén from Linköping University. During November and December she was on maternity leave.

Dürango, Jonas
MSc, graduate student since July 2010. So far, most of his time has been spent on courses. He has also been involved in the basic course in automatic control as teaching assistant.

Giselsson, Pontus
MSc, graduate student since November 2006. Pontus' research interests include optimal control and Model Predictive Control (MPC). His work covers both practical and theoretical aspects of MPC. The practical work, in which MPC is applied to a pendulum system, became a laboratory exercise in the under-graduate course, Nonlinear Control and Servo Systems. His current research focus is on theory for distributed MPC. The objective is to find a stopping condition for the optimization problem that guarantees certain closed-loop properties.

Hagander, Per
Senior Professor, PhD (1973). Per has been with the department since 1968 and works with linear system theory and with applications in biotechnology and medicine. During 2010 he taught the course Control Theory.

Hägglund, Tore
Professor, PhD (1984). Has been at the department since 1978 except for four years when he worked for ABB. He is responsible for two of the basic courses in Automatic Control in the engineering program. His main research interests include process control, PID control, adaptive control, control loop monitoring and diagnosis. Main research activities during the year have been design of PID controllers, decentralized control structures, and valve stiction diagnosis. Tore Hägglund is also deputy centre director of Centre for Research and Competence Development for the Process Industry, PIC-LU.

Hast, Martin
M. Sc in Engineering Physics, PhD student since February 2010. His research interests are in feedforward structures and the design of feedforward controllers for disturbance attenuation, supervised by Prof. Tore Hägglund. During the spring, Martin has been involved in the development of a Modelica verison of TrueTime. He has also been a teaching assistant in the basic course and the project course.

Henningsson, Maria
LicSc, graduate student since August 2005. She is working with Professor Rolf Johansson in the project Diesel combustion with low environmental impact, in cooperation with Volvo Powertrain and the division of combustion engines at Lund University. During 2010 she was mainly working on upgrades of the experimental setup and computer software for engine management. Part of the year she was on maternity leave with her daughter Alice.

Henningsson Perby, Toivo
Lic. Tech., graduate student since August 2005. His research interests are in event based, distributed and embedded control and estimation. Toivo was on paternal leave during June through October 2010. During the rest of the year, he has been working on event based control using approximate value functions.

Johannesson, Erik
M.Sc. in Engineering Mathematics. Ph.D. student since May 2006. He is currently working in the research project ”Control with Communication Constraints”. Previously, he has done some work in event-based control. During the spring, Erik supervised one M.Sc. thesis: ”Optimal Pairs Trading using Stochastic Control Techniques”. He was also a teaching assistant in the Project course. During the early fall semester, Erik was a teaching assistant in the basic control course. In November and December, he was on leave from his PhD studies to instead work as University Lecturer. During that time he was responsible for the basic course held at Zhejiang University, Hangzhou, China.

Johansson, Rolf
Professor, MD, PhD. Active at the department since 1979. Rolf Johansson’s research interests are in system identification, robotics and nonlinear systems and automotive control. He is node leader for the research projects DIAdvisor, SMErobot, HYCON, SSF ProViking ProFlexa, Vinnova PFF Diesel HCCI, ROSETTA. He is coordinating director for Robotics Laboratory with cooperation partners from Dept Computer Science, Dept Mechanical Engineering, Dept. Mathematics and industrial partners. He has industrial cooperation with ABB Robotics, ABB Corporate Research, Novo Nordisk AS, Volvo Powertrain and SAAB. He is responsible for the two courses FRT041 System Identification and FRT050 Adaptive Control. Together with Dr. Måns Magnusson he leads research at the Vestibular Laboratory, Dept. Otorhinolaryngology, Lund University Hospital.

Johnsson, Charlotta
Research Associate, PhD (1999). Charlotta has been at the department since 1993 except for 4 years (2000-2004) when she worked for Siemens. Charlotta’s main research interest is in Production Control, Batch Control Systems, Manufacturing Operations System. Charlotta is one of the principal investigators of the LCCC research program. She is also part of the management team for the research center PIC-LU in which she is leading one of the sub-projects.

Charlotta is serving as the Program Leader for Technology Management, a joint programme run by Lund Institute of Technology and the School of Economics and Management at Lund University. Charlotta is also working 10% for Genombrottet, LTH’s center for Pedagogical Development. Charlotta is co-responsible for the Pedagogical magazine Lärande i LTH.

During the year, Charlotta has been involved in a variety of courses stretching from technical courses for master students to pedagogical courses for teachers in higher education. Charlotta acted as supervisor and/or examiner for six (6) master theses. Most projects were done in cooperation with industry.

Johnsson, Ola
MSc in Biotechnology, graduate student since August 2010. Works within the field of fermentation control, as a project within Process Industrial Centre Lund (PIC-LU). Spent most of 2010 taking courses in maths and automatic control as well as planning fermentation experiments to be performed in 2011.

Kristalny, Maxim
PhD 2010. He has been a post-doctoral researcher at the LCCC since August 2010. His research interests include analytical methods in distributed control and the use of preview in control and estimation. Maxim has been involved in the Aeolus project focusing on the distributed control of wind farms. His current work within this project is on developing methods for distributed feedforward control of the farm and for the use of previewed measurements of the wind speed for load reduction.

Larsson, Per-Ola
MScEE (2005), graduate student since January 2006. His research interests are within process control and he is involved in two separate projects. The first project concerns tuning methods for a dead-time compensating PID controller. Additionally, automatic tuning of measurement filter for this controller and ordinary PID controllers are developed such that control signal variations due to measurement noise may be set. The second project, which is together with Borealis AB and the Department of Chemical Engineering, concerns modeling and optimization of grade changes for a chain of polyethylene reactors using the Modelica language and the JModelica.org framework.

Lindberg, Mikael
MSc, graduate student since July 2007. Main research interests lie in resource management and control for embedded systems using feedback scheduling and reservation based scheduling techniques. Currently participating in the ACTORS-project, a EU sponsored project run by Ericsson Mobile Platform (EMP), and in the "Feedback Based Resource Management and Code Generation for Soft Real-Time Systems", a VINNOVA sponsored project also in co-operation with EMP. During the spring, he was a teaching assistant in Automatic Control (basic course) and in Real-Time systems. In September he presented his licentiate thesis. During the fall, Mikael was on parental leave.

Linderoth, Magnus
MSc, graduate student since September 2008. He is working in the Rosetta project, which aims to develop robots that are easy to program, adaptive, can share information and work safely next to humans. Magnus focuses on force control, redundancy resolution and vision feedback. During 2010 he has been involved in teaching of Real-Time Systems and the advanced course in Mathematical Modeling.

Lindholm, Anna
M.Sc., graduate student since February 2009. Her current research concerns developing methods for handling plant-wide disturbances. This research is performed in collaboration with her supervisor Charlotta Johnsson and the company Perstorp AB. The research project is denoted ”Upset Management” and is part of the Process Industrial Centre at Lund University, PIC-LU. During 2010 she has also been a teaching assistant in the Multivariable Control course and ”Feedback Systems”, a Ph.D. course concerning automatic control for physicists.

Madjidian, Daria
Daria has a M.Sc in Electrical Engineering and started as a Ph.D student at the department of Automatic control in August, 2008. He is involved in the EU-funded research project Aeolus with Anders Rantzer. The objective of AEOLUS is to address the effect of aerodynamic coupling in wind farms. During spring 2010 Daria supervised the Master Thesis of Thomas Alexander Clevnhult and Fredrik Himmelman titled ”Added Turbulence and Optimal Power Distribution in Large Off-Shore Wind Farms”. During fall 2010 he tutored the basic course in Automatic Control at Zhezhang University, Hangzhou, China.

Mannesson, Anders
MSc (2005), Graduate student since June 2010. Anders joined the department with 4 years of experience from the electronics industry. At the department, Anders has focused on courses but also been a teaching assistant in the control basic course. His research topic is indoor navigation and SLAM.

Mårtensson, Britt-Marie
Secretary at the department since 1974. She is responsible for the department library, orders books and handles the mail and office supplies. Assistant Webmaster. She also handles the contact with printing offices for dissertations and other publications. Britt-Marie is also the department’s service person.

Mårtensson, Karl
MSc, graduate student since December 2006. Karl’s research concerns Distributed Control. In this area, he is working with Professor Anders Rantzer. He is currently part of the CHAT project. He has also worked with Model Predictive Control, es-

pecially dealing with computational delays. Karl has been involved in teaching the basic course in Automatic Control, as well as in some more advanced courses, e.g. Control Theory.

Nilsson, Ingrid
Administrator at the department since March 2009. Ingrid is mainly responsible for the financial transactions at the department such as bookkeeping and reporting to our sponsors.

Nordh, Jerker
MSc Engineering Physics, graduate student since August 2010. During 2010 the work has mainly consisted of teaching in the Basic Course in Automatic Control, supervising a master thesis and attending PhD courses.

Olofsson, Björn
MSc in Engineering Physics, PhD student at the department since August 2010. His research interests are in robotics and control of resonant systems. During the year, he has been active in the EU/FP7 project COMET and the SSF/ProViking project ProFlexA, both involving industrial robots for performing tasks relevant for industry. He has also taken graduate courses within control theory and mathematics and taken active part in the teaching at the department within the undergraduate engineering programs.

Rantzer, Anders
Professor of Automatic Control since 1999 and head of department. He is also coordinator for the Linnaeus center LCCC. He has broad interests in modeling, analysis and synthesis of control systems, with particular attention to robustness, optimization and distributed control. Anders Rantzer is the main supervisor for several PhD students. During 2010, he taught the courses ”FRTN10 Multivariable Control” and ”FRT095 Mathematical Modelling”.

Reuterswärd, Philip
Civ.ing., Dipl.-math.techn., graduate student since January 2008. Has been involved with teaching at the department. Is currently looking into pseudospectral optimal control and its applications.

Robertsson, Anders
Associate professor (2007), ”Docent” (2005), Research Associate (May 2003), PhD (1999). Excellent Teaching Practitioner (ETP) in 2007. His main interest is in nonlinear control and robotics. Currently he is working on parallel kinematic robots, sensor-data integration and force control of industrial robots in collaboration with ABB Robotics/ABB CRC. The research has been conducted with the LUCAS project, the

Robotics Lab, The Linneaus Centre LCCC and the EU funded projects ROSETTA (FP-7), COMET (FP-7). He has also been doing research on admission control in network nodes and control of server systems in cooperation with the Department of Electrical and Information Technology, LTH and Ericsson, Karlskrona. He has lectured in the course Multivariable Control and in the course on Nonlinear Control and Servo Systems, lectured in a graduate course an advanced robotics and acted as advisor/co-advisor for 8 PhD students and several Master's Thesis projects.

Romero Segovia, Vanessa
Born in Peru, she has an MSc in Electrical Engineering since August 2008. Vanessa is a PhD student at the department since September 2008. Her research interests are related to real-time systems. As a member of the EU Project ACTORS, she has designed and implemented different control algorithms to achieve CPU bandwidth adaption in multicore systems. Her new research directions are related to the development of control algorithms for industrial process applications. As part of her PhD duties she is a teaching assistant of courses such as Automatic Control, Market-Driven Systems, International Project Course in Automatic Control, and Real-Time Systems.

Schildt, Eva
Secretary at the department since 1970. Eva is mainly responsible for the personnel administration and takes care of the administration concerning visitors at the department. Eva works part time since 2010.

Soltesz, Kristian
M.Sc., graduate student since October 2008. Kristian has spent the first two years of his PhD looking into system identification for PID tuning, within the Process Industrial Centre at Lund University (PICLU). During 2010 he has been involved in teaching a course in market driven systems. Kristian spent the second half of 2010 as a visiting graduate student at the University of British Columbia (UBC), Vancouver, Canada, under the supervision of professor Guy Dumont. His work there consisted in developing an identification and tuning method for robust PID, to be used in closed-loop controlled anesthesia of human patients. This work was conducted with the Department of Anesthesia at the British Columbia Children's Hospital (BCCH), Vancouver, Canada as clinical partner.

Sootla, Aivar
Lic.Sc., graduate student since September 2006. Aivar's main research interests are model reduction of systems with a structure and decentralized control. During the 2010 he published two papers in major conferences: Conference on Decision and Control and American Control Conference. He has also participated in Symposium on Mathematical Theory of Networks and Systems and Model Reduction Work-

shop. As a teaching assistant he has been involved in the Multivariable Control course and in the Automatic Control basic course.

Sörnmo, Olof
MSc in Engineering Physics, PhD student since May 2010. Olof's main research interests are within robotics and he is involved in both the EU/FP7-project COMET and the SSF/ProViking-project ProFlexA. His research in these projects include force control, modeling and control of a high dynamics compensation mechanism in combination with a milling process, and hysteresis compensation in piezo-actuators.

Ståhl, Fredrik
M.Sc.(2003), 50 % graduate student since 2008. Fredrik is involved in the DIAdvisor project, where his research has focused on modeling, identification and prediction of blood glucose dynamics. In 2010 the following conference contributions were published; "Observer Based Plasma Glucose Prediction in Type I Diabetes" at the 3rd IEEE Conference on Systems and Control, Yokohama, Japan, September 2010, and "Post-prandial Plasma Glucose Prediction in Type I Diabetes Based on Impulse Response Models" at the IEEE EMBS 32nd Annual International Conference, Buenos Aires, Argentina, September 2010.

Stemmann, Meike
MSc, graduate student since November 2009. Meike is involved in the DIAdvisor project within the European FP7-ICT program. Within this project, she has worked on sensor calibration models for a Non-Invasive Blood Glucose Measurement Sensor, resulting in the following conference contribution co-authored by Rolf Johansson and Fredrik Ståhl: The paper "Sensor Calibration Models for a Non-Invasive Blood Glucose Measurement Sensor" was presented at the 32nd Annual International Conference of the IEEE EMBS in September 2010 in Buenos Aires. Furthermore, she was involved in research about predictive control for regulating the blood glucose concentration in diabetic patients. Her teaching activities were within the Automatic Control Basic Course in Spring and within the Predictive Control course in Autumn.

Stolt, Andreas
MSc, graduate student since March 2010. He is working in the Rosetta project, which aims to develop technology for industrial robots that will not only appear more human-like, but also cooperate naturally with human workers. Andreas main focus has been force controlled compliant assembly. During the spring, he was a teaching assistant in the systems engineering course.

Theorin, Alfred
MSc in Engineering Physics. PhD student since January 2010. Alfred's main research interests involve control languages and robotics and during the year he has been working with development of the JGrafchart tool. During the spring he was a teaching assistant in the basic course of Automatic Control. During the fall he was a teaching assistant and created a new laboratory exercise variant in the Real-Time Systems course.

Westin, Eva
PhD in French linguistics. Administrator at the department since November 2008. She has the overall responsibility for the registration of students and PhD students as well as for their exam results. She updates parts of the department's web site. Eva is also working with administration of the LCCC Linnaeus project and visitors at the department. She organizes conferences and meetings. Together with Charlotta Johnsson she is responsible for the Activity Report 2010. Eva is the co-supervisor of two PhD theses in French linguistics at the Center of Languages and Literature at Lund University.

Widd, Anders
LicSc, graduate student since December 2006. He is working with Professor Rolf Johansson on the Project "KCFP, Closed-Loop Combustion Control", which is a cooperation with the Division of Combustion Engines. He has also participated in the project "Diesel-HCCI in a Multi-cylinder Engine". During the year, he has been a teaching assistant in the Automatic Control basic course, Systems Engineering, and Predictive Control.

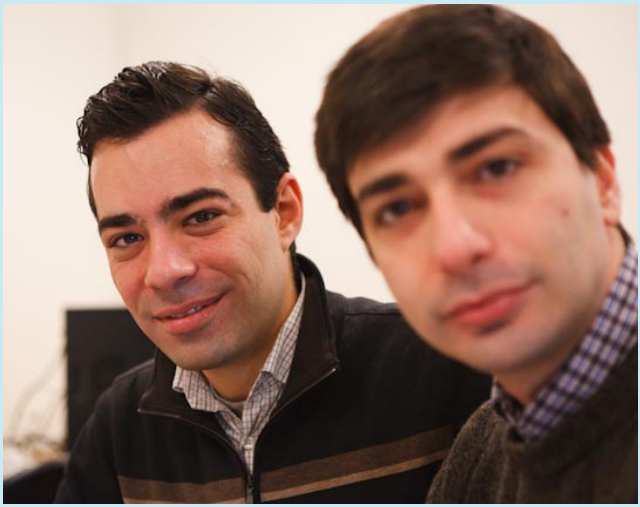
Wittenmark, Björn
He joined the department in 1966 and took his PhD in 1973. He became full professor at the department 1989. His main research interests are adaptive control, sampled-data systems, and process control. He is currently working within projects in the area of process design and control and control of communication networks. He is now professor emeritus at the department.

DAWN TILBURY, guest professor

I am a Professor of Mechanical Engineering at the University of Michigan, with a joint appointment in Electrical Engineering and Computer Science. I received my Bachelor's Degree (in EE) from the University of Minnesota, and my MS and PhD (in EECS) from the University of California, Berkeley - and have been on the faculty at Michigan since then. I am on sabbatical leave for the academic year 2010-11. From 2007-10, I was Associate Department Chair, with heavy administrative duties to allocate space in the department (for research and teaching) and assign instructors to courses. I was very involved with planning for a new building, and was advised that it would be a good idea to spend my sabbatical "far away" so I didn't get pulled back into the ongoing discussions (I still get questions over email once in awhile). I thought about coming to Lund because it is one of the top controls research groups in the world (in my opinion). I wanted to use my sabbatical as an opportunity to learn something new. While I am here, I am working on the DIAdvisor project, with the objective of giving diabetes patients advice about how much insulin to take based on measurements of their current blood glucose and models of their physiology. I think that the application of feedback control into biological, physiological and medical systems is a really interesting and growing area - sensors are becoming available to enable control, but mathematical models are very difficult to build, so control algorithms are still in their infancy. Rolf Johansson is the project lead in Lund, Marzia Cescon, Fredrik Ståhl, and Meike Stemmann are also working on the project, as well as partners from several other groups around Europe. In my free time, I really enjoy travelling - visiting cities and museums, hiking through parks and mountains, eating local foods and meeting new people. Over Christmas break I went to India for a friend's wedding, and this winter I visited friends in Paris the weekend after a DIAdvisor meeting. I also like to read, and have been studying a little bit of Swedish while I'm here. So far my stay has been great! It is going by quickly, though - I return to Michigan at the end of June.

Maxim Kristalny
PhD in 2010 at Technion in Israel with Leonid Mirkin as his supervisor. He is interested in analytical methods in distributed control and the use of preview in control and estimation. Maxim is involved in the Aeolus project focusing on developing methods for distributed feedforward control of the farm and for the use of previewed measurements of the wind speed for load reduction. In his spare time he likes to cycle and play the guitar.
Last read books: ”What I Talk About When I Talk About Running” by H. Murakami and ”Rabbits and boas” by F. Iskander.
Best thing about Sweden (so far): Too many good things. I would pick out: graceful nature, calm atmosphere, friendly people and, especially, patient administrators :)

Georgios Chasparis
PhD in 2008 at UCLA with Jeff Shamma as his supervisor. Post doc at the department from December 2010. His research interests are Learning in games, Efficient decision making under uncertainty, Self-configured systems, Complex networked systems and Operation research.
When not working he is jogging and playing basketball.
Last Read book: The Selfish Gene by R. Dawkins
Best thing about Sweden so far: the cycling culture, the pancakes, the anticipation for a sunny day.



5.3 Assignments

Board Member

Karl-Erik Årzén: Member of the Board for the ELLIIT strategic research area project. Member of the Steering Committe for the International Conference on Cyber-Physical Systems (ICCPS). Member of the Strategic Management Board for the EU/IST FP7 IP ArtistDesign.
Karl Johan Åström: Member of Advisory Board for EU-project FeedNetBack: Feedback design for wireless networked controlled systems.
Anton Cervin: Board member of SNART (the Swedish National Real-Time Association).
Tore Hägglund: Expert member in legal proceedings for patent at Svea Court of Appeal.
Rolf Johansson: Board Member of DIAdvisor Executive Board. Board Member of ROSETTA Project Management Board, 2009-2013. Board Member of ROSETTA Project Scientific Board, 2009-2013.
Charlotta Johnsson: Board member of WBF (Org. for Production Technology)
Anders Rantzer: Member of the Scientific Council for Natural and Engineering Sciences within the Swedish Research Council; Member of the steering committee for the International Symposium on Mathematical Theory of Networks and Systems; Member of the IEEE CSS student paper price committee; Member of the Advisory Board for Lecture Notes in Control and Information Sciences at Springer Verlag Heidelberg; Member of the IEEE Control System Society Technical Committee on Nonlinear Systems and Control; Member of the IFAC Technical Committee on Nonlinear Systems
Björn Wittenmark: Chairman Lund Laser Center; Board member of LUCAS and EASE; Board member Gyllenstiernska Krapperupsstiftelsen; Member of the Technical Committee for IFAC Adaptive Control and Learning

Member of International Program Committee (IPC)

Karl-Erik Årzén: Member of the Program Committe for the Fifth International Workshop on Feedback Control Implementation and Design in Computing Systems and Networks (FeBID 2010). Member of the Program Committe for the 22nd Euromicro Conference on Real-Time Systems (ECRTS 2010). Member of the Program Committe for the Special track on Cyber-Physical Systems at the 31st Real-Time Systems Symposium (RTSS 2010). Member of the Program Committe for the First International Conference on Cyber-Physical Systems (ICCPS 2010). Member of the Proigram Committee for the First International Workshop on Adaptive Resource Management (WARM 2010)
Anton Cervin: Member of the Program Committee for the Workshop on Analysis, Methodologies and Tools for Embedded and Real-time Systems (WATERS'10).
Anton Cervin, Charlotta Johnsson and Anders Robertsson: Program Committee

for Reglermöte 2010 in Lund, Sweden
Member of the Program Committee for the Real-Time and (Networked) Embedded Systems track of the IEEE International Conference on Emerging Technologies and Factory Automation (EFTA'10).
Per Hagander: Member of IPC for the 11th Symposium on Computer Applications in Biotechnology (CAB 2010) in Leuven, Belgium.
Tore Hägglund: Control Systems 2010, Stockholm, Sweden. IFAC Conference on Advances in PID Control, Brescia, Italy, 2012
Rolf Johansson: IPC Member, IFAC Symposium Advances in Automotive Control (AAC 2010), 12-14 July 2010, Munich, Germany. IPC Member, 9th Portuguese Conference on Automatic Control CONTROLO'2010, Coimbra, Portugal, 8-10 September 2010. IPC Member of the UKACC International Conference Control 2010, Coventry, Britain, 7-10 September 2010. Advisory Committee Member, IEEE RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob 2010), Tokyo, Japan, September 26-29, 2010. IPC Member of the 2010 IEEE International Conference on Robotics and Biomimetics (ROBIO 2010), Tianjin, China, December 14-18, 2010. Associate Editor at Large, 2011 IEEE International Conference on Robotics and Automation (ICRA 2011), May 9-13, 2011, Shanghai, China.
Anders Rantzer: Member of the IPC for European Control Conference 2010.

Opponent and Member of Examination Committee
Karl-Erik Årzén: Deputy member of the PhD thesis committee for Matthias Haage, Dec 16, Department of Computer Science, Lund University. External examiner of the PhD thesis by Gonzalo Farias on May 17 at Universidad Nacional de Educación a Distancia (UNED), Madrid
Karl Johan Åström: Member of Examination Committee of the thesis on Low-Cost Navigation Systems A Study of Four Problems by Isaac Skog from KTH.
Bo Bernhardsson: Part of the examination committee for Henrik Ohlsson PhD defence in Linköping November 2010.
Tore Hägglund: Member of the Examination Committee for the PhD thesis by Björn Halvarsson, May 21 at Uppsala University, Uppsala, Sweden; Member of the Examination Committee for the PhD thesis by Magnus Nilsson, June 11 at Chalmers University of Technology, Gothenburg, Sweden.
Rolf Johansson: Pål Johan FROM, Off-Shore Robotics—Robust and Optimal Solutions for Autonomous Operation, Doctoral Thesis 2010:96, Dept. Engineering Cybernetics, Norwegian University of Science and Technology (NTNU), Trondheim, Norway, May 26, 2010.External examiner of the doctoral thesis.
Charlotta Johnsson: External examiner of licentiate thesis by Bo Svensson, Chalmers University of Technology, Gothenburg, Sweden
Anders Rantzer: External examiner of PhD thesis by Jose Vasconcelos on January 8, at Instituto Superior Tecnico (IST), Lissabon, Portugal

Advisory Committees and Working Groups

Karl-Erik Årzén: Member of the evaluation committee for promotions at Department of Engineering Cybernetics, Norwegian University of Science and Technology

Per Hagander: Member of IFAC Technical Committee BIOMED; Member of IFAC Technical Committee Biotechnical Processes; Member of ESBES-Working Group M^3C.

Rolf Johansson: Member of IEEE EMBS Technical Committee (TC) for Biomedical Robotics. Member of Joint EMBS/RAS Advisory Committee on Biorobotics. Reviewer, Norway Research Council, Information and Communication Technology (ICT) Program, VERDIKT, February 2010.

Björn Wittenmark: Reviewer for research evaluations for the Australian Research Council, Italian Ministry for Education University and Research (MIUR) and Norwegian Research Council; Evaluation of university colleges in Halmstad and Skövde for the Swedish National Agency for Higher Education (Högskoleverket) for acquiring permission to graduate PhD students.

Book and Journal Editor

Tore Hägglund: Editor for Control Engineering Practice.

Rolf Johansson: Associate Editor, Int. J. Adaptive Control and Signal Processing. Associate Editor, Chinese Journal of Scientific Instrument, (China Instrument and Control Society)

Björn Wittenmark: Member of Editorial Board for Journal of Forecasting IEE Proceedings Control Theory & Applications.

Patent

Rolf Johansson: J. Gámez García, A. Robertsson, J. Gómez Ortega, R. Johansson, Dispositivo para la estimación de fuerzas y pares de contacto en robots manipuladores industriales y procedimiento de implementación del mismo, Patent No. P200602797, Publication No. 2315130, 03 Feb 2010, Oficina Española de Patentes y Marcas, Ministerio de Industria, Turismo y Comercio, Madrid, Spain

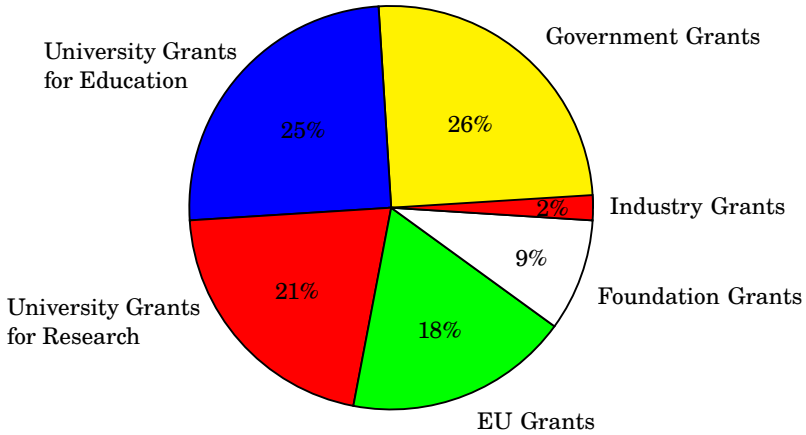
Other assignments

Rolf Johansson: ICRA 2010 Workshop on Innovative Robot Control Architectures for Demanding (Research) Applications—How to Modify and Enhance Commercial Controllers, Anchorage, Alaska, May 3, 2010, Co-chairman. LCCC Symposium, Adaptation and Learning in Autonomous Systems, April 6–30; Workshop Apr. 21–23, 2010, Organizing Committee Member. The 37th International Congress on Electrocardiology (ICE2010), June 3-5, 2010, Lund, Sweden, Organizing Committee Member. Workshop on Identification in Automotive Systems, Linz, Austria, July 15-16, 2010, Organizing Committee Member. XXVI Bárány Society Meeting: Session on Mathematical Modeling of Human Balance, Vertigo and their Disorders, Reykjavik, Iceland, August 19, 2010, Organizing Committee Member. Summer School on Model-based Automotive Control, Linz, Austria, August 25-27, 2010, Co-chairman.

6. Economy and General Information

6.1 Economy and Funding

The turnover for 2010 was 46,4 MSEK. About half of the income comes from Lund University, and the rest from external grants. The distribution is shown below.



The activity and the number or employees have increased substantially in the last few years, mainly because of the Linnaeus grant "Lund Center for Control of Complex Engineering Systems", LCCC, funded by the Swedish Research Council. The department participated in nine projects funded by European Union, EU, during 2010. The Swedish Foundation for Strategic Research has also provided substantial support of the activities.

During 2010 we had the following contracts:

VR-Control with decentralized information
VR – Active Control of Compressor Systems Based on New Methods of Nonlinear Dynamic Feedback Stabilization
VR - Modelling and Control of Server Systems
VR – Decentralized Structures for Industrial Control II
VR – Periodic and Event-Based Control over Networks
VR – Linnaeus grant Lund Center for Control of Complex Engineering Systems LCCC
VR - Active Control of Compressor Systems Based on New Methods of Nonlinear Dynamic Feedback Stabilization
VR – Suboptimal Methods for Event-based State Estimation and Control
VR – Remuneration for Anders Rantzers' function as Member of the Scientific Council

for Natural and Engineering Sciences within the Swedish Research Coun cil 2010-2012
VR – Resource Allocation and Control of Distributed Service Management Systems
VINNOVA/VR - Excellence Center at Linköping - Lund on Information Technology ELLIIT
VINNOVA-Ericsson – Feedback Based Resource Management and Code Generation for Soft Real-Time Systems
VINNOVA – 2006-03689 ITEA - European Leadership in System Modeling and Simulation through advanced Modelica Libraries
VINNOVA- Saab - Adaptive Control in Flying Vehicles
SSF – Productive Flexible Automation
SSF – Enabling GROwing Software Systems ENGROSS
SSF – PICLU
EU – FP7 ICT-230902 Robot control for Skilled ExecuTion of Tasks in natural interaction with humans; based on Autonomy, cumulative knowledge and learning ROSETTA
EU – ICT-216586 Adaptivity and Control o Resources in Embedded Systems ACTORS
EU – ICT-216592 Personal Health Systems for Monitoring and Point-of-Care Diagnostics DIAdvisor
EU – ICT-97518 ArtistDesign – Design for Embedded Systerms ARTIST-DESIGN
EU – ICT-224428 Control of Heterogeneous Automaton Systems: Technologies for Scalability, Reconfigurability and Security CHAT
EU – ICT-224548 Distributed Control of Large-Scale Offshore Wind Farms project proposal AEOLUS
EU – FP7 Plug-and-procedure Components and METthods for adaptive Control of industrial robots enabling cost effective, high precision manufacturing in factories of the future, COMET
EU – FP7 Highly-complex and networked control systems, HYCON
EU – FP7 Hyper-Modular Open Networked RObot systems with Excellent Performance, MONROE
Toyota Motor Corporation – Project on Nonlinear Model Reduction
Swedish Energy Agency (STEM) – Competence Center Combustion Processes, KCFP
SKB - Control of Stirwelding Process for Sealing
Vägverket – Estimation of Road Friction
Novozymes – Agreement on co-financed PhD student
Emissions Control for Low Climate Impact, KCFP2

The block grants from VR and some of the VINNOVA projects are long range. Several projects do, however, have a duration of only two years. To match these with the length of a PhD position, which is much longer, we have an internal research planning that is much more long range and we are careful to bid on projects that ft our long range research plan. This has proven an effcient way to match short-term funding to long term planning.

6.2 Internet Services

World Wide Web

Visit our homepage at this address: www.control.lth.se
Our website contains information about personnel, research, publications, seminars, education etc. It also contains fairly complete lecture notes for many courses, and in some cases software tools such as Matlab tool-boxes developed at the department. Our home-page frst appeared on the World Wide Web (WWW) in April 1994.

Electronic Mail

All personnel can be contacted by electronic mail. A personal email address consists of the full name and the department address in the following form:
firstname.lastname@control.lth.se
Double names are separated by underline, hyphens are treated as ordinary characters and accents are ignored. Examples:
anders.rantzer@control.lth.se
karl-erik.arzen@control.lth.se

APPENDIX

Publications 2010

You can find references to all the publications on www.control.lth.se/publications/ and almost all of them can be downloaded from this site. Only a limited number of copies of our reports are available for sale from the department. Any of the reports may, however, be borrowed through your library service or from the following libraries in Sweden:

- Linköpings Universitetsbibliotek, Svensktrycket, SE-581 83, Linköping
- Universitetsbiblioteket Lund, Svenska Tryckavdelningen, Box 1010, SE-221 03 Lund
- Stockholms Universitetsbibliotek, Svenska Tryckavdelningen, SE-106 91 Stockholm
- Kungliga Biblioteket, Box 5039, SE-102 41 Stockholm
- Umeå Universitetsbibliotek, Box 718, SE-901 10 Umeå
- Uppsala Universitetsbibliotek, Box 510, SE-751 20 Uppsala

	2006	2007	2008	2009	2010	Sum
Books	1	1	3	1	1	7
Book Contributions	4	2	4	3	4	17
Articles	19	19	21	16	13	88
Conference Contributions	53	32	33	41	50	209
PhD theses	3	5	3	2	0	13
Licentiate theses	3	0	2	3	1	9
Master's theses	20	24	24	16	45	129
Technical reports	4	5	3	2	2	16

Book

Åström, Karl Johan and Richard M. Murray: Feedback Systems - An Introduction for Scientists and Engineers; Posts and Telecom Press 2010, Beijing, China, ISBN 978-7-115-24180-1

Book chapter

Åström, Karl Johan and Tore Hägglund: **PID Control** in *William S. Levine (Eds.): The Control Handbook, Second Edition: Control System Fundamentals*, CRC Press, December 2010

Åström, Karl Johan and Tore Hägglund: **Automatic Tuning of PID Controllers** in *William S. Levine (Eds.): The Control Handbook, Second Edition: Control System Advanced Methods*, CRC Press, December 2010

Bernhardsson, Bo: **Control Inside Mobile Phones Overview, Success Stories, and Research Challenges, The Impact of Control Technology** in "The Impact of Control Technology, T. Samad and A.M. Annaswamy (eds.), IEEE Control Sys tems Society, 2010, available at www.ieeecss.org."

Hess, Anne-Kathrin and Anders Rantzer: **Distributed Kalman Filter Algorithms for**

Self-Localization of Mobile Devices in *Proceedings of the 13th ACM Inter national Conference on Hybrid Systems: Computation and Control*, The Associa tion for Computing Machinery, New York, April 2010. ISBN:978-1-60558-955-8

Johansson, Rolf, Per Tunestål and Anders Widd: **Modeling and Model-based Control of Homogeneous Charge Compression Ignition (HCCI) Engine Dynamics** in *L. del Re, F. Allgöwer, L. Glielmo, C. Guardiola, I. Kolmanovsky (Eds.): Automotive Model Predictive Control---Models, Methods and Applications*, Springer-Verlag, Berlin-Heidelberg, May 2010

Journal Article

Åkesson, Johan, Karl-Erik Årzén, Magnus Gäfvert, Tove Bergdahl and Hubertus Tummescheit: *Modeling and Optimization with Optimica and JModelica.org—Languages and Tools for Solving Large-Scale Dynamic Optimization Problem* in Com puters and Chemical Engineering, 34:11, pp. 1737-1749, November 2010. Doi:10.1016/j.compchemeng.2009.11.011

Åkesson, Johan, Torbjörn Ekman and Görel Hedin: *Implementation of a Modelica Compiler Using JastAdd Attribute Grammars* in Science of Computer Programming, 75:1-2, pp. 21-38, January 2010. doi:10.1016/j.scico.2009.07.003

Cervin, Anton, Manel Velasco, Pau Martí and Antonio Camacho: *Optimal On-Line Sampling Period Assignment: Theory and Experiments* in IEEE Transactions on Control Systems Technology, 2010. Published online.

Farias, Gonzalo, Karl-Erik Årzén, Anton Cervin, Sebastián Dormido and Francisco Esquembre: *Teaching Embedded Control Systems* in International Journal of Engineering Education, 2010. Published online.

Farias, Gonzalo, Anton Cervin, Karl-Erik Årzén, Sebastián Dormido and Francisco Esquembre: *Java Simulations of Embedded Control Systems* in Sensors, 10:9, pp. 8585–8603, 2010

Freidovich, Leonid, Anders Robertsson, Anton Shiriaev and Rolf Johansson: *LuGre-Model-Based Friction Compensation* in IEEE Transactions on Control Systems Technology, 18:1, pp. 194–200, January 2010

Hedin, Görel, Johan Åkesson and Torbjörn Ekman: *Extending Languages by Everaging Compilers—from Modelica to Optimica* in IEEE Software, March 2010. Doi: http://doi.ieeecomputersociety.org/10.1109/MS.2010.62. Published online.

Kotsalis, Georgios and Anders Rantzer: *Balanced Truncation for Discrete Time Markov Jump Linear Systems* in IEEE Transactions on Automatic Control, 55:11, pp. 2606–2611, November 2010

Mariethoz, Sebastien, Stefan Almer, Mihai Baja, Andrea Beccuti, Diego Patino, Andreas Wernrud, Jean Buisson, Herve Cormerais, Tobias Geyer, Hisaya Fujioka, Ulf Jönsson, Chung-Yao Kao, Manfred Morari, Georgios Papafotiou, Anders Rantzer and Pierre Riedinger: *Comparison of Hybrid Control Techniques for Buck and Boost DC-DC Converters* in IEEE Transactions on Control Systems Technology, 18:5, pp. 1126-1145, September 2010

Olsson, Tomas, Mathias Haage, Henrik Kihlman, Rolf Johansson, Klas Nilsson, Anders Robertsson, Mats Björkman, Robert Isaksson, Gilbert Ossbahr and Torgny Brogårdh: *Cost-Efficient Drilling Using Industrial Robots with High-Bandwidth Force Feedback* in Robotics and Computer-Integrated Manufacturing, 26, pp. 24-

38, January 2010
Patel, M., P. A. Fransson, Rolf Johansson and Måns Magnusson: *Foam Posturography: Standing on Foam is not Equivalent to Standing with Decreased Rapidly Adap ting Mechanoreceptive Sensation* in Experimental Brain Reseach, December 2010. Published online.
Shiriaev, Anton, Leonid Freidovich, Rolf Johansson and Anders Robertsson: *Global Stabilization for a Class of Coupled Nonlinear Systems with Application to Active Surge Control* in Dynamics of Continous, Discrete and Impulsive Systems, Series B, Applications and Algorithms, 17:6b, pp. 875-908, December 2010
Wu, Yifan, Giorgio Buttazzo, Enrico Bini and Anton Cervin: *Parameter Selection for Real-Time Controllers* in Resource-Constrained Systems in IEEE Transactions on Industrial Informatics, 6:4, pp. 610–620, November 2010

Conference Contributions

Blomdell, Anders, Isolde Dressler, Klas Nilsson and Anders Robertsson: *Flexible Application Development and High-performance Motion Control Based on External Sensing and Reconfiguration of ABB Industrial Robot Controllers* in Proc. ICRA 2010 Workshop on Innovative Robot Control Architectures for Demanding (Research) Applications, Anchorage, AK, June 2010
Cederqvist, Lars, Olof Garpinger, Tore Hägglund and Anders Robertsson: *Cascaded Control of Power Input and Welding Temperature During Sealing of Spent Nu clear Fuel Canisters* in Proc. ASME Dynamic Systems and Control Conference, Cambridge, Massachusetts, September 2010
Cescon, Marzia and Rolf Johansson: *Multi-step-ahead Multivariate Predictors: A Com parative Analysis* in Proc. 49th IEEE Conference on Decision and Control, At lanta, GA, December 2010
Cheong Sou, Kin and Anders Rantzer: *A Singular Value Decomposition Based Closed Loop Stability Preserving Controller Reduction Method* in Proc. American Control Conference, Baltimore, MD, June 2010
Cheong Sou, Kin and Anders Rantzer: *A SVD Based Controller Reduction Method* in Proc. SICE Annual Conference, Taipei, Taiwan, August 2010
Cheong Sou, Kin and Anders Rantzer: *Controller Reduction with Closed Loop Performance Guarantee* in Proc. 49th IEEE Conference on Decision and Control, At lanta, GA, December 2010
Cheong Sou, Kin and Anders Rantzer: *On the Minimum Rank of a Generalized Matrix Approximation Problem in the Maximum Singular Value Norm* in Proc. 19th International Symposium on Mathematical Theory of Networks and Systems, Budapest, Hungary, July 2010
Dressler, Isolde, Torgny Brogårdh, och Anders Robertsson: *A Kinematic Error Model for a Parallel Gantry-Tau Manipulator* in Proc. IEEE International Conference on Robotics and Automation (ICRA2010), Anchorage, Alaska, USA, May 2010
Dressler, Isolde and Anders Robertsson: *Positioning Accuracy of a Parallel Kinematic Gantry-Tau Robot* in Proc. Swedish Control Conference 2010, Lund, June 2010
Gestegård Robertz, Sven, Lorenz Halt, Sameer Kelkar, Klas Nilsson, Dominique Schär, Anders Robertsson and Johannes Schiffer: *Precise Robot Motions Using Dual Motor Control* in Proc. IEEE International Conference on Robotics and Automa-

tion, Anchorage, AK, May 2010
Giselsson, Pontus: *Adaptive Nonlinear Model Predictive Control with Suboptimality and Stability Guarantees* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010
Giselsson, Pontus and Anders Rantzer: *Distributed Model Predictive Control with Subop timality and Stability Guarantees* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010
Hägglund, Tore: *Steel Belt Position Control at Sandvik Process Systems* in Proc. Reglermöte, Lund, Sweden, June 2010. Published online.
Henningsson, Toivo and Anton Cervin: *A Simple Model for the Interference Between Event-Based Control Loops Using a Shared Medium* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010
Herreros, A., E. Baeyens, P. Rivera, R. Johansson: *Performance Improvement of a Phase Space Detection Algorithm for ECG Wave Morphology Classification*, The 37th International Congress on Electrocardiology (ICE2010), June 3-5, 2010, Lund University, Lund, Sweden
Johannesson, Erik, Anders Rantzer, Bo Bernhardsson and Andrey Ghulchak: *Encoder and Decoder Design for Signal Estimation* in Proc. American Control Conference, Baltimore, USA, June 2010
Johannesson, Erik, Andrey Ghulchak, Anders Rantzer and Bo Bernhardsson: *MIMO Encoder and Decoder Design for Signal Estimation* in Proc. 19th International Symposium on Mathematical Theory of Networks and Systems, Budapest, Hungary, July 2010
Johansson, Rolf: *Continuous-Time Model Identification and State Estimation Using Non-Uniformly Sampled Data* in Proc. 19th International Symposium on Mathematical Theory of Networks and Systems, Budapest, Hungary, July 2010
Jonsson, Marie, Tom Murray, Anders Robertsson, Andreas Stolt, Gilbert Ossbahr and Klas Nilsson: *Force Feedback for Assembly of Aircraft Structures* in Proc. SAE Aerospace Manufacturing and Automated Fastening Conference, September 2010. DOI 10.4271/2010-01-1872
Jörntell, Henrik, Jonas Dürango and Rolf Johansson: *Stochastic Neural Firing Properties in Neurons of a Cerebellar Control System* in Proc. 3rd IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics, Tokyo, Japan, September 2010
Karlsson, Maria, Kent Ekholm, Petter Strandh, Per Tunestål and Rolf Johansson: *Dynamic Mapping of Diesel Engine through System Identification* in Proc. American Control Conference, Baltimore, MD, June 2010
Karlsson, Maria, Kent Ekholm, Petter Strandh, Rolf Johansson and Per Tunestål: *Multiple-Input Multiple-Output Model Predictive Control of a Diesel Engine* in Proc. Fifth IFAC Symposium on Advances in Automotive Control, Munich, Germany, July 2010
Kjær, Martin Ansbjerg and Anders Robertsson: *Analysis of Buffer Delay in Web-Server Control* in Proc. American Control Conference, Baltimore, MD, June 2010
Larsson, Per-Ola, Niklas Andersson, Johan Åkesson and Staffan Haugwitz: *Modeling and Optimization of Grade Changes for a Polyethylene Reactor* in Reglermöte, June 2010

Larsson, Per-Ola, Johan Åkesson, Staffan Haugwitz and Niklas Andersson: *Modelica Based Grade Change Optimization for a Polyethylene Reactor* in Proc. 9th International Symposium on Dynamics and Control of Process Systems, Leuven, Belgium, July 2010

Larsson, Per-Ola, Johan Åkesson, Staffan Haugwitz and Niklas Andersson: *Modeling and Optimization of Grade Changes for Multistage Polyethylene Reactors* in Proc. 16th Nordic Process Control Workshop, Lund, Sweden, August 2010

Liao, Hsien-Hsin, Nikhil Ravi, Adam Jungkunz, Anders Widd and J. Christian Gerdes: *Controlling Combustion Phasing of Recompression HCCI with a Switching Controller* in Proc. Sixth IFAC Symposium on Advances in Automotive Control, Munich, Germany, July 2010

Lindberg, Mikael: *A Convex Optimization-Based Approach to Control of Uncertain Ex ecution Platforms* in Proc. 49th IEEE Conference on Decision and Control, At lanta, GA, December 2010

Lindberg, Mikael: *Convex Programming-Based Resource Management for Uncertain Execution Platforms* in Proc. First International Workshop on Adaptive Resource Management, Stockholm, Sweden, April 2010

Lindberg, Mikael and Karl-Erik Årzén: *Feedback Control of Cyber-Physical Systems with Multi Resource Dependencies and Model Uncertainties* in Proc. 31st IEEE Real-Time Systems Symposium, San Diego, CA, December 2010

Linderoth, Magnus, Anders Robertsson, Kalle Åström and Rolf Johansson: *Object Tracking with Measurements from Single or Multiple Cameras* in Proc. International Conference on Robotics and Automation, Anchorage, AK, May 2010. DOI: 10.1109/ROBOT.2010.5509775.

Lindholm, Anna, Hampus Carlsson and Charlotta Johnsson: *Availability Estimations for Utilities in the Process Industry* in Proc. 16th Nordic Process Control Workshop, Lund, Sweden, August 2010

Lindholm, Anna, Krister Forsman and Charlotta Johnsson: *A General Method for Defining and Structuring Buffer Management Problems* in Proc. American Control Confe rence, Baltimore, MD, July 2010

Lindholm, Anna, Krister Forsman and Charlotta Johnsson: *Buffer Management Strategies for Improving Plant Availability* in Proc. Reglermöte, Lund, Sweden, June 2010.

Maestre Torreblanca, Pepe, Pontus Giselsson and Anders Rantzer: *Distributed Receding Horizon Kalman Filter* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010

Mårtensson, Karl and Anders Rantzer: *Sub-Optimality Bound on a Gradient Method for Iterative Distributed Control Synthesis* in Proc. 19th International Symposium on Mathematical Theory of Networks and Systems, Budapest, Hungary, July 2010

Parrotto, Roberto, Johan Åkesson and Fracesco Casella: *An XML Representation of DAE Systems Obtained from Continuous-Time Modelica Models* in Third International Workshop on Equation-based Object-oriented Modeling Languages and Tools, Oslo, Norway, September 2010

Patel, M., P.-A. Fransson, R. Johansson, M. Magnusson: *Foam surfaces and standing balance testing: The balance perturbing effects, the perturbing mechanisms and considerations for clinical and experimental practice*, XXVI Bárány Society Mee ting, Reykjavik, Iceland, August 18-21, 2010.

Poulsen, J. U., A. Avogaro, F. Chauchard, C. Cobelli, R. Johansson, L. Nita, M. Pogose, L. del Re, E. Renard, S. Sampath, F. Saudek, M. Skillen, J. Soendergaard: *A Diabetes Management System Empowering Patients to Reach Optimised Glucose Control: From Monitor to Advisor*. Invited Paper. 32nd Annual International IEEE EMBS Conference (EMBC2010), August 31 - September 4, 2010, Buenos Aires, Argentina.

Prölss, Katrin, Hubertus Tummescheit, Stéphane Velut and Johan Åkesson: *Dynamic Model of a Post-combustion Absorption Unit for Use in a Non-linear Model Predictive Control Scheme* in Proc. International Conference on Greenhouse Gas Technologies, Amsterdam, The Netherlands, September 2010

Rantzer, Anders: *Distributed Performance Analysis of Heterogeneous Systems* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010

Romero Segovia, Vanessa and Karl-Erik Årzén: *Towards Adaptive Resource Management of Dataflow Applications on Multi-Core Platforms* in Work-in-Progress Session at Euromicro Conference on Real-Time Systems, July 2010

Romero Segovia, Vanessa, Karl-Erik Årzén, Stefan Schorr, Raphael Guerra, Gerhard Fohler, Johan Eker and Harald Gustafsson: *Adaptive Resource Management Framework for Mobile Terminals—The ACTORS Approach* in Proc. First Interna tional Workshop on Adaptive Resource Management, Stockholm, Sweden, April 2010

Samii, Soheil, Anton Cervin, Petru Eles and Zebo Peng: *Runtime Trade-Offs Between Control Performance and Resource Usage in Embedded Self-Triggered Control Systems* in Proc. First International Workshop on Adaptive Resource Management, Stockholm, Sweden, April 2010

Samii, Soheil, Petru Eles, Zebo Peng, Paulo Tabuada and Anton Cervin: *Dynamic Schedu ling and Control-Quality Optimization of Self-Triggered Control Applications* in Proc. 31st IEEE Real-Time Systems Symposium, San Diego, CA, December 2010

Soltesz, Kristian, Tore Hägglund and Karl Johan Åström: *Transfer Function Parameter Identification by Modified Relay Feedback* in Proc. American Control Conference 2010, Baltimore, USA, June 2010

Sootla, Aivar: *Hankel-type Model Reduction Based on Frequency Response Matching* in Proc. 49th IEEE Conference on Decision and Control, Atlanta, GA, December 2010. DOI: 10.1109/CDC.2010.5716947

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Sootla, Aivar: *Properties of a Parameterized Model Reduction Method* in Proc. 19th International Symposium on Mathematical Theory of Networks and Systems, Budapest, Hungary, July 2010

Sootla, Aivar and Anders Rantzer: *Parameter Dependent Model Reduction Framework with Applications* in Proc. Reglermöte, Lund, Sweden, June 2010. Published online.

Sootla, Aivar and Kin Cheong Sou: *Frequency Domain Model Reduction Method for Parameter-Dependent Systems* in Proc. American Control Conference, Baltimore, MD, USA, July 2010. ISBN: 978-1-4244-7426-4

Ståhl, Fredrik and Rolf Johansson: *Observer Based Plasma Glucose Prediction in Type*

I Diabetes in Proc. 3rd IEEE Conference on Systems and Control, Yokohama, Japan, September 2010

Ståhl, Fredrik, Rolf Johansson and Eric Renard: *Post-prandial Plasma Glucose Prediction in Type I Diabetes Based on Impulse Response Models* in Proc. IEEE EMBS 32nd Annual International Conference, Buenos Aires, Argentina, September 2010

Stemmann, Meike, Fredrik Ståhl, Jordane Lallemand, Eric Renard and Rolf Johansson: *Sensor Calibration Models for a Non-Invasive Blood Glucose Measurement Sen sor* in Proc. IEEE EMBS 32nd Annual International Conference, Buenos Aires, Argentina, October 2010

Licentiate Theses

Lindberg, Mikael: Adaptive Resource Management for Uncertain Execution Platforms; Licentiate Thesis ISRN LUTFD2/TFRT--3249--SE, Department of Automatic Control, Lund University, Sweden, September 2010

Master's Theses

(The Master's Theses completed within the Technology Management Program, marked TM, are published on the TM homepage: www.tmonline.se)

Alenmyr, Sara and Anneli Ögren: Model Predictive Control for Stock Postfolio Selection; Master's Thesis ISRN LUTFD2/TFRT--5847--SE, Department of Automatic Control, Lund University, Sweden, February 2010

Andersson, Bengt-Arne: Implementation of the Functional Mock-up Interface in Matlab and Simulink; Master's Thesis ISRN LUTFD2/TFRT--5869--SE, Department of Automatic Control, Lund University, Sweden, December 2010

Andersson, Karin: The Nucleus of CSR - Creating and Communicating a Strategic Corporate Social Responsability Agenda in a Controversial Industry (TM)

Bengtsson, Rikard and Jasper Gundersen: Truck Differential and Rear Axle Modeling; Master's Thesis ISRN LUTFD2/TFRT--5851--SE, Department of Automatic Control, Lund University, Sweden, May 2010

Björk, Henrik: Grating Motor Control; Master's Thesis ISRN LUTFD2/TFRT--5868--SE, Department of Automatic Control, Lund University, Sweden, December 2010

Blomdell, Tor: Technology Scouting in China - Identifying Cost Reductions and Opportunities for innovation (TM)

Bonnedahl, Tobias: Road Slope Estimation Using a Longitudinal Accelerometer and Kalman Filtering; Master's Thesis ISRN LUTFD2/TFRT--5856--SE, Department of Automatic Control, Lund University, Sweden, April 2010

Bunjaku, Sebahate: Managing Coordination in Global Projects (TM)

Clevenhult, Thomas Alexander and Fredrik Himmelman: Added Turbulence and Optimal Power Distribution in Large Off-Shore Wind Farms; Master's Thesis ISRN LUTFD2/TFRT--5867--SE, Department of Automatic Control, Lund University, Sweden, October 2010

Dürango, Jonas: Analysis and Simulation of Cerebellar Circuitry; Master's Thesis ISRN LUTFD2/TFRT--5860--SE, Department of Automatic Control, Lund University, Sweden, June 2010

Espersson, Magnus: Vision Algorithms for Ball on Beam and Plate; Master's Thesis ISRN LUTFD2/TFRT--5859--SE, Department of Automatic Control, Lund University,

Sweden, May 2010
Forsberg, Per-Ola: Identification and Modeling of Sensory Feedback Processing in a Brain System for Voluntary Movement Control; Master's Thesis ISRN LUTFD2/TFRT--5849--SE, Department of Automatic Control, Lund University, Sweden, February 2010
Friman, Johan: Kinematic and Force Control for a Gantry-Tau Robot; Master's Thesis ISRN LUTFD2/TFRT--5850--SE, Department of Automatic Control, Lund University, Sweden, January 2010
Galeev, Roman and Wang Ching Ho: Optimal Pairs Trading Using Stochastic Control Approach—A Critical Evaluation; Master's Thesis ISRN LUTFD2/TFRT--5857--SE, Department of Automatic Control, Lund University, Sweden, June 2010 (TM)
Ganestam, Per: Empirical Knock Model for Automatic Engine Calibration; Master's Thesis ISRN LUTFD2/TFRT--5864--SE, Department of Automatic Control, Lund University, Sweden, October 2010
Gerdin, Christer: Why are Profitable Energy Efficient Investments not made? - A Study of the Desicion-making-process for Energy Efficient Investments within the Real Estate Business (TM)
Grau Torres, Ana: From CAD-Design to Force Controlled Robot Manufacturing; Master's Thesis ISRN LUTFD2/TFRT--5863--SE, Department of Automatic Control, Lund University, Sweden, September 2010
Haas, Christoph: Development of Interactive Simulator for Telepresence Robot in Surgical Applications; Master's Thesis ISRN LUTFD2/TFRT--5866--SE, Department of Automatic Control, Lund University, Sweden, June 2010
Hansson, Fredrik: Finding Optimal Logistical Hubs for Swedish Export - A Study of Selecting Global Locations (TM)
Hebrand, Viktor: RFID goes bananas - Change Management for Implementing RFID (TM)
Henriksson, Mikael: Hedging Portfolio Tail Risk (TM)
Johnsson, Andreas: Producing on Real Demand - In a High Efficient Industry (TM)
Johnsson, Ola: Probing Control in B. licheniformis Fermentations; Master's Thesis ISRN LUTFD2/TFRT--5853--SE, Department of Automatic Control, Lund University, Sweden, May 2010
Kralmark, Mikael: Resource Management for Mobile Robots; Master's Thesis ISRN LUTFD2/TFRT--5876--SE, Department of Automatic Control, Lund University, Sweden, August 2010
Nilsson, Henrik and Björn Olofsson: Optimal Tracking and Identification of Paths for Industrial Robots; Master's Thesis ISRN LUTFD2/TFRT--5858--SE, Department of Automatic Control, Lund University, Sweden, June 2010
Nilsson, Linnea: The Social Brand - Aspects of Social Media Implementation (TM)
Nilsson, Sofie: Real-Time Trajectory Generation and Control of a Semi-Omnidirectional Mobile Robot; Master's Thesis ISRN LUTFD2/TFRT--5854--SE, Department of Automatic Control, Lund University, Sweden, May 2010
Parrotto, Roberto: An XML Representation of DAE Systems Obtained from Continuous-Time Modelica Models; Master's Thesis ISRN LUTFD2/TFRT--5865--SE, Department of Automatic Control, Lund University, Sweden, November 2010
Persson, Erik: Robotic Gas Source Localization in an Industrial Environment; Master's Thesis ISRN LUTFD2/TFRT--5872--SE, Department of Automatic Control, Lund University, Sweden, October 2010

Persson, Jenny: Prissättning av tjänster i byggkonsultbranschen - införandet av alternativa prissättningsmodeller (TM)

Rudberg, Arvid: Optimization Based Control Strategy for Energy Efficient Decelerations in an Automobile Cruise Controller; Master's Thesis ISRN LUTFD2/TFRT--5861--SE, Department of Automatic Control, Lund University, Sweden, August 2010

Shawwaf, Adham: Optimization of the Electric Properties of Thermoelectric Generators; Master's Thesis ISRN LUTFD2/TFRT--5873--SE, Department of Automatic Control, Lund University, Sweden, December 2010

Sigot, Adrian: Using Conjunctural Indices in Prediction Models for Gas Sales—A Case Study; Master's Thesis ISRN LUTFD2/TFRT--5862--SE, Department of Automatic Control, Lund University, Sweden, September 2010

Singer, Mira: Estimating Market Penetration of Multi-Industrial Companies on a Global Market (TM)

Sjögren, Märtha: The MaP of Opportunities - How to Create Value in the Older Machine Segment (TM)

Sjölund, Fredrik: Brukarinvolverad innovationsprocess inom fuzzy front end (TM)

Skjutar, Kristin: Value for Money Assessment in Public Private Partnership Projects (TM)

Stenquist, Björn: Larmhantering i processindustrin; Master's Thesis ISRN LUTFD2/TFRT--5855--SE, Department of Automatic Control, Lund University, Sweden, June 2010

Torstensson, Patrik: Supply Services to Arctic Offshore Operations; Macro-environment, Market Demand and Business Potentials - The Case of Maersk Supply Service (TM)

Waldemarsson, Ola: Agility Enhancement and Tyre Estimation for Autmotive Vehicles; Master's Thesis ISRN LUTFD2/TFRT--5852--SE, Department of Automatic Control, Lund University, Sweden, March 2010

Technical Report

Bernhardsson, Bo: Control Inside Mobile Phones; Technical Report IEEE Control Systems Society, November 2010. Overview, Success Stories, and Research Challenges, The Impact of Control Technology

Westin, Eva and Rolf Johansson: Automatic Control Activity Report 2009; Technical Report 4037, Department of Automatic Control, Lund University, Sweden, May 2010

Proceedings

Hägglund, Tore: 16th Nordic Process Control Workshop - Preprints; August 2010

Seminars at the department

January 19: Efficient Distributed Optimization of Team Detection Networks
Patrick Kreidl, Massachusetts Institute of Technology

January 22: Decision Independent Information Content
Ather Gattami, KTH, Stockholm

January 27: The fluctuation-dissipation theorem - A control-theoretic perspective

Henrik Sandberg, KTH, Stockholm
January 27: Event-triggered sampling for state estimation: effect of losing samples
Maben Rabi, University of Cambridge
February 2: Design of optimal structured feedback gains for interconnected systems with application to large-scale vehicular formations
Mihailo Jovanovic, University of Minnesota
February 9: Synchronization and collective motion in natural and engineered networked systems
Luca Scardovi, Technische Universität München
February 9: Coordination on nonlinear spaces
Alain Sarlette, University of Liège, Belgium
February 12: Convergence Rates of Consensus Algorithms in Stochastic Networks
Stacy Patterson, University of California at Santa Barbara
February 26: Cooperative Differential Games
Puduru Viswanadha Reddy, Tilburg University
February 26: The Flexines project: Distributed Control for a network of households that are also producers of energy
Gunn K. H. Larsen, University of Groningen
March 2: Multi-Agent Reinforcement Learning Algorithms
Natalia Akchurina, University of Paderborn
March 2: Broadcast gossip averaging algorithms: interference and asymptotical error
Paulo Frasca, Politecnico di Torino
March 4: Team theory and person-by-person optimization with binary decisions
Dario Bauso, University of Palermo
March 4: Computing Pure Nash and Strong Equilibria in Bottleneck Congestion Games
Alexander Skopalik, Aachen University
March 5: Electric Load Prediction and Distributed Predictive Control of Micro Grid
Toru Namerikawa, Keio University
March 9: Aspiration Learning in Coordination Games and Network Formation
Georgios C. Chasparis, Georgia Inst. of Technology
March 9: Completely Uncoupled Dynamics and Nash equilibria
Yakov Babichenko, Hebrew University of Jerusalem
March 16: Modeling interbank liquidity markets using loss networks
Johan Ugander, Cornell University
Tuesday 16: Competition and Collaboration in Repeated Zero-Sum Games
Archie Chapman, University of Southamton
March 18: A Three-Tier Architecture for Autonomous Networked Systems
John S. Baras, University of Maryland
March 19: Distributed Consensus in Multi-vehicle Cooperative Control: Theory and Applications
Wei Ren, Utah State University, Logan, UT
March 19: CEO Ownership and Stock Market Performance
Ulf von Lilienfeld-Toal, Stockholm School of Economics
April 9: Distributed averaging on digital noisy networks
Paolo Frasca, Politecnico di Torino
April 9: Learning Through Experience - Improving Performance by Repetition

Angela Schoellig, Institute of Dynamic Systems and Control, ETH Zurich
April 29: Bundle Methods for Regularized Risk Minimization
S V N Vishwanathan, Purdue University
May 5: Model Predictive Control: From Minutes to Microseconds
Colin Jones, ETH Zurich
May 5: Challenges in modeling and control of interacting dynamic systems
João Tasso de Figueiredo Borges de Sousa, Porto University
May 11: Stability analysis of unconstrained MPC and its applicability to networked control systems
Karl Worthmann, University of Bayreuth
May 11: Decomposition methods for separable convex problems
Ion Necoara, University Politehnica Bucharest
May 18: Set-theoretic methods for multi-sensor control schemes. Switching, fault tolerance and optimisation based design
Sorin Olaru, Supelec
May 18: Distributed moving horizon estimation for linear and nonlinear constrained systems
Marcello Farina, Politecnico di Milano
May 25: Controller design for networks of switching servers with setup times
Erjen Lefeber, Eindhoven University of Technology
May 25: Distributed nonlinear MPC with applications in hydroelectricity production
Carlo Savorgnan, Katholieke Universiteit Leuven
May 27: Stability and robustness of logistics networks
Mikael Schönlein, University of Würzburg
May 27: Multi-Level Model Predictive Control of Large-Scale Networks: An Outlook
Noortje Groot, Delft University of Technology
June 2: The dynamics of confusion and consensus in cooperative multi-agent systems
Roy Smith, ECE Dept., University of California, Santa Barbara
August 26: Optimal Power Flow Problems
Stephen Low, Caltech
August 31: Distributed decision in networks with limited information
Giacomo Como, MIT
October 7: Understanding the Hardness of Proving Formulas in Propositional Logic
Jakob Nordström, KTH, Stockholm
October 8: Network Control Systems using Scheduling Strategies
Hector Benitez-Perez, UNAM, Mexico
October 8: Master's Thesis Presentation
Gas Leakage Detection and Localization in Oil and Gas Facilities
Erik Persson
October 15: Practical Adaptive Control: Foundations, Validation & Verification
Anuradha Annaswamy, Active-Adaptive Control Laboratory, MIT
October 26: Efficient model-based nonlinear optimization for large scale chemical processes
Yu Zhu, Texas A&M University
October 26: Master's Thesis Presentation
Added wake turbulence and optimal power distribution in large offshore

wind farms
Thomas Clevenhult and Fredrik Himmelman
October 29: Principles for Planning and Analyzing Motions of Mechanical Systems
Uwe Mettin, NTNU, Trondheim
October 29: Real-Time Sensor Servoing using Line-of-Sight Path Generation and Tool Orientation Control
Johannes Schrimpf, NTNU, Trondheim
November 23: Presentation of TU Kaiserslautern/SmartFactory/DFKI
Tobias Gerber, Technische Universität Kaiserslautern
Lisa Ollinger, Technische Universität Kaiserslautern
November 26: Master's Thesis Presentation
Grating Motor Control Algorithm
Henrik Björk
December 15: CasADi — an open-source tool for rapid development of state-of-the-art dynamic optimization algorithms
Joel Andersson, K.U.Leuven
December 23: Master's Thesis Presentation
Optimization of the electric properties of thermoelectric generators
Adham Shawwaf

Lectures by the Staff Outside the Department

Karl-Erik Årzén: Adaptive Resource Management in ACTORS, First International Workshop on Adaptive Resource Management WARM 2010, CPSWEEK, KTH, April 12
Embedded Systems: Characteristics and Challenges, ELLIIT Workshop, Linköping, November 11
Karl Johan Åström: The Future of Control ABB Research Västerås and ABB Video Conferencing, January 21
Bursting Phenomena in Adaptive Control 4th LCCC Workshop: Adaptation and Learning in Autonomous System, Lund, April 21
Axplock från tidig svensk reglerteknik. Reglermöte 2010, June 8
Relay Systems IFAC Workshop 50 Years of Nonlinear Control and Optimization. Royal Sociecy London, Sept 30
Anton Cervin: TrueTime: Simulation of Networked and Embedded Control Systems. Lectures within PhD course on Advanced Topics in Embedded Systems at the Department of Informatics and Mathematical Modelling, Technical University of Denmark, June 16-17.
Tore Hägglund: Automatic supervision of control loops,, University of Almeria, Almeria, Spain, March 25; Process Control inPractice,, Industrial course, Luleå, Sweden, March 17-18.
Anders Rantzer: Dual Decomposition for Distributed Control, Instituto Superior Tecnico (IST), Lissabon, Portugal, Jan 8, 2010;
Dual Decomposition for Distributed Control, Darmstadt, Germany, Jan 13, 2010;
Distributed Verification of Sparse Systems, Caltech, USA, June 24, 2010;
Dual Decomposition for Distributed Control, UC Berkeley, USA, June 28, 2010;
Distributed Model Predictive Control using Price Mechanisms, Control Systems 2010 hosted by the SPCI (The Swedish Association of Pulp and Paper Engineers) and Innventia,

Stockholm, Sep 16, 2010;
Decomposition for Distributed Control, Seville University, Spain, Nov 25, 2010;
Controlling Dynamic Power Flow, Pre-conference workshop on Smart Grids, Atlanta, USA, Dec 14, 2010;
Björn Wittenmark: November 5, 2010: On a windy road with adaptive control, Department of Electrical Engineering and Computer Science, University of Newcastle, Newcastle, Australia;
November 9, 2010: On a windy road with adaptive control, Department of Electrical and Electronic Engineering, University of Melbourne, Melbourne, Australia