Activity Report: Automatic Control 2013

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2014

Document Version:
Publisher's PDF, also known as Version of record

Activity Report 2013

DEPARTMENT OF AUTOMATIC CONTROL | LUND UNIVERSITY

Activity Report 2013

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Printed: Media-Tryck, Lund, Sweden, May 2014

ISSN 0280-5316
ISRN LUTFD2/TFRT--4041--SE

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Introduction

This report describes the main activities at the Department of Automatic Control at Lund University during the period January 1 to December 31, 2013









AUTOMATIC CONTROL 2013

The department is stable in size. The turnover for 2013 (2012) was 54,8 MSEK (53,9 MSEK) and we are 59 (59) persons working at the department (guests not included). More about the financial figures is found in the chapter *Economy*.

Today (year 2013) the department has 6 full time professors, 3 senior professors, 3 associate professors, one assistant professor, 6 research engineers, 4 administrators, 6 post-docs and 31 PhD students including one industrial PhD student. Some of these numbers include part-time positions. During the year 4 new PhD students were admitted to the department. Moreover, Giacomo Como was appointed associate professor. Both Charlotta Johnsson and Pontus Giselsson are now spending a year for research at UC Berkeley and Stanford University, respectively. Rolf Braun retired in December after having served the department for more than 40 years. More about this in the chapter *Staff*.

Four PhD theses by Kristian Soltész, Anna Lindholm, Magnus Linderoth and Marzia Cescon, were completed during 2013. The total number of PhD graduating from the department is now up to 99. There were also 7 licentiate theses presented by Meike Stemmann, Björn Olofsson, Olof Sörnmo, Anders Mannesson, Alfred Theorin, Anders Pettersson and Ola Johnsson.

During 2013 we gave 18 courses to 1 210 students at LTH and 50 students presented their master's theses at the department. We also arranged 7 PhD courses. More about this in the chapter *Education*.

We have been able to get new offices and a workshop for our research engineers close to the Robotics Lab. The old workshop has been transformed into an office for 4 PhD students. On the second floor in the main building, the seminar room has been restored after serving as office for PhD students for some time. Moreover, our library has been merged with the new seminar room.

Anders Robertsson took part of a delegation from Lund University invited to Taiwan to enhance cooperation and exchange in research and industry. He was participating in the delegation with the vice chancellor of Lund University, visiting the minister of Education, Taiwan, and several major universities and research institutes.

This year, EU robotics week took place at the end of November. More than 800 visitors, from pupils at primary schools to university students, faculty staff and other visitors attended presentations and guided tours in the Robotics Lab. During our 27 one-hour lab tours Monday to Friday dedicated for schools we reached 35 school classes in the age span of 10 to 20 years. During our 4 open sessions we had about 70 visiting adults and children.

Anders Rantzer and Monika Rasmusson

Education 2013

Education on basic level, PhD studies, and Licentiate and Doctoral dissertations

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 thaught as part of the engineering curriculum in Engineering Physics (F), Medicine and Technical Engineering (BME), Electrical Engineering (E), Computer Engineering (D), Mechanical Engineering (M), Information and Communication Engineering (C), Environmental Engineering (W), Engineering Mathematics (P), Industrial Management and Engineering (I), Biotechnology (B), Engineering Nanoscience (N) and Chemical Engineering (K).

During 2013 the department has been involved in courses given together with Lund University School of Economics and Management. Within this interdisciplinary cooperation called Technology Management, 18 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, in total 1 210 students passed our courses and 50 students completed their master's thesis projects. A list of the master's theses is given in the *Appendix "Master's Theses"*. The number of registered students correspond to 177 full year equivalents during the year. The numbers for 2012 were 980, 47 and 149 respectively.

In the table on the next page, our courses are listed along with the number of students who passed each course. Each course in the engineering program has its own web page, documentation, manuals, old exams, etc. We have also information sheets about the engineering courses, the master's thesis and the doctorate program. You will find the links at www.control.lth.se/education.

TOTAL NUMBER OF STUDENTS WHO PASSED OUR COURSES 2013

Reglerteknik AK FRT010
(Automatic Control, Basic Course) 605

Realtidssystem FRTN01
(Real-Time Systems) 87

Prediktiv reglering FRTN15
(Predictive Control) 51

Processreglering FRTN25
(Process Control) 35

Reglerteori FRT130
(Control Theory) 40

Flervariabel reglering FRTN10
(Multivariable Control) 95

Systemidentifiering FRT041
(System Identification) 17

Systemteknik FRT110
(Systems Engineering) 57

Olinjär reglering och servosystem FRTN05
(Nonlinear Control and Servo Systems) 44

Projekt i reglerteknik FRT090
(Projects in Automatic Control) 31

Internationell projektkurs i Reglerteknik FRT100
(International Project Course in Automatic Control) 3

Matematisk modellering, FRT095
(Mathematical Modeling, Advanced Course) 40

Marknadsstyrda system FRTN20
(Market Driven Systems) 26

Fysiologiska modeller och beräkningar FRTF01
(Psysiological Models and Computations) 38

Examensarbete FRT820
(Master's Thesis Project) 32

Examensarbete för teknologie kandidatexamen FRTL01
(Degree Project for a Bachelor of Science in Automatic Control) 1

Examensarbete TMA820
(Master's Thesis Project within Technology Management) 18

TMA-kurser (Technology Management Courses)
(TMA035, TMA037, TMA010) 40

PHD STUDIES

The PhD education consists of four years of studies. 120 hp of courses and 120 hp of thesis work. Since most students have 20% of department duties, the nominal time for the PhD education is 5 years. In the Swedish system there is also a possibility to do a half-time degree called a "licentiate".

Seven licentiate theses were presented during 2013, by Meike Stemmann, Björn Olofsson, Olof Sörnmo, Anders Mannesson, Alfred Theorin, Anders Petersson and Ola Johnsson.

Four doctoral theses were also defended during the year by Kristian Soltész, Anna Lindholm, Magnus Linderoth and Marzia Cescon.

We have admitted Gabriel Ingesson, Anton Jacobsson, Carolina Lidström and Gustav Nilsson as PhD students during 2013.

The following PhD Courses were given in 2013

- Advanced Computer-Controlled Systems, Björn Wittenmark
- Network Dynamics, Giacomo Como
- Functional Analysis in Systems Theory, Andrey Ghulchak
- Convex Optimization, Bo Bernhardsson
- Advanced PID control, Tore Hägglund and Karl Johan Åström
- Distributed Control, Anders Rantzer and Enrico Lovisari
- Linear Systems, Bo Bernhardsson

The student orchestra "Bleckhornen" honoring their former member Anna Lindholm after her doctoral defence in October 2013.

LICENTIATE DISSERTATIONS

The licentiate theses, of which the abstracts are presented below, are available in their entirety at www.control.lth.se/publications

EXTREMUM-SEEKING CONTROL OF INDUSTRIAL-SCALE FERMENTATION PROCESSES

Johnsson, Ola

The work presented here is based on two papers, both pertaining to perturbation-based control strategies in industrial fed-batch fermentation processes.

The first paper describes a new control strategy for avoiding overflow metabolism in the exponential growth phase of a fermentation, based on analysis of the frequency spectrum of the dissolved oxygen measurement following a periodic perturbation in the feed rate. A controller based on this strategy was tested in pilot scale, where it gave higher specific growth rates and lower concentrations of overflow metabolites during the exponential growth phase of the process compared to a reference strategy currently used to control the process, resulting in approximately 30 % higher biomass concentrations (w/w) 8 h after inoculation in two different processes utilizing different strains. Adding excess substrate at different points in time showed that the controller can detect and respond to excess substrate. In a set-up with inoculum volume decreased to 1/3 of its normal value, the controller compensated for the decreased feed demand whereas the reference strategy caused excessive accumulation of overflow metabolites leading to process failure.

The second paper is based on an experimental study in an industrial production-scale (> 100 m3) process, in which sinusoidal perturbations in the feed rate were applied to evaluate the applicability of perturbation-based control strategies and to model the process for the purpose of such strategies. The results indicated that perturbations in the feed rate of the process can give rise to measurable responses in dissolved oxygen measurements without decreasing process productivity and that a second-order model can be used to describe feed and oxygen dynamics in the process. The perturbation frequency range 3.33-5 mHz was identified as suitable for utilization of the model for perturbation-based control and a simple example of an observer is given to illustrate how the model can be used in on-line control.

JOINT POSE AND RADIO CHANNEL ESTIMATION

Mannesson, Anders

This thesis investigates the combination of pose and radio channel estimation. Pose is the knowledge of the position and orientation of a device whereas the radio channel describes the transmission medium between radio transmitters and receivers. The two subjects are both active research topics with a long history of applications but there has to the author's knowledge been very little work published about combining the two areas using a sensor fusion framework.

A well established approach for pose estimation is using an inertial measurement unit (IMU). Using an inexpensive IMU standalone for dead reckoning pose estimation is tempting but it is not a working solution due to noise and other imperfections in the IMU. There is also a fundamental limitation of inertial sensors, they can not, because of Galileo's principle, obtain any information about absolute velocity of the device. To obtain reliable pose estimates for a longer time, the measurements from the IMU must be fused with some other sensor information. This thesis shows how the pervasive electric magnetic fields from existing radio communication systems such as the cellular mobile systems GSM, 3G, or 4G can be used.

Angle of arrival estimation using antenna arrays is a well studied problem with many different algorithms resolving the individual rays impinging on the array. However, less attention has been given to so called virtual array antennas where only one receiver element is used. By tracking the movement of the element, an array with properties similar to a stationary array with multiple elements is formed. By combining the IMU and the radio channel information, a map of the local radio environment can be obtained. At the same time, the map is used for adjusting for the errors in the IMU that lead to inaccurate pose estimates by using tightly coupled nonlinear state estimation algorithms from the sensor fusion framework.

The goals for this thesis is to develop a dynamic model for kinematics and a ray-trace based radio channel model that can be used together with the particle filter for sensor fusion. It also contains an initial investigation of limitations and achievable performance for the joint pose and radio channel estimation problem, including radio imperfection such as thermal noise, and phase/frequency error. The proposed model is evaluated using both simulations and datasets from experiments. The analysis of the evaluation shows that the proposed model, together with sensor fusion algorithms, provides a breakthrough in pose estimation using a low cost IMU.

TOPICS IN MACHINING WITH INDUSTRIAL ROBOTS AND OPTIMAL CONTROL OF VEHICLES

Olofsson, Björn

Two main topics are considered in this thesis: Machining with industrial robots and optimal control of road-vehicles in critical maneuvers. The motivation for research on the first subject is the need for flexible and accurate production processes employing industrial robots as their main component. The challenge to overcome here is to achieve high-accuracy machining solutions, in spite of strong process forces affecting the robot end-effector. Because of the process forces, the nonlinear dynamics of the manipulator, such as the joint compliance and backlash, significantly degrade the achieved position accuracy of the machined part. In this thesis, a macro/micro manipulator configuration is considered to the purpose of increasing the position accuracy. In particular, a model-based control architecture is developed for control of the micro manipulator. The macro/micro manipulator configuration are validated by experimental results from milling tests in aluminium. The main result is that the proposed actuator configuration, combined with the control architecture proposed in this thesis, can be used for increasing the accuracy of industrial machining processes with robots.

The interest for research on optimal control of road-vehicles in timecritical maneuvers is mainly driven by the desire to devise improved vehicle safety systems. Primarily, the solution of an optimal control problem for a specific cost function and model configuration can provide indication of performance limits as well as inspiration for control strategies in time-critical maneuvering situations. In this thesis, a methodology for solving this kind of problems is discussed. More specifically, vehicle and tire modeling and the optimization formulation required to get useful solutions to these problems are investigated. Simulation results are presented for different vehicle models, under varying road-surface conditions, in aggressive maneuvers, where in particular the tires are performing at their limits. The obtained results are evaluated and compared. The main conclusion here is that even simplified road-vehicle models are able to replicate behavior observed when experienced drivers are handling vehicles in time-critical maneuvers. Hence, it is plausible that the results presented in this thesis provide a basis for development of future optimization-based driver assistance technologies.

AUGMENTING L1 ADAPTIVE CONTROL OF PIECEWISE CONSTANT TYPE TO AERIAL VEHICLES

Pettersson, Anders

In aerial vehicle control design, the industrial baseline is to use robust control methods together with gain-scheduling to cover the full airspeed and altitude flight envelope. An adaptive controller could possibly add value by increasing performance while keeping robustness to deviation from nominal assumptions. In this thesis L1 adaptive control is studied and evaluated as it is applied to a pitch-unstable fighter aircraft. The recently developed L1 adaptive control method originates from aerospace adaptive control problems and achieves fast adaptation while robust stability to bounded plant parameter changes is claimed. Even though large adaptation gains create large and rapidly varying internal signals, the L1 adaptive controller output is limited in amplitude and frequency, since a low-pass filter directly at the output, is used to make the controller act within the control channel bandwidth. An L1 adaptive controller of piecewise constant type has been applied to a fighter aircraft by augmenting a baseline linear state feedback controller. Once some experience is gained, it is relatively straightforward to apply this design procedure because only a few controller parameters need tuning. To design an L1-controller for roll-pitch-yaw-motion of an aerial vehicle, a five-state reference system with desired dynamics was created and five bandwidths of low-pass filters were tuned. The L1-controller activates when the vehicle aided by the state feedback controller deviates from the reference dynamics resulting in better reference following. Load disturbance rejection was improved by the L1-controller augmentation. This comes at the cost of having high frequency control signals fed into the plant. The L1 adaptive controller is in its original design sensitive to actuator limitations and to time delays when compared to the baseline controller. Introducing nonlinear design elements corresponding to actuator dynamics (e.g. rate limits) makes tuning easier if such dynamics interfere with the reference system dynamics. Sensitivity to known time delays can be reduced using prediction in a state observer. With these additions to the design, the L1-controller augmentation can be tuned to achieve improved nominal performance and robust performance when compared to a typical aeronautical linear state feedback controller. This was verified by simulations using a high fidelity model of the aircraft. Use of feedforward can alleviate feedback and adaptive actions. Feedforward signals can be generated from reference models and corresponding models can also be used as reference models in adaptive control. A method for aerial vehicle reference model design was developed, that makes

it possible to find reference models that scale to the present flight condition and vehicle configuration. In some situations the closed-loop system obtained by L1 adaptive control is equivalent to linear systems. The architectures of these systems were investigated. An effort was made to understand and describe what fundamental characteristic of L1 adaptive controllers make them suitable for aeronautical applications. With the L1-controller, performance and robustness was increased when compared to the baseline controller. It is possible to add L1-controller characteristics gradually to a linear state feedback design, which is something that this thesis recommends to aerospace industry.

CONTROL STRATEGIES FOR MACHINING WITH INDUSTRIAL ROBOTS

Sörnmo, Olof

This thesis presents methods for improving machining with industrial robots using control, with focus on increasing positioning accuracy and controlling feed rate.

The strong process forces arising during high-speed machining operations, combined with the limited stiffness of industrial robots, have hampered the usage of industrial robots in high-end machining tasks. However, since such manipulators may offer flexible and cost-effective machining solutions compared to conventional machine tools, it is of interest to increase the achievable accuracy using industrial robots. In this thesis, several different methods to increase the machining accuracy are presented. Modeling and control of a piezo-actuated high-dynamic compensation mechanism for usage together with an industrial robot during a machining operation, such as milling in aluminium, is considered. Position control results from experiments are provided, as well as an experimental verification of the benefit of utilizing the online compensation scheme. It is shown that the milling surface accuracy achieved with the proposed compensation mechanism is increased by up to three times compared to the uncompensated case. Because of the limited workspace and the higher bandwidth of the compensator compared to the robot, a mid-ranging approach for control of the relative position between the robot and the compensator is proposed. An adaptive, model-based solution is presented, which is verified through simulations as well as experiments, where a close correspondence with the simulations was achieved. Comparing the IAE from experiments using the proposed controller to previously established methods, a performance increase of up to 56 % is obtained.

Additionally, two different approaches to increasing the ac-

curacy of the machining task are also presented in this thesis. The first method is based on identifying a stiffness model of the robot, and using online force measurements in order to modify the position of the robot to compensate for position deflections. The second approach uses online measurements from an optical tracking system to suppress position deviations. In milling experiments performed in aluminum, the absolute accuracy was increased by up to a factor of approximately 6 and 9, for the two approaches, respectively.

Robotic machining is often performed using position feedback with a conservative feed rate, to avoid excessive process forces. By controlling the applied force, realized by adjusting the feed rate of the workpiece, precise control over the material removal can be exercised. This will in turn lead to maximization of the time-efficiency of the machining task, since the maximum amount of material can be removed per time unit. This thesis presents an adaptive force controller, based on a derived model of the machining process and an identified model of the Cartesian dynamics of the robot. The controller is evaluated in both simulation and an experimental setup.

PREDICTIVE CONTROL OF DIABETIC GLYCEMIA
Stemmann, Meike

Diabetes Mellitus is a chronic disease, where the blood glucose concentration of the patient is elevated. This is either because of missing insulin production due to failure of the beta-cells in the pancreas (Type 1) or because of reduced sensitivity of the cells in the body to insulin (Type 2). The therapy for Type 1 diabetic patients usually consists of insulin injections to substitute for the missing insulin. The decision about the amount of insulin to be taken has to be made by the patient, based on empirically developed rules of thumb. To help the patient with this task, advanced mathematical algorithms were used in this thesis to determine intakes of insulin and counteracting glucose that can bring the blood glucose concentration back to normoglycemia. The focus in this work was to determine insulin and glucose intakes around mealtimes. These algorithms used optimization methods together with predictions of the blood glucose concentration and mathematical models describing the patient dynamics to determine the insulin and glucose doses. For evaluation, the control algorithms were tested insilico using a virtual patient and are compared to a simple bolus calculator from the literature. The aim was to increase the time spent in the safe range of blood glucose values of 70 – 180 mg/dL.

ADAPTING GRAFCHART FOR INDUSTRIAL AUTOMATION

Theorin, Alfred

Current trends in industrial automation are the need for customizable production, vertical integration, more advanced sensors and actuators, and shorter time to market. The currently used control systems and languages for control were developed with a more static production in mind. More flexible languages and tools are needed to get a more flexible production. The flexible graphical programming language Grafchart, based on the IEC 61131-3 standard language Sequential Function Charts (SFC), is considered with the focus to make it usable in an industrial context.

Modern compiler techniques are evaluated for JGrafchart, a Grafchart implementation, with focus on extensible automation language implementations. In particular implementing the High Level Version (HLV) of Grafchart as an extension would make JGrafchart more dynamic and enable further research on HLV.

To make Grafchart possible to use at the lowest levels of automation, realtime execution with JGrafchart is considered. For this to be possible the execution engine must be separated from the editor. In the first step the execution engine is still an interpreter, but an order of magnitude faster than before.

Finally Service Oriented Architecture (SOA), a highly flexible software design methodology widely used for business processes, is brought to automation by integrating support for Devices Profile for Web Services (DPWS) in JGrafchart.

DOCTORAL DISSERTATIONS

The Doctoral theses, of which the abstracts are presented below, are available in the entirety at www.control.lth.se/publications

MODELING AND PREDICTION IN DIABETES PHYSIOLOGY
Cescon, Marzia

Diabetes is a group of metabolic diseases characterized by the inability of the organism to autonomously regulate the blood glucose levels. It requires continuing medical care to prevent acute complications and to reduce the risk of long-term complications. Inadequate glucose control is associated with damage, dysfunction and failure of various organs. The management of the disease is non trivial and demanding. With today's standards of current diabetes care, good glucose regulation needs constant attention and decision-making by the individuals with diabetes. Empowering the patients with a decision support system would, therefore, improve their quality of life without additional burdens nor replacing human expertise. This thesis investigates the use of data-driven techniques to the purpose of glucose metabolism modeling and short-term blood-glucose predictions in Type I Diabetes Mellitus (T1DM). The goal was to use models and predictors in an advisory tool able to produce personalized short-term blood glucose predictions and on-the-spot decision making concerning the most adequate choice of insulin delivery, meal intake and exercise, to help diabetic subjects maintaining glycemia as close to normal as possible. The approaches taken to describe the glucose metabolism were discrete-time and continuous-time models on input-output form and statespace form, while the blood glucose short-term predictors, i.e., up to 120 minutes ahead, used ARX-, ARMAX- and subspace-based prediction.

ON ROBOTIC WORK-SPACE SENSING AND CONTROL
Linderoth, Magnus

Industrial robots are fast and accurate when working with known objects at precise locations in well-structured manufacturing environments, as done in the classical automation setting. In one sense, limited use of sensors leaves robots blind and numb, unaware of what is happening in their surroundings. Whereas equipping a system with sensors has the potential to add new functionality and increase the set of uncertainties a robot can handle, it is not as simple as that. Often it is difficult to interpret the measurements and use them to draw necessary conclusions

about the state of the work space. For effective sensor-based control, it is necessary to both understand the sensor data and to know how to act on it, giving the robot perception-action capabilities.

This thesis presents research on how sensors and estimation techniques can be used in robot control. The suggested methods are theoretically analyzed and evaluated with a large focus on experimental verification in real-time settings.

One application class treated is the ability to react fast and accurately to events detected by vision, which is demonstrated by the realization of a ball-catching robot. A new approach is proposed for performing high-speed color-based image analysis that is robust to varying illumination conditions and motion blur. Furthermore, a method for object tracking is presented along with a novel way of Kalman-filter initialization that can handle initial-state estimates with infinite variance.

A second application class treated is robotic assembly using force control. A study of two assembly scenarios is presented, investigating the possibility of using force-controlled assembly in industrial robotics. Two new approaches for robotic contact-force estimation without any force sensor are presented and validated in assembly operations.

The treated topics represent some of the challenges in sensor-based robot control, and it is demonstrated how they can be used to extend the functionality of industrial robots.

HIERARCHICAL SCHEDULING AND UTILITY DISTURBANCE MANAGEMENT IN THE PROCESS INDUSTRY

Lindholm, Anna

This thesis deals with control of production at large-scale process industrial sites in the presence of disturbances. The main focus is on disturbances in the supply of utilities such as steam, cooling water and electricity. A general method for reducing the revenue loss due to disturbances in utilities is introduced, which may provide both proactive and reactive disturbance management strategies. Utility availability and area availability are introduced as performance indicators. These measures are used to obtain quick estimations of the revenue losses related to each utility. To obtain reactive strategies for utility disturbance management, a simple model of how utilities affect production in an area, and how utilities are shared between areas, is introduced. The modeling approach is utilized to formulate the production control problem at disturbances in utilities as an optimization problem. Measurement data are used to obtain empirical models of utility

disturbances at an industrial site, which may be used as input to the optimization. Since production control closely relates to production scheduling, the integration of production scheduling based on orders and forecasts with production control at disturbances in utilities is studied in the final part of the thesis.

ON AUTOMATION IN ANESTHESIA
Soltesz, Kristian

The thesis discusses closed-loop control of the hypnotic and the analgesic components of anesthesia. The objective of the work has been to develop a system which independently controls the intravenous infusion rates of the hypnotic drug propofol and analgesic drug remifentanil. The system is designed to track a reference hypnotic depth level, while maintaining adequate analgesia. This is complicated by inter-patient variability in drug sensitivity, disturbances caused foremost by surgical stimulation, and measurement noise. A commercially available monitor is used to measure the hypnotic depth of the patient, while a simple soft sensor estimates the analgesic depth. Both induction and maintenance of anesthesia are closed-loop controlled, using a PID controller for propofol and a P controller for remifentanil. In order to tune the controllers, patient models have been identified from clinical data, with body mass as only biometric parameter. Care has been taken to characterize identifiability and produce models which are safe for the intended application. A scheme for individualizing the controller tuning upon completion of the induction phase of anesthesia is proposed. Practical aspects such as integrator anti-windup and loss of the measurement signal are explicitly addressed. The validity of the performance measures, most commonly reported in closed-loop anesthesia studies, is debated and a new set of measures is proposed. It is shown, both in simulation and clinically, that PID control provides a viable approach. Both results from simulations and clinical trials are presented. These results suggest that closed-loop controlled anesthesia can be provided in a safe and efficient manner, relieving the regulatory and server controller role of the anesthesiologist. However, outlier patient dynamics, unmeasurable disturbances and scenarios which are not considered in the controller synthesis, urge the presence of an anesthesiologist. Closed-loop controlled anesthesia should therefore not be viewed as a replacement of human expertise, but rather as a tool, similar to the cruise controller of a car.

Research 2013

This chapter contains the different projects that were ongoing during 2013

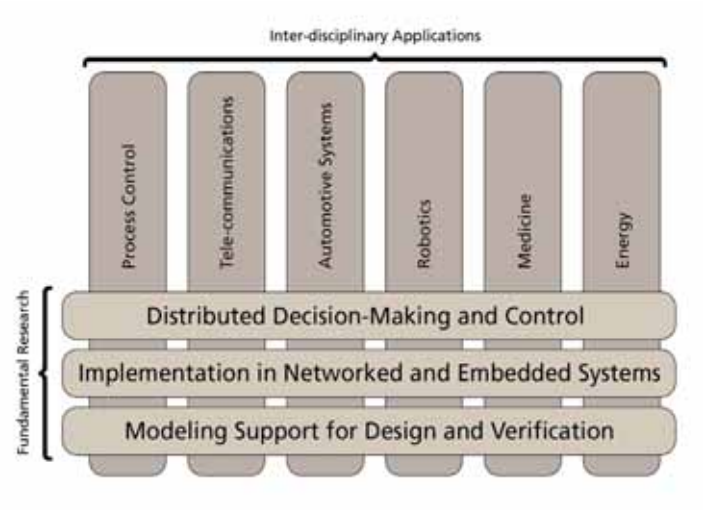
EXCELLENCE CENTERS

LCCC - LUND CENTER FOR CONTROL OF COMPLEX ENGINEERING SYSTEMS

LCCC is developing theory, methods and tools for control of complex engineering systems. Computer control is present in most, if not all, technical applications today, e.g., cars, robots, medical devices, industrial production, consumer electronics, computers, communication devices, traffic and transportation systems, etc. Sometimes this is called "cyber-physical systems". The research of LCCC is therefore naturally motivated by a wide range of application areas, where improved information and computing technology has enabled the use of feedback control in new and innovative ways. The vision of LCCC is to maintain a world-leading center for research on control of complex engineering systems. This vision influences LCCC's research, dissemination and outreach strategy.

LCCC is mainly devoted to fundamental research. The efforts are inspired by applications, but most results are of general nature and not application-specific. In fact, one purpose of LCCC is to transfer ideas and methodology between different fields. To meet this objective, LCCC research emphasizes the interaction between theory and applications.

Three horizontal blocks illustrate the main directions of fundamental research, and six vertical blocks illustrate the application areas. Research is pursued within the vertical and horizontal blocks as well as in the intersections. The research is led by LCCC faculty members, with competence including control, computer engineering and communications. Most PhD projects emphasize fundamental research and general purpose tools, but they usually also have an application component involving industrial partners or colleagues from other disciplines.



LCCC Focus Period and Workshop on Formal Verification of Embedded Control Systems

From April 2 to May 3, 2013, LCCC hosted a focus period on Formal verification of Embedded Control Systems. The focus period included a workshop with approximately 25 distinguished speakers, held at the Old Bishop's Palace, Lund, from April 17 to April 19, 2013.

Formal verification and validation (V&V) have been subject to research in controls, computer science, and networking but often in isolation from each other. With recent convergence of controls, computation, and communication into cyber-physical systems there is a need for unified theories and algorithms. Despite advances in V&V tools in respective areas, such unification is in its infancy. Moreover, rigorous V&V for systems of current interest is a complicated task due to common difficulties including the interaction between the software and the physical world, nontraditional information flow, modeling/environmental uncertainties, and unavoidable explosion of computational complexity of the currently available tools (in both domains). For example, model-based development of control systems makes it possible to verify the correctness of designs using simulation and formal methods before the control system is implemented. However, to be able to guarantee that the specifications also in the final software or hardware implementation is substantially more difficult due to, e.g., shared computing and communications resources, timing uncertainties, and partially open deployment platforms. The workshop will focus on vertical verification covering both the control design level and the software artifact level. We believe that the success of formal methods and V&V in the intersection of controls, computer science, and networking is stringent on the development of truly hybrid methods that blend ideas from these areas and possibly others. The main purpose of the proposed LCCC workshop is to bring experts from academia, and industry together and promote exchange of ideas and establishment of interdisciplinary collaborations. A workshop with similar content was organized at Caltech by Richard Murray in 2009.

Speakers: Patricia Bouyer, LSV, CNRS; Calin Belta, Boston University; Oded Maler, Verimag; Bruce Krogh, CMU; Alessandro Abate, TU Delft; Gernot Heiser, Univ of New South Wales; Necmiye Ozay, Caltech; Marta Kwiatkowska, Oxford University; Antoine Girard, Univ Joseph Fourier; Jean-François Raskin, Univ Libré de Bruxelles; Kim G. Larsen, Aalborg University; Susanne Graf, Verimag; Paulo Tabuada, UCLA; Sanjit Seshia, University of California, Berkeley; Jyotirmoy Desmukh, Toyota US; Ufuk Topku, University of Pennsylvania; Holger Hermanns, University of Saarlands; Andre Platzer, CMU; Anders Rantzer, Lund University; Alberto Ferrari, ALES/UTC; Thomas Thelin, ABB.

Participants at LCCC Focus Period in April/May 2013

ELLIIT - THE LINKÖPING - LUND INITIATIVE ON IT AND MOBILE COMMUNICATION

Researchers: Karl-Erik Årzén, Bo Bernhardsson, Anton Cervin, Anders Rantzer, Jerker Nordh, Anders Mannesson, Anders Robertsson, Rolf Johansson, Yang Xu, Karl Berntorp, Meike Stemman, Josefin Berner, Björn Olofsson, Isolde Dressler, in collaboration with researchers at the Dept 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)
Duration: 2010 - 2014

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 ELLIIT, Director for the Lund part of ELLIIT, and area leader for the Embedded Systems area within ELLIIT. Bo Bernhardsson is an ELLIIT professor.

The Department participate in the following ELLIIT projects:

- Integrated Scheduling and Synthesis of Networked Embedded Event-Based Control Systems
- Tools and Languages for Modeling and Optimization
- Cooperative Cyber-Physical Systems
- Navigation and Perception
- Process Learning
- Optimal Maneuvers
- Large-scale Optimization for Systems Analysis
- Enabling End-User-Centered Energy Management Systems

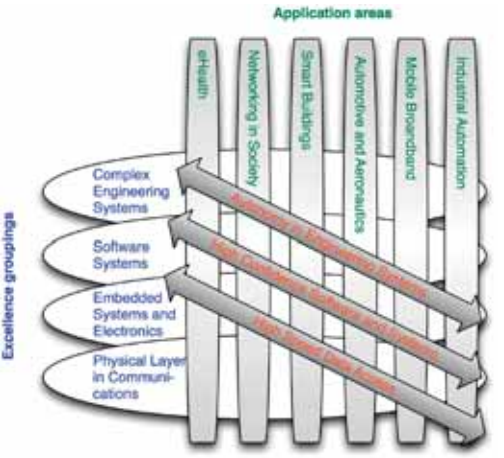


Illustration of the interaction between the themes, the application areas and the groupings (http://www.liu.se/elliit)

PIC - PROCESS INDUSTRIAL CENTER

Researchers: Olof Garpinger, Tore Hägglund, Martin Hast, Charlotta Johnsson, Ola Johnsson, Anna Lindholm, Vanessa Romero Segovia, Kristian Soltész

Funding: SSF
Duration: 2008-2013

The Process Industry Centre PIC was founded in 2008 by the Swedish process industry and the Foundation for Strategic Research (SSF). Located at Lund University and Linköping University, the aim of PIC is to provide knowledge for the process industry to ensure future success. The academic disciplines of Chemical Engineering, Automatic Control and Production Economy form the centre together with several industrial partners from the process industry. The research projects are focused on the three topics; flexibility, controllability and availability.

The research program at Lund University, PIC-LU, is organized in five integrated projects. The joint research program, PIC-opic, is organised in three projects.

- Optimal transitions, was a collaboration between the two departments and partner companies Borealis, Siemens and Modelon mainly focused on flexibility, started in 2008. During phase I the project studied grade changes at a Polyethylene process at Borealis. During phase II it has studied model calibration for dynamic models for start-up of power plants at Siemens.
- Disturbance management, was a collaboration between Automatic Control and Perstorp, and availability was the research theme. It started in 2009. During phase I the project studied utility disturbances in Perstorp site at Stenungsund. In phase II it was focused on local disturbance management in low level control systems.
- Quality by design and control, was a collaboration between Novo Nordisk, Pfizer and Chemical Engineering, started in 2008, with the main theme controllability.

This project has grown and was divided in two subprojects. Subproject A has studied design and control issues while subproject B has studied modelling and model calibration.

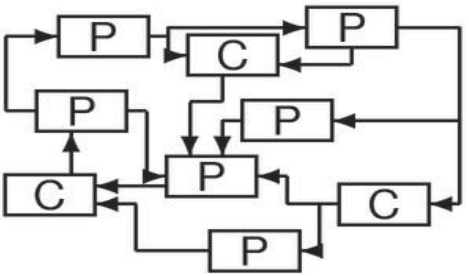
- Flexible design, was a collaboration between Chemical Engineering and K.A.Rasmussen and started in 2010, based on industrial funding. The theme was flexibility and was a research project with additional experimental resources.
- Fed-batch control, was a collaboration with Automatic Control, Chemical Engineering and Novozymes. The project started in the second half of 2010 and has controllability as research theme.
- Buffer Management and Inventories is a collaboration between Automatic control, production economics and Perstorp. The aim is to combine traditional methods used in automatic control with traditional methods used for Inventory management.
- Performance Metrics is a colloboration between Automatic Control, production economics and Perstorp. The project focuses on finding production related key performance indicators suitable for use in the process industries. The project further aims at linking them to strategic initiatives and metrics of the company. The project includes active participation in the developing activities of the international ISO 22400 standard (Key Performance Indicators for Manufacturing Operations Management).
- Economic Optimization is a collaboration between Automatic Control, production economics and Perstorp. The project aims at minimizing the economic effects of utilitiy disturbances at the plant-wide level.

MODELING AND CONTROL OF COMPLEX SYSTEMS

DISTRIBUTED DECISION-MAKING AND CONTROL

Researchers: Anders Rantzer, Bo Bernhardsson, Giacomo Como, Christian Grussler, Daria Madjidian, Leonid Mirkin, Enrico Lovisari, Gustav Nilsson, Sei Zhen Khong

Funding: VR



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. The purpose of this research area is to meet this demand.

Distributed Control using Price Mechanisms
The idea to use price mechanisms for coordination of large scale systems has a long history in economics as well as in optimization theory. Our research is exploiting similar ideas for engineering applications involving interaction between many sub-systems. In particular, we study Model Predictive Control where the optimization problem is decomposed using Lagrange multipliers. The multipliers can be viewed as prices and the optimization problem is solved iteratively through price negotiations between the subsystems. Special algorithms, called accelerated gradient methods, are exploited to speed up the iterations. Such methods are well established in the optimization literature, but using them for real-time control poses new challenges and opportunities.

Fundamental Limitations in Control Systems with Distributed Information
Theory for multivariable control has mainly 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 particular, industrial practice often relies on distributed control structures and there is a strong need for more systematic approaches to design of such structures and the corresponding information interfaces. During the past several years we have been actively contributing to an emerging theory for control with distributed information and a better understanding for the fundamental limitations imposed by the information structure.

Control of Traffic Networks and other Monotone Systems
Traffic network models are often expressed in terms of a monotone dynamical system. This means that additional traffic can never lead to reduced congestion. The monotonicity property turns out to be very useful in analysis and synthesis of large scale systems, not only in traffic networks. Our research is devoted to fundamental questions regarding performance and robustness of traffic networks, but we are also trying to see how the methods can be applied to more general monotone systems.

Low-Rank Distributed Control

We study a class of distributed control laws, comprising a diagonal (decentralized) term perturbed by a low-rank component. A control law of this form reduces the information processing by aggregating information from all systems into a single quantity, which is then made available to each of the systems. These type of controllers appear as the optimal solution to a class of resource allocation problems in multi-agent applications, including wind farms.

ACTIVE CONTROL OF COMPRESSOR SYSTEMS

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

Funding: VR

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 a 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.

DISTRIBUTED CONTROL OF LARGE-SCALE WIND FARMS

Researchers: Daria Madjidian, Maxim Kristalny, Anders Rantzer, in collaboration with project partners from Aalborg University, Technion and Vestas Wind Systems

Funding: LCCC Linnaeus center

This work was initiatied within Aeolus - a European research project funded by the European Commission under FP7. The goal is to get improved effciency and reduced maintainance costs for wind farms using real-time control and coordination of the wind turbines. Several new control paradigms have been developed, incorporating measurements from spatially distributed sensor devices. Acknowledging modelling uncertainty, the wind resource is dynamically managed in order to optimise specific control objectives.

LANGUAGE SUPPORT FOR DYNAMIC OPTIMIZATION

Researchers: Johan Åkesson, Fredrik Magnusson, Karl-Erik Årzén, Görel Hedin (Dept of Computer Science)

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

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 from 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.

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 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 web page. The project is also related research on parallel methods for dynamic optimization.

ICT PLATFORM FOR SUSTAINABLE INFRASTRUCTURES

Researchers: Anders Rantzer, Bo Bernhardsson, Georgios Chasparis, Magnus Perninge, partners at IEA and KTH

Funding: SSF

Resource-efficient infrastructures are critical for sustainable societies that want to maintain and improve today's standard of living. National and international climate goals imply large increases in renewable electricity production. This variable generation together with the increasing international trading of electricity affects the power flows in the electricity networks, which needs to be managed by system operators on local, regional and national levels. This development is in addition to the continuously increasing demand on reliable electricity supply. Traditionally this double challenge would be met by the building of new power lines. This is a simple and effective solution, but due to public reluctance to new power lines and the lengthy permission process alternatives are sought for. One general alternative is the use of automation for optimizing the use of the available network capacity. This concept - currently referred to as Smart Grids - involves investment in and installation of ICT equipment rather than physical capacity. While having been applied locally before, the situation now calls for application on a system-wide scale. Similar trends can be observed in other infrastructures.

This project aims to to design the decision-layer of an ICT platform for controlling large-scale infrastructures to operate reliably, economically, and with minimum resource waste. Special attention is given to functionality for detecting, clearing and recovering from critical operating conditions. A key component is the ARISTO real-time power system simulator, which will be used as demonstrator to illustrate the results.

NUMERICAL AND SYMBOLIC ALGORITHMS FOR DYNAMIC OPTIMIZATION

Researchers: Fredrik Magnusson, Johan Åkesson

The target of this project is the development of collocation methods for numerical solution of large-scale, DAE-constrained, non-convex dynamic optimization problems. The project targets both optimal control and parameter estimation. Applications include minimization of material and energy consumption during set-point transitions in power plants and chemical processes, minimizing lap times for vehicle systems, trajectory optimization in robotics and identifying unknown parameter values of models using measurement data.

The first step of the project has been to implement state-of-the-art algorithms based on collocation methods and integrate them with the high-level, object-oriented modelling language Modelica and its extension Optimica. This allows basic users to conveniently formulate and solve problems of moderate difficulty without worrying about the details of the solution algorithms, while still allowing Model Diagram advanced users to tailor the algorithm as needed for complex problems. This implementation is a part of the open-source JModelica.org project. One of the important benchmarks has been based on a model of a combined cycle power plant. Two important third-party tools used within the project is CasADi, for automatic differentiation, and IPOPT, for solution of non-linear programs.

Future and present activities include investigating the possibilities of improving robustness and execution times of collocation methods using symbolic algorithms to exploit model structure.

ESTIMATION AND OPTIMAL CONTROL OF COMBINED CYCLE POWER-PLANTS

Researchers: Niklas Andersson (Dept of Chemical Engineering) Johan Åkesson, Bernt Nilsson (Dept of Chemical Engineering)

In the electricity market of today, characterized by an increasing demand for electricity production on short notice, the combined cycle power plant stands high regarding fast start-ups and efficiency. In this project, modeling, parameter and state estimation, and optimal control for efficient operation, in particular fast start-ups of combined power-plants are explored.

The basis for the work is a Modelica library containing optimization-friendly components, from which plant models are constructed. Measurement data from real plants is exploited in order to select an efficient combination of parameters to calibrate, with the goal of deriving a model with a good match between model response and data.

A critically limiting factor during start-up optimization is the stress of important components, e.g., the evaporator. In order to take this aspect into account, constraints on the stress levels of such components are explored in the start-up optimization formulation.

Control and estimation problems are solved in the project using the OSS platform JModelica.org.

LISA - LINE INFORMATION SYSTEM ARCHITECTURE

Researchers: Charlotta Johnsson, Alfred Theorin, with partners from KTH, Chalmers, Siemens, Rockwell Automation, Leax, Scania and Volvo Cars

Funding: VINNOVA FFI Sustainable Production Engineering

Future sustainable competitive production systems need to be productive and flexible, as well as environmentally friendly and safe for the personnel. There are today few system solutions that assist production management with a coherent information model and a modular system architecture that facilitates for data gathering regarding products and processes throughout the entire plant. To solve this problem the aim of this project is to develop a line information system architecture – LISA that can be used in industrial production systems in general and in automotive discrete manufacturing specifically.

Involvement: The department of Automatic Control is involved in the LISA-workpackage that assures development of new relevant standards, in order to guarantee that the automotive manufacturer's perspective is taken into account. The workpackage makes it possible to obtain feedback and interaction between the industries involved in LISA and corresponding standard committees. Examples of relevant standards currently developed are: IEC 62264 and ISO 22400.

GRAFCHART FOR INDUSTRIAL AUTOMATION

Researchers: Alfred Theorin, Charlotta Johnsson

Funding: LCCC Linnaeus Center

Grafchart has proven to be a very capable and suitable language for various control applications on both local and on supervisory level as well as for all levels of automation. It also has potential for formal descriptions, validation, and analysis. It has been used with for a wide variety of applications, e.g. batch control, discrete control, and diagnosis and the paradigm fits all of these very well.

Project aims:

- To evaluate the advantages and disadvantages of using Grafchart for industrial applications compared to the languages used today
- To improve the state of art of Grafchart

The research in this project primarily focuses on aspects that are considered important and useful for the industry. In particular the current focus is on the following topics:

- Add SOA support for Grafchart, and evaluate it in real setups. The SOA paradigm is promising approach to deal with the currently increasing complexity, increasing requirements on flexibility, and increasing demand for vertical integration.
- Real-time execution of Grafchart applications. This also enables exploring how to handle e.g. reconfiguration of running applications. Reconfiguration is taken for granted in the automation world but is rather unexplored from a research point of view.
- Improved object orientation support for Grafchart. Analyse various constructs of other modern programming languages, check if they are possible to add to Grafchart, and evaluate the benefits of adding them.

ENERGY AND BUILDING MANAGEMENT

Researchers: Josefin Berner, Meike Stemmann, Anders Rantzer

Funding: ELLIIT and LCCC

Buildings account for 40 % of total energy consumption in the European Union, in Sweden one third of the energy used is related to the building sector, and 60% of the energy used in buildings is for heating and ventilation. With a growing building sector, it is necessary to decrease the energy used by heating and ventilation in buildings, so the total energy used in the buildings sector is not increased. Improved control and management of heating and ventilation systems in buildings can help to decrease the energy usage.

This project aims at improving the temperature control in buildings, especially using PID control and Model Predictive Control (MPC). One approach involves automatic tuning of PID controllers (for more details on automatic tuning see Automatic Tuning). To perform well for temperature control, PID controllers must be tuned correctly, which is often not the case is practice. Automatic tuning can help to overcome this problem. Another approach is to investigate the temperature interaction between different rooms or zones in a building. Usually, each room would be controlled by a local controller (e.g. On/Off-control or PID). However, the temperature dynamics of adjacent rooms or zones have an influence on each other, which can be significant. To take this interaction into account, the local PID controllers are connected with a decoupling network in order to improve the overall performance. This is compared to a Model Predictive Controller controlling the temperature of all rooms at the same time.

CONTROL AND REAL-TIME COMPUTING

In the Control and Real-Time Computing area we work 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.

PERFORMANCE MODELLING AND CONTROL OF SERVER SYSTEMS

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

Funding: LCCC Linnaeus Center

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 a 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.

EVENT-BASED CONTROL

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

Funding: LCCC Linnaeus Center

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.
- developing theory and design methodology for suboptimal event-based observers and comparing the achievable performance to the linear time-invariant case.
- 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, Yang Xu, Enrico Bini, 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 em-

bedded 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.

LUCAS - LUND CENTER FOR APPLIED SOFTWARE RESEARCH

Researchers: Karl-Erik Årzén, Rolf Johansson, Anders Robertsson, Anton Cervin, 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.

CLOUD CONTROL

Researchers: Karl-Erik Årzén, Bo Bernhardsson, Anders Robertsson, Anton Cervin, Anders Rantzer, Martina Maggio, Manfred Dellkrantz, Jonas Dürango, in collaboration with Maria Kihl's group at the Dept of Electrical and Information Technology, Lund University and Erik Elmroth's group at Umeå University

Funding: VR
Duration: 2013 - 2016

We take a control theoretic approach to a range of cloud management problems, aiming to transform today's static and energy consuming cloud data centers into self-managed, dynamic, and dependable infrastructures, constantly delivering expected quality of service with acceptable operation costs and carbon footprint for large-scale services with varying capacity demands. Such data centers will form the backbone of the digitalized society by providing unparalleled information storage and processing capabilities.

Today's explosive growth of the Internet and mobile connectivity hints at a digitized society where information is created, stored, processed, and distributed at a previously unparalleled rate, already today including, e.g., multimedia services as online TV and music, social networks, scientific applications, and business services such as e-commerce, online banking, enterprise applications, etc. Whereas the Internet is becoming ubiquitous and provides reasonably mature communication abilities, significant advancements are required to create the future cloud data centers that will form a backbone for information processing and storage, and thus be a key enabler of the digitized society.

However, with a continued extreme growth in capacity demands, today's cloud data center infrastructures are literally jeopardizing the continued development of the digitized society by simply being too static, providing too low Quality-of-Service (QoS), and by consuming ridiculous amounts of energy. Today's data center infrastructures are not even near being able to cope with the enormous and rapidly varying capacity demands that will be reality in a near future. So far, very little is understood about how to transform today's data centers (being large, power-hungry facilities, and operated through heroic efforts by numerous administrators) into a self-managed, dynamic, and dependable infrastructure, constantly delivering expected QoS with reasonable operation costs and acceptable carbon footprint for large-scale services with sometimes dramatic variations in capacity demands.

To meet these challenges, the project addresses a set of fundamental and inter-twined auto-management challenges assuming that there during execution are stochastic variations in capacity needs and resource availability, as well as changes in system response and operation costs (in monetary and energy terms). The challenges include how much capacity to allocate at any time for an elastic application, where to allocate that capacity including optimizing complete data center energy efficiency, if to admit an elastic service with unknown lifetime and future capacity demands, as well as how holistic management can be performed to optimize the various management tools' concerted actions.

This cross-disciplinary project builds on a collaboration between Umeå University and Lund University with complementing expertise on cloud management and control of computing systems. The collaboration addresses fundamental algorithmic challenges that in industrial collaborations have been identified as crucial.

The project is funded by a 20 million SEK framework grant from the Swedish research council (VR).

FEEDBACK-BASED RESOURCE MANAGEMENT FOR EMBEDDED MULTICORE PLATFORMS

Researchers: Karl-Erik Årzén, Martina Maggio, Enrico Bini, Georgios Chasparis

Funding: VR
Duration: 2012 - 2015

This project is aimed at advancing the state of the art in dynamic resource management for embedded multicore computing platforms by applying control theory. Efficient resources usage is becoming one of the most important design criteria for all types of computer systems from large data centers over laptops, cellular smart phones, and embedded computing devices down to sensor network nodes. The overall goal of the resource management can be to minimize power consumption or generated heat, or to have better means for differentiating applications against each other, e.g., ensure that a safety-critical application is guaranteed sufficient resources also in the presence of less important applications.

In embedded systems there are many resources that need to be managed, e.g.,memory, buses, and power. The most important resource, however, is the CPU. By controlling how much and where different applications may execute it is also possible to control the power consumption and the heat generation. Hence, the focus of this project is control of CPU resources.

VICYPHYSYS - VIRTUAL CYBER-PHYSICAL SYSTEMS

Researchers: Enrico Bini, Karl-Erik Årzén

Funding: Marie Curie Actions—Intra-European Fellowships (IEF)
Duration: 2012-2013

In Cyber-Physical Systems (CPS), a physical process is controlled by a pervasive network of embedded computers. In this environment, computation, communication, and the physical environment are so tightly coupled that process dynamics blends into the behavior of computation. A proper design of such systems requires understanding the joint dynamics of computers, software, networks, and physical processes. The project investigates the creation of a foundational theory and a design methodology for Cyber-Physical Systems.

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.

Most of the process control research is today performed within the Process Industrial Center at Lund University, PICLU.

PROCESS INDUSTRIAL CENTRE AT LUND UNIVERSITY

Researchers: Olof Garpinger, Tore Hägglund, Martin Hast, Charlotta Johnsson, Ola Johnsson, Anna Lindholm, Vanessa Romero Segovia, Kristian Soltész

Funding: SSF

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

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 are 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 industrial partners are Borealis, K A Rasmussen, Modelon, Novo Nordisk, Novozymes, 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.

PROCESS INDUSTRIAL CENTRE – OPTIMIZATION, PERFORMANCE, INTEGRATION AND CONTROL (PIC-OPIC)

Researchers; Charlotta Johnsson, Anna Lindholm and Tore Hägglund

Funding: SSF

With support from the Swedish Foundation for Strategic Research (SSF), the PIC-opic project was established in 2012 in order to strengthen the integration between the various hierarchical control level found in companies today. Generally, the lower levels of the automation hierarchy are focused on operational decisions and thereby close to the real production and real time control and measurements, whereas the higher levels are closer to strategic decisions and thereby closer to economical performance evaluations. PIC-opic is a joint research between Lund Uni-

versity and Linköping University. It consists of three (3) subprojects with the aim of integrating different levels in the hierarchy. Subproject A focuses on buffer management and inventories, subproject B focuses on key performance indicators and subproject C focuses on economical optimization. The three projects all incorporate knowledge and personnel from the two research centres PIC-LI and PIC-LU.

PID CONTROL

Researchers: Karl Johan Åström, Olof Garpinger, Tore Hägglund, Martin Hast, Vanessa Romero Segovia

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:

Measurement noise filtering for PI and PID controllers

Measurement signals are always corrupted with noise.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 reasonable 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 investigate the trade-offs between load disturbance attenuation, robustness and the undesired control activity generated by measurement noise. The goal is to find design rules that take all this aspects into account in the PID design, where the measurement noise filter is included.

Software tools for design of PID controllers

An 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 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. It has shown to work well on several industrial plants.

The tool has also shown able to tune PID controllers with measurement noise filters, i.e. four parameter control. By adjusting the lowpass filter time constant, one can plot the trade-off relationship between performance and noise sensitivity and thus select a controller that amplifies measurement noise less than a factor Vk to the control signal. This way one can also judge whether a PI or a PID controller is preferable for the control problem at hand, which should also enable tuning of more PID controllers in industry.

PID design by convex optimization

Convex optimization has grown to become a mature and powerful tool in a vast number of research fields. Design of PID controllers subject to robustness constraint is not a convex optimization problem, however, it fits well into the framework of the convex-concave procedure. Although globally optimal controllers cannot be guaranteed, the method produces robust controllers with good performance. The work is done in collaboration with Stephen Boyd, Stanford University.

Criteria and Trade-offs in PID Design
Control design is a rich problem which requires that many issues such as load disturbances and set-point tracking, model uncertainty, and measurement noise are taken into account. In this work we introduce trade-off plots for PI and PID controllers, which give insight into the design methods, criteria and design compromises.

Interactive 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: Josefin Berner, Kristian Soltesz, Tore Hägglund, Karl Johan Åström

Methods for automatic tuning of PID controllers were developed in the early eighties, and implemented in industrial single-station controllers and DCS systems. A main reason was the technology shift from analog to computer-based controllers and systems at that time, which made implementation of such tuning functions possible. These methods were limited by the computer power and the knowledge about PID design that were available at that time. Since then, the computational power and the knowledge about PID design has increased, which provides the possibility to develop new tuning functions with better performance.

Within process industry, a large number of processes can be accurately modeled using simple models, i.e. SISO FOTD or SOTD, and there are efficent tuning rules for PID controllers that are based on these model structures.

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 closed-loop controlled anesthesia.

Another approach for automatic tuning is to conduct a simple experiment, using an asymmetric relay function as feedback. From the experiment the static gain and the normalized time delay of the system can be estimated, and from this a FOTD model can be achieved from analytical formulas. The experiment data can also be used to find a higher order model using numerical parameter estimation methods. From the achieved model the parameters of a PI or PID controller can be tuned either by existing tuning rules or by optimization methods.

This auto-tuner is currently under development and will hopefully be tried out on some applications in an energy management system for buildings during the spring.

HIERARCHICAL SCHEDULING AND UTILITY DISTURBANCE MANAGEMENT

Researchers: Anna Lindholm, Charlotta Johnsson

The research is part of the Process Industry Centre (PIC), and is performed in collaboration with Perstorp AB and researchers from the Department of Mathematics and the Department of Management and Engineering at Linköping University.

The chemical industry has during the past decades become a global marketplace with strong competition between manufacturers, which requires a more agile plant operation to increase flexibility and decrease production costs. Planning, scheduling, and control are some key features that have large economic impact on process industry operations. In this research project, a hierarchical approach to integrate scheduling (on a timescale of days) with production control (on a timescale of hours) is suggested. The approach focuses on sites with several interconnected production areas with continuous production The scheduling level is denoted production scheduling (PS) and the production control level detailed production scheduling (DPS), in agreement with the ISA-95 terminology. The production scheduling takes orders, forecasted orders, and the actual production per day as inputs to make a production schedule for a month ahead divided into daily time periods. The objective of the production scheduling is to make a production schedule that serves as an input to the lower level in the hierarchy, the detailed production scheduling. The production schedule is updated every day in receding horizon. The objective of the detailed production scheduling is to handle daily disturbances at the site in order to minimize the economical influence of these disturbances. Reference values for the sales of products are given by the production schedule, and predicted disturbance trajectories are also given as input for the detailed production scheduling. The detailed production schedule has a timescale of hours and is updated every hour in receding horizon.

The focus for the detailed production scheduling is currently disturbances in the supply of utilities, such as steam and cooling water. Utilities are often shared between the production areas at a site, and management of these disturbances thus becomes an interesting topic when production areas are also connected by the flow of products. A generic method for minimizing the effects of disturbances in utilities has been developed, which requires a model of the site. Different modeling approaches have been suggested and the objective has been to

Perstorp site at Stenungsund

start with simple and quickly obtained models, and step by step move towards more elaborate models. The current model for utilities assumes a linear relation between the supply of a utility to an area and the production in the area.

The research is conducted in close collaboration with process industrial companies, in particular with Perstorp, that is a world leader within several sectors of the specialty chemicals market.

DECENTRALIZED CONTROL STRUCTURES

Researchers: Martin Hast, Tore Hägglund

There is an unfortunate gap between the centralized computational approaches of multivariable 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.

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 feedforward 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. This collaboration continues, and University of Brescia has also been involved in the project where e.g. performance indices for feedforward control have been developed.

Using a structure that decouples feedback and feedforward action, optimal design rules that minimizes ISE has been developed. The used structure simplifies tuning of the feedforward controller by allowing the controller to be tuned with respect to the open-loop system while maintaining its properties and performance when used in a closed-loop setting. The structure also enables independent re-tuning of both the feedback and the feedforward controller. Work has also been done concerning characterization of optimal low-order feedforward controllers and practical considerations for implementation.

OPTIMIZING FERMENTATION CONTROL FOR *B. LICHENIFORMIS*

Researchers: Ola Johnsson, Charlotta Johnsson, Tore Hägglund

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

The project will focus 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.

IN-VEG

Researcher: Charlotta Johnsson

Funding: Vinnova

The In-Veg research project (Innovative production systems for more attractive vegetablebased products) is run by Department of Food Engineering, Technology and Nutrition and contains a collaboration project with Department of Automatic Control. The The aim of the project is to strengthen Swedish SMEs capacity for innovation and cost efficiency in product development and production of food from fruits and vegetables.

The project contains four subprojects with interdisciplinary research. Automatic Control is mainly involved in the first of the four projects;

- School meal potato for the future - quality throughout the value chain
- Locally produced and processed onions
- Use of waste and by-products from leek
- Added-value through fermentation - new products and processes

ROBOTICS

ROBOTICS RESEARCH

Researchers: Rolf Johansson, Anders Robertsson, Fredrik Bagge Carlson, Martin Holmstrand Magnus Linderoth, Andreas Stolt, Olof Sörnmo, Björn Olofsson, Karl Berntorp, Karl-Erik Årzén, Mahdi Ghazaei, Anders Blomdell, Anders Nilsson, Jang Ho Cho, Pål Johan From, 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. Robotics is a multi-disciplinary topic and 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 (S4CPlus) to the more modern ABB IRB140 (IRC5), Gantry-Tau robot (IRC5), ABB IRB120 (IRC5) and the latest dual-arm concept robot Frida (ABB 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.

ROBOTICS LAB

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.

PROFLEXA — PRODUCTIVE FLEXIBLE AUTOMATION

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

Funding: SSF under the programme ProViking.

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, including 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 compensation 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 delivers 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

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, Olof Sörnmo, in cooperation with Dept of Computer Science, Lund University and several academic and industrial partners.

Funding: European Union FP7 under the programme COMET.
Duration: 2010-2013

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 four pieces of the puzzle 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.

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.

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

Funding: European Union FP7, under the programme 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 functionality without the need for highly skilled robot programmers
- to provide new sensing, control and decision making methods for safe physical human-robot interaction.

Members: ABB AB, Sweden; 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 1st, 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 central 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.

Research in Lund @Control

Research was focused on force-controlled assembly. The main scenario was the assembly of an emergency stop button. The implementation used was based on iTaSC, instantaneous Task Specification using Constraints. Learning was applied to increase the assembly speed and adaptation was used to automatically adjust the force control parameters.

Force estimation

Two different methods for force estimation were developed, to be used in cases when there are no force sensor available. The first method was based on the joint control errors, and the second method was based on the measured motor torques. Both methods were successfully used in different assembly scenarios.

The FRIDA robot and the setup for the emergency stop button assembly.

Emergency stop button assembly

The assembly of an emergency stop button was performed using the ABB concept robot FRIDA. A table-mounted force sensor was used for some operations, while estimated forces from the motor torques were used for screwing the nut. The assembly was implemented using both standard position-based control described in RAPID code, and force-controlled parts using the iTaSC framework and the ExtCtrl interface.

Mobile phone assembly

Another assembly scenario considered was the assembly of a shield can onto a mobile phone PCB (printed circuit board). The assembly was performed as a sequence of guarded search motions. Both forces measured by a force sensor and forces estimated based on the joint control errors were used to accomplish the assembly.

ENGROSS - ENABLING GROWING SOFTWARE SYSTEMS

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

Funding: SSF
Duration: 2009 - 2013

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 robot from ABB 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, Anders Robertsson, in cooperation with Prof. Il Hong Suh, Hanyang University, Seoul, Korea.

Funding: STINT

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.

PRACE – THE PRODUCTIVE ROBOT APPRENTICE

Researchers: Rolf Johansson, Anders Robertsson, Mahdi Ghazaei

Funding: European Union FP7, under the programme PRACE
Duration: 2011-2014

The objective of PRACE is the development of a highly adaptable two handed, mobile robot system for automation of typical small batch assembly operations. An important key feature is the fast and intuitive training of the PRACE system.

Driven by the trend to a more and more customer specific production the boundary conditions for assembly automation have changed significantly. As the systems available on the market cannot cover this extreme flexibility towards weekly changing applications a new robot system concept will be developed within PRACE. An important requirement is the ability to train the robot system with worker skill fast and intuitive.

The PRACE concept basically relies on robot learning by demonstration. We compare the robot learning to a master-apprentice-relationship. There, a master teaches an apprentice by instructing certain skills by demonstration. The apprentice watches the actions and effects to categorize this newly gathered knowledge into his knowledge base. Then, while applying this new skill, the master corrects the execution by refining the experience. This loop is iterated until the master is satisfied with the result.

Another important aspect of the PRACE robot system is the operation without safeguards to reach the target of fast setup times. Operation without safeguards however limits the maximum robot velocity. To remain competitive with the human worker a dual-armed robot approach is followed to reach a similar working output as the human worker by modest robot velocities.

With the combination of dual-armed manipulation and a mobile platform to provide local mobility within the working place basically new application tasks may be now automated economically by this new system approach. Using a modular approach the PRACE system can even be recombined to use only parts of the robot system for dedicated applications, i.e. using only a single arm or using the system without mobility.

Different assembly use cases are defined as test environment of the PRACE concept. At end of the project an evaluation phase in real production environment is planned to test the functionality of the system and to ensure the ability to train the system by non-expert users within half a day.

SMEROBOTICS

Researchers: Rolf Johansson, Anders Robertsson, Björn Olofsson, Olof Sörnmo

Funding: European Union FP7, under the programme SMErobotics
Duration: 2012-2015

Over two-thirds of European workers in manufacturing are employed in small and medium-sized enterprises (SMEs). Their primary means of competition is to respond rapidly to changing production needs and to keep product quality at a very high level.

While robots are able to carry out repetitive tasks to a high standard, they do not meet the demands of SMEs for high flexibility. Today's robots know only their nominal task, which limits their ability to deal with frequent changes in the manufacturing process.

For the operation of robots in an SME environment, which is typically less structured and involves more uncertainties than large-scale or mass-production industries, the currently available solutions result in overly complex system integration.

Instead, cognitive abilities should be included in the equipment and cognition should take place in both the robot and the human, such that the worker's knowledge can be fully utilised and productivity demands can be met. Additionally, the concepts and symbols used in dialogues need to have a common grounding in order to guarantee ease of use.

Therefore, we propose the SMErobotics work system, which covers all phases of the robot lifecycle and in which humans and robots can together deal with SME manufacturing uncertainties and are symbiotically able to learn from each other and to learn from the past handling of uncertainties. The SMErobotics vision is to deploy such robots on SME shop floors, with the benefit of long-term improvements in productivity.

The SMErobotics initiative pays careful attention to SME-related issues and scientific challenges, as is reflected by its strong industrial involvement supported by leading researchers and building on successful collaboration between industry and academia as well as on demonstration-driven research from the SMErobot project.

Additional partners will be included in order to widen the initiative's impact by transferring project results to European pilot applications of SME-compatible cognitive robot systems.

FLEXIFAB

Researchers: Rolf Johansson, Anders Robertsson, Fredrik Bagge Carlsson, Martin Holmtrand

Funding: European Union FP7, under the programme FLEXIFAB
Duration: 2013-2016

The FlexiFab system will provide the following key competitive advantages to the European welding Industry

- Enable European fabricators, metal-workers and welding companies to effectively compete in the growing use of aluminium alloys in the light-weight transport sector.
- Capitalising on the increasing pressure to replace traditional iron and steel material with aluminium alloys to reduce weight and thus fuel consumption of vehicles, trains, ships/boats and aeroplanes.
- Reduce the costs associated with the fabrication of aluminium structures, especially focussed on components used within the transport sectors.

RobotLab@Lund will mainly work on the sensor integration, logging for weld status for automated quality asurance and control system of industrial robots for the frictions stir welding process.

The system will use friction stir welding technology (FSW), invented by one of the project partners, TWI, in the beginnining of the 1990s. The welding method offers a number of benefits for aluminium joining/welding such as:

- Excellent weld mechanical properties.
- A mechanised repeatable process.
- No special pre-weld edge profiling or cleaning required.
- No shielding gas required.
- Low distortion and shrinkage due to solid-state nature of welding process.
- Welding in any position.
- High efficiency processing with very low energy consumption.
- Ability to weld the 'non-weldable' aluminium alloys such as the 2000 and
- 7000 series
- Operator Health & Safety benefits: 1. No harmful welding fumes or hot metal spatter 2. No UV radiation hazards.

AUTOMOTIVE SYSTEMS

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

KCFP, CLOSED-LOOP COMBUSTION CONTROL

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

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

Project aims:

- Reducing emissions, improving efficiency and repeatability of HCCI and partially premixed combustion (PPC) 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 HCCI model 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. The benefits of using hybrid models comprised of several linearizations of a nonlinear model have also been investigated.

During 2011, a continuous-time model of partially premixed combustion was developed and implemented in the Modelica language. The JModelica.org framework was used to formulate optimization problems on the resulting model. One use of this possibility is automatic calibration of the model parameters.

DIESEL COMBUSTION WITH LOW ENVIRONMENTAL IMPACT

Researchers: Rolf Johansson, Maria Henningsson, 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

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. Beside 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 2011, a new six-cylinder heavy-duty Volvo engine was installed in the lab. Research focused on machine-learning methods to extract information from in-cylinder pressure sensors to predict emissions during transient engine operation. Niklas Everitt, a master's thesis student, implemented and evaluated an experimental setup for using Cargine's free valve system on a six-cylinder engine.

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

PREDICTIVE CONTROL AND SYSTEM OPTIMISATION OF WHEEL LOADERS

Researchers: Toivo Henningsson, Anton Cervin, in cooperation with Bobbie Frank and Mats Alaküla, Dept Industrial Electrical Engineering and Automation, Lund University, Anders Fröberg, Volvo Construction Equipment

Funding: Energimyndigheten
Duration: 2011—2014

The today evaluating a hybrid drivetrain concept for contruction machine applications is a time consuming process. This is true as the control strategy needs to be developed by hand and tuned for the concept and each new sizing of the components and eventually optimized such that the concept can be compared with other concepts at its best.

The result is that too few concepts are studied and strategic decisions on drivetrain types is most suitable per machine / region / application / customer type and in overall are stalled due to insufficient decision material.

The project at hand implements tools for comparing concepts in a fast manner where the control strategy is generated during concept optimisation. The same control strategy is input to online control performed in the prototype machine used for validation of the results within the project.

The goal in the project is to make the transition from the generated control code to implementation in machine with real-time constraints as smooth as possible. Actual concept comparison is carried out in the project and will be used as decision material for which future drivetrain layout to use for wheel loaders of different sizes.

The project also results in competence development at Lund University and that the Volvo CE industrial student reaches a licentiate degree.

BIOMEDICAL PROJECTS

ANESTHESIA IN CLOSED LOOP

Researchers: Tore Hägglund, Kristian Soltesz, in collaboration with professor Guy Dumont and the ECEM group, University of British Columbia, Vancouver, Canada

Duration: 2011-2013

After being an LCCC seedproject, the research became part of the department's biomedical projects and the results published in a PhD thesis.

Computer controlled, or automatic, drug delivery is the process of administering a therapeutic regime to a patient with computer assistance for calculation of optimal dose and delivery schedules. Computer control can improve drug therapy by reducing drug usage and costs, by permitting health care staff to work more efficiently and to provide better standard of care, by allowing the safe use of drugs that are difficult to administer, and by compensation for human failings with computer strengths, such as unlimited attention span and patience, and capacity for quick, accurate and redundant calculation.

Our goal is to develop an automatic control system for anesthesia and to demonstrate its efficacy, safety and benefits in an operating room. Although closed-loop anesthesia has previously been proposed and tested, it has yet to have a significant impact on clinical practice. Recent developments in sensing for anesthesia have opened new possibilities for closing the loop. Our research will focus on the deployment of new sensors optimized for controlled drug delivery, robust control methodology and extensive clinical validation.

Clinical partner in the project is the Department of Anesthesia at the British Columbia Children's Hospital (BCCH), Vancouver, Canada, where patient modeling data is collected and clinical trials of the control system are conducted.

A PID controller based drug delivery system for depth of hypnosis control was evaluated in a patient study (BCCH REB approval H10-01174) during 2011.

Our current aim is to extend the system to control hypnosis and analgesia simultaneously, by adding a second drug.

CEREBELLAR CONTROL AND ADAPTATION

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

Funding: LCCC Linnaeus Center

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.

DIADVISOR™-PERSONAL MOBILE SHORT-TERM BLOOD GLUCOSE PREDICTOR AND TREATMENT ADVISOR

Researchers: Marzia Cescon, Fredrik Ståhl, Meike Stemmann, Rolf Johansson, Dawn Tilbury

Partners: Novo Nordisk A/S, Bagsværd, Denmark; Johannes Kepler University, Linz, Austria; Lunds University, Lund, Sweden; University of Padova, Padova; Centre Hospitalier Universitaire de Montpellier, Montpellier, France; Toumaz Technology Ltd, Abingdon, UK; Sensor Technology and Devices Ltd, Belfast, UK; Ondalys, Montpellier, France; RomSoft, Iasi, Romania; Institute for Clinical and Experimental Medicine , Prague, Czech Republic; RICAM, Linz, Austria; Ramboll, Virum, Denmark; Federation Internationale du Diabete Region Europe, Brussels, Belgium

Funding: European Commision FP7

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 feasibility of 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.

TOOLS
Downloadable software developed at the department

JGRAFCHARTS

Grafchart is a language for supervisory level sequence control and procedure handling that has been developed at the department since 1991. Grafchart 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 2001 an open implementation of Grafchart was made in Java. It is called JGrafchart and supports the following features:

- Steps and transitions with parallel and alternative paths
- Hierarchically structured Workspaces
- Procedures for code reuse
- Macro steps and Procedure Steps with exception handling
- Process Steps for asynchronous Procedure execution
- Digital IO, analog IO, socket-based IO, XML-based IO, and DPWS IO
- Simple and complex variables
- Interactive graphical elements
- XML-based storage on file
- Printing as vector graphics

JGrafchart is used in our laboratory exercises on logical sequence control and batch control as well as in the Grafchart for Industrial Automation project. It has also been used within the EU/GROWTH project CHEM for control in process industry, the EU FP7 project ROSETTA for robotic assembly, and several master's theses for example for modeling or code generation.

JGrafchart is available for download as freeware. The included documentation for the latest version is also available online.

Example

The Batch Heating Process 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.

JITTERBUG: A MATLAB TOOLBOX FOR REAL-TIME CONTROL PERFORMANCE ANALYSIS

JITTERBUG is a MATLAB-based toolbox that allows the computation of a quadratic performance criterion for a linear control system under various timing conditions. Using the toolbox, one can easily and quickly assert how sensitive a control system is to delay, jitter, lost samples, etc., without resorting to simulation. The tool is quite general and can also be used to investigate jitter-compensating controllers, a periodic controllers, and multi-rate controllers. As an additional feature, it is also possible to compute the spectral density of the signals in the control system. The main contribution of the toolbox, which is built on well-known theory (LQG theory and jump linear systems), is to make it easy to apply this type of stochastic analysis to a wide range of problems.

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 provides a platform for technology transfer where industrially relevant problems can inspire new research and where state of the art algorithms can be propagated from academia into industrial use. JModelica.org is a result of research at the Department of Automatic Control, Lund University, and is now maintained and developed by Modelon AB in collaboration with academia.

MPCTOOLS

MPCtools is a freely available Matlab/Simulink-based toolbox for simulation of MPC controllers. MPCtools provides easy to use functions to create and simulate basic MPC controllers based on linear state space models.

The key features of the toolbox include:

- Support for linear state space models for prediction
- Quadratic cost function
- Linear inequality constraints on states and controls
- Observer support for state and disturbance estimation
- Integral action by means of disturbance estimation
- Two different QP solvers for solving the optimization problem

TRUETIME: SIMULATION OF NETWORKED AND EMBEDDED CONTROL SYSTEMS

TrueTime is a Matlab/Simulink-based simulator for real-time control systems. TrueTime facilitates co-simulation of controller task execution in real-time kernels, network transmissions, and continuous plant dynamics. Features of the simulator include:

- Written in C++ MEX, event-based simulation
- External interrupts
- Possibility to write tasks as M-files or C++ functions. It is also possible to call Simulink block diagrams from within the code functions
- Network block (Ethernet, CAN, TDMA, FDMA, Round Robin, Switched Ethernet, FlexRay and PROFINET)
- Wireless network block (802.11b WLAN and 802.15.4 ZigBee)
- Battery-powered devices, Dynamic Voltage Scaling, and local clocks
- Stand-alone network interface blocks

From June 2010 the network parts of TrueTime are also available for Modelica using the Dymola 7.4 simulation tool from Dassault Systemes.

External Contacts

External contacts during 2013 both academic and industrial

Together with external contacts and partners the goal is to solve real control problems. A mix of fundamental and applied work is a cornerstone of our activities. In these kind of 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.

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;

Automation and Control, Dept of Electronic Systems, Aalborg University, Aalborg, Denmark
Blekinge University, Sweden
California Institute of Technology
Center for Entrepreneurship and Technology, Fung Institute, University of California, Berkeley, USA
Centre Hospitalier Universitaire de Montpellier, Montpellier, France
Chalmers, Sweden
Control Science and Engineering, Zheijang university, Hangzhou, China.
DFKI GmbH, Kaiserslautern, Germany
École Polytechnique de Montréal
Halmstad University, Sweden
Imperial College London, UK
KTH, Sweden
KU Leuven, Belgium
Linköping University, Dept of Management and Engineering
Linköping University, Dept of Mathematics
Linköping University, Institute of Technology, Dept of Automatic Control
Lund University, Dept of Chemical Engineering, Sweden
Lund University, Div Combustion Engines, Dept of Heat and Power Engineering
Lund University, Dept of Computer Science
Lund University, Dept of Mathematics
Lund Unversity, Dept of Electrical and Information Technology
Massachusetts Institute of Technology, Computer Science and Artificial Intelligence Laboratory
Norwegian School of Economics, Bergen, Norway
Norwegian University of Science and Technology (NTNU)
Politecnico di Milano, Italy
Politecnico di Milano, Dipartimento di Elettronica Informazione e Biomedica
Prof. Dumont's group at The University of British Columbia, Vancouver, Canada.
SmartFactory, DFKI, Kaiserslautern, Germany.

Software Competence Center Hagenberg GmbH
Technion-IIT, Haifa, Israel
TU Delft, The Netherlands
TU Kaiserslautern, Germany
UNED, Spain
Universidad de Almeria, Spain
University of Chicago, Dept of computer science
University of Illinois at Chicago, Dept of Computer Science
University of Zagreb, Croatia
UC Berkeley, USA

We have been sending two MSc students to California Institute of Technology and hosted one of their PhD students for four weeks.

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;

3E, Belgium
ABB Robotics, Sweden
ABB Corporate Research Sweden/Germany
Delcam plc, UK
Fraunhofer IPA, Stuttgart, Germany
Gambro, Lund, Sweden
Gudel AG, Switzerland
Modelon AB, Sweden
myVision IT-management, Vettelschoß-Kalenborn, Germany
Novozymes AS, Denmark
Perstorp AB, Sweden
Ridea, Sweden
Rockwell Automation
SAAB AB, Linköping, Sweden
SAAB Bofors Dynamics, Linköping, Sweden
Scania
Sesam - Sverige
Swedish Nuclear Fuel & Waste Management Company (SKB)
TWI Ltd, UK
Volvo Cars
Volvo Powertrain, Inc., Göteborg, Sweden

EUROPEAN COLLABORATION

During 2013 the department was involved in the 7th Framework Program of the European Commission in the below listed projects;

COMET Consortium
Flexi-Fab Consortium
PRACE Consortium
ROSETTA Consortium
SMERobotics Consortium
ViCyPhySys - Marie Curie

Staff

During 2013 the staff at Automatic Control is stable. Four new PhD students have been employed. We have also had the pleasure of hosting several international guests for shorter or longer periods.

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

PERSONNEL AND VISITORS

PROFESSORS
Årzén, Karl-Erik
Åström, Karl Johan, senior professor
Bernhardsson, Bo, deputy head of department
Hagander, Per, senior professor
Hägglund, Tore, head of department
Johansson, Rolf
Mirkin, Leonid, guest professor (until August)
Rantzer, Anders
Robertsson, Anders
Wittenmark, Björn, professor emeritus

ASSOCIATE PROFESSORS
Cervin, Anton (on leave 100%)
Como, Giacomo (from October)
Eker, Johan (20% from February)
Johnsson, Charlotta (on research leave from July)

ASSISTANT PROFESSORS
Åkesson, Johan (on leave 100%)
Como, Giacomo (until September)

MARIE CURIE FELLOWS
Bini, Enrico

RESEARCH ENGINEERS
Andersson, Leif (30%)
Andersson, Pontus
Blomdell, Anders
Braun, Rolf (retired in December)
Holmstrand, Martin (from December)
Nilsson, Anders

ADMINISTRATORS
Borgeram, Lizette (50% from October)
Nilsson, Ingrid (80% from February)
Rasmusson, Monika (90% from November)
Westin, Eva

POSTDOCTORS
Cho, Jang Ho (until May)
From, Pål Johan (20%)
Giselsson, Pontus (on research leave from September)
Ishido, Yumiko (until February)
Khong, Sei Zhen (from August)
Lovisari, Enrico
Maggio, Martina
Perninge, Magnus (from January)

PHD STUDENTS
Andersson, Alina (b. Rubanova)
Antonsson, Jacob (from August)
Berner, Josefin
Berntorp, Karl (Partly on parental leave September-December)
Cescon, Marzia
Dellkrantz, Manfred
Dürango, Jonas
Garpinger, Olof (80%)
Ghazaei, Mahdi
Grussler, Christian
Hast, Martin
Henningsson, Toivo (until January)
Ingesson, Gabriel (from January)
Johnsson, Ola
Lidström, Carolina (from June)
Lindberg, Mikael
Linderoth, Magnus
Lindholm, Anna
Madjidian, Daria (parental leave August-December)
Magnusson, Fredrik
Mannesson, Anders (parental leave August-December)
Nilsson, Gustav (from August)
Nordh, Jerker
Olofsson, Björn
Pettersson, Anders (50%)
Romero Segovia, Vanessa
Soltész, Kristian
Sörnmo, Olof
Ståhl, Fredrik
Stemmann, Meike
Stolt, Andreas (parental leave from August)
Theorin, Alfred
Xu, Yang

PROJECT ASSISTANTS

Bagge Karlsson, Fredrik (June-December)
Cairén, Patrik (August-November)
Henriksson, Mikael (November-December)
Nilsson, Adam (April-September)
Tomohiro Nakano (June-July)

LONGER AND SHORTER STAYS

Brero, Gianluca; MSc student, Politecnico di Torino, Italy (October-November)
Cano Marchal, Pablo; PhD, Universidad de Jaén, Spain (March-June)
Ceriani, Nicola, PhD student, Politecnico di Milano, Italy (until February)
Drakopoulos, Kimon; PhD student, research assistant, MIT, USA (June)
Fagnani, Fabio; professor, Politecnico di Torino, Italy (June + September)
Gilly, Katya; PhD, Universidad Miguel Hernández, Spain (August-September)
Hamon, Camille; PhD student KTH Stockholm, Sweden (November)
Kristalny, Maxim; lecturer, Technion, Israel (end of January-beginning of February)
Laird, Carl; assistant professor, Texas A&M University, USA (August)
Li, Yuling; PhD scholarship holder, University of Science and Technology Beijing, China
Matni, Nikolai; PhD student, Caltech, USA (October-November)
Mirkin, Leonid; guest professor, Technion, Israel (until August)
Pchelkin, Irina; PhD student, Umeå University, Sweden (October)
Pchelkin, Stepan; PhD student, Umeå University, Sweden (October)
Rossi, Wilbert Samuel; PhD student, Politecnico di Torino, Italy (January-June)
Word, Daniel; PhD student, Texas A&M University, USA (August)

LCCC FOCUS PERIOD

Aréchiga, Nikos; focus period guest (3 weeks), CMU Toyota
Aydin Gol, Ebru; focus period guest (3 weeks), Boston University, USA
Hahn, Ernst Mortitz; focus period guest (3 weeks), Oxford University, Great Britain
Ozay, Necmiye; focus period guest (3 weeks), Caltech, USA
Quinton, Sophie; focus period guest (3 weeks), TU Braunschweig, Germany
Tkachev, Ilya; focus period guest (3 weeks), TU Delft, The Netherlands
Ramsgaard Wognsen, Erik; focus period guest (3 weeks), Aalborg University, Denmark

STAFF ACTIVITIES

Åkesson, Johan
Johan has been engaged part time at the Department of Automatic Control and at Modelon. As from mid August he has been on leave from the Departmen to focus on his work at Modelon. He will continue to serve as advisor of a few PhD students.

Andersson, Leif
MSc, Research Engineer since 1970. Leif started at the department with a responsibility for the teaching and research laboratory. After some years he drifted to computer maintenance and became computer manager.

He retired formally in 2012, but was rehired, working 30%. He currently functions as a general resource to the computer group, with some special interest in the maintenance of our webserver, and also in computer typography for the publications of the department.

Andersson, Pontus
Research engineer at the department since May 2012.

His main tasks include maintenance and development of laboratory equipment and also mechanic and electronic design and implementation.

Antonsson, Jacob
MSc in Engineering Biology and with the department as a PhD student since August 2013. His research interests lie within statistical estimation and machine learning. During the year he has been involved in teaching of the courses in basic control and system identification as well as taking part in several PhD courses as a student.

Årzén, Karl-Erik
Professor (2000), PhD (1987): Joined the department in 1981. His research interests are real-time and embedded control, real-time systems, cloud control, feedback computing, and programming languages for control.

Co-director for the strategic research area ELLIIT on IT and mobile computing.

During the year he has primarily been involved in the VR project Feedback-based resource management for embedded multicore platforms 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 five PhD students.

Åström, Karl Johan
Professor in Automatic Control since 1965 and founder of the department, emeritus from 2000, senior professor since 2010.

He cosupervised PhD students on PID control and auto-tuning. A major effort was to coauthor a perspective paper on control for the Golden Anniversary Issue of Automatica with P. R. Kumar. The paper appeared in January 2014.

He was a Member of the United Technology Technical Advisory Committe for systems and control.

Berner, Josefin
MSc in Engineering Physics. PhD student since August 2012.

Her research interests are in automatic tuning of PID controllers and within the ELLIIT project on control of energy usage in buildings.

During the year she has also taken some courses and been a teaching assistant in the course on multivariable control and in the basic control course.

Bernhardsson, Bo
PhD 1992, Professor since 1999, has also worked at Ericsson for 9 year. Director of Studies for the PhD education, vice head of the department and a member of the LCCC board.

His research interests are in linear systems, applications of control theory and the connection between communication and control theory.

During 2013 he gave the two PhD courses Linear Systems and Convex Optimization and

one of the basic courses in Automatic Control. He also lectured at the Sonja Kovalevsky days in Umeå.

During the year he was supervisor/cosupervisor of 7 PhD students.

Berntorp, Karl
MSc in Engineering Physics (2008), doctoral student since February 2009.

Karl is part of the SSF funded project ENabling GROwing Software Systems (ENGROSS). He is also directly involved in cooperation with vehicular Systems at Linköping University, as a result of ELLIIT excellence center. His supervisors are Karl-Erik Årzén and Anders Robertsson.

During 2013 he has made contributions within several areas. He has published several papers within optimal control of road vehicles, where emphasis has been on model investigations. Within sensor fusion he has shown how to cope with delayed measurements in nonlinear systems with linear substructure. He has also improved trajectory generation algorithms for wheeled vehicles, where focus has been on delivering optimal control signals online. He was on paternity leave during the fall.

Bini, Enrico
Since March 2012, Enrico works at the department within a Marie-Curie Intra European EU project. His research interests are at the boundary between computation and control, and include the optimal design of embedded controllers, as well as the resource management.

As he works full-time on the Marie-Curie project, he has performed his research mostly on Cyber-Physical Systems.

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.

During 2013 the LabComm protocol and interface got an overhaul, and transition to a virtualized server infrastructure was started.

Borgeram, Lizette
Administrator at the department since February 2012. She handles student registry in Ladok and has contact with the printing office when it comes to dissertations and other publications. She is responsible for the library and archives and for purchase of office supplies, books and furniture. She also updates parts of the web pages and keep keys in order among other service oriented tasks.

During the autumn Lizette has been on leave part time because of an other challenge at Skissernas museum, also part of Lund university. A nice opportunity to develop new administrative skills.

Braun, Rolf
Research Engineer at the department since 1969. He has designed and built equipment for education, research and robotics. He has also handled hardware maintenance of computers, robotics and safety systems, as well as planned and supervised maintenance and rebuilding of offices and labs.

He retired at the end of this year.

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 the year he has been on leave to work in industry.

Cescon, Marzia
PhD, with the department since autumn 2008. Her research interests are in system modeling and identification, in particular applied to diabetes.

She has been a teaching assistant for Control Theory during the spring 2013.

Como, Giacomo
PhD (2008), Docent (2012). He has been with the faculty at the Department of Automatic Control since August 2011 and was promoted Associate Professor (universitetslektor) in October 2013.

In the last two years, he has taught two undergraduate courses, Nonlinear Control and Mathematical Modelling, and developed two new PhD courses, Network Dynamics and Information Theory.

He is serving as main supervisor of Gustav Nilsson and co-supervisor of Christian Grussler.

His research interests are in Dynamics, Information, and Control in Networks, with applications to transport and infrastructure networks, as well as social and economic networks. In 2013, he has served as LCCC board member and TPC member of the IEEE International Symposium on Information Theory, and has been co-editor of the book Information and Control in Networks, published by Springer.

Dellkrantz, Manfred
MSc in Computer Science Engineering since November 2011, PhD student at the department since June 2012.

He works with automatic elasticity control and load balancing of applications deployed in cloud environments.

He was involved in teaching the Real Time Systems course during the autumn.

Dürango, Jonas
MSc in Engineering Physics, with the department as PhD student since July 2010.

He has the last year been involved in the Cloud control project, where his research interests include autoscaling and performance aware cloud applications.

He has also been active in teaching several of the departments graduate courses, as well as taking courses himself.

Eker, Johan
Johan Eker is an adjoint Associate Professor at 20% since February 1, 2013 and a Principal Researcher at Ericsson Research at 80%. Main research areas are resource management for real-time systems and cloud computing and tools and methodologies for many- and multi-core systems.

He is also co-superviser of graduate student Mikael Lindberg.

From, Pål Johan
PhD 2010. He has been a researcher with the LCCC since July 2011. His research includes surgical robotics.

Garpinger, Olof
Lic. Tech., graduate student since August 2005 with a break from January 2010 to September 2012. Currently on a 80% work load, Olof is doing research on four parameter design of robust PID controllers, trade-off plots for PID design criteria as well as control of a Friction Stir Welding machine for thick copper welds. Olof is part of the Process Industrial Centre at Lund University and supervised by professor Tore Hägglund.

In 2013, Olof has developed a new project for the Automatic Process Control course in cooperation with two of his colleagues. Olof was also one of the teachers in the graduate course on Advanced PID Control.

Giselsson, Pontus
Postdoc, PhD (2012). Pontus defended his PhD thesis entitled *Gradient-Based Distributed Model Predictive Contro*l in November 2012.

During the first half of 2013, Pontus pursued postdoctoral research at the Dept of Automatic Control and he was course responsible and lecturer for undergraduate courses Systems Engineering and Automatic Process Control. He also visited Prof. Colin Jones at EPFL in Lausanne, Switzerland, for two weeks in May, and Ass. Prof. Panagiotis Patrinos at IMT Lucca in Lucca, Italy, for two weeks in June. Starting September 2013, Pontus is a postdoctoral researcher in the Electrical Engineering Department at Stanford University, where he is visiting Prof. Stephen Boyd.

Pontus's main research interest is convex optimization. Particular focus during 2013 has been on preconditioning for optimization methods used in model predictive control.

Ghazaei Ardakani, M Madhi
Since the beginning of 2012, he is with the Dept of Automatic Control as a PhD student.

His research interests include developmental robotics, system and control theory, machine learning and physical modeling.

His major assignment, is within the scope of an European robotic project named PRACE – the Productive Robot ApprentiCE. The target is to develop a dual-armed mobile robotic system to automatize a part of shop floor environments. A challenge is to increase flexibility and productivity by shortening the set-up time through intuitive demonstration of tasks to the robot.

During 2013, he built a haptic teleoperation system which facilitates demonstrating assembly tasks. The result is going to be presented at IFAC 2014 in South Africa. Additionally, he did some theoretical work on the convergence of iterative learning.

He supervised an international master student in his thesis work, *Physical Parameter Identification Using Haptic Device without Force Sensor.*

In the capacity of teaching assistant and lab supervisor, he was involved in basic control course and system identification course.

Grussler, Christian
Since 2012, he is a PhD student at Lund University. His research interests include Model reduction, Positive and Invariant Systems and Numerical analysis. Prior to his PhD studies, he was a double degree student of Industrial Mathematics at TU Kaiserslautern and Engineering Mathematics at LTH Lund. He received a Diploma from TU Kaiserslautern and a MSc from LTH Lund in 2011.

In 2013, he was a teaching assistant within the following courses: Basic Course in Control, International Project Course with TU Kaiserlautern.

Hagander, Per
Senior Professor, PhD (1973). Per has been with the department since 1968 and works with linear system and with applications in biotechnoloy and medicine.

Hägglund, Tore
Professor, PhD (1984). He 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 and decentralized control structures.

Tore is also head of the department and deputy centre director of "Centre for Research and Competence Development for the Process Industry", PIC-LU.

Hast, Martin
MSc in Engineering Physics, PhD student since February 2010. Martin's research interests are in optimal controller design for disturbance attenuation for both feedforward and PID-controllers, supervised by Prof. Tore Hägglund. During the autumn Martin has worked together with Karl-Johan Åström and Stephen Boyd on tuning of MIMO PID-controllers using convex optimization methods. Work related to tuning rules for low-order feedforward controller has also been conducted.

Martin has previously been involved in the development of a Modelica-based verison of TrueTime and has been a teaching assistant in the basic control course, the automatic process control course and the project course.

Holmstrand, Martin
Research engineer since December 2013. His work is mainly related to robotics, and spends most of his days working within the EU-project FlexiFab.

Ingesson, Gabriel
PhD student since January 2013. He is working with Professor Rolf Johansson in the KCFP PPC Control project, which is a cooperation with the Division of Combustion Engines. Gabriel is studying how the rate of heat released (the burning rate) are aected by fuel injection timings in PPC engines, the idea is that the rate of heat released could be controlled in real-time by using a suitable injection timing strategy.

Gabriel has during the year been a teaching assistant in the Automatic Control basic course and in the Real-Time Systems course.

Ishido, Yumiko
PhD. Yumiko's main research interests are analysis and synthesis of nonlinear systems. Her postdoc position ended in February and she has returned to Japan.

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 participates and leads the research projects SSF ProViking ProFlexa, Vinnova PFF Diesel HCCI, Vinnova NFFP5 Adaptive Control, KCFP Control, ROSETTA, SMErobotics, COMET, PRACE and VR Active Control. He is coordinating director for Robotics Laboratory with cooperation partners from Dept Computer Science and industrial partners. He has industrial cooperation with ABB Robotics, ABB Corporate Research, SAAB, Volvo.

He is responsible for the three courses FRT041 System Identification, FRTN15 Predictive Control, and FRTF01 Physiological Models and Computation

Johnsson, Charlotta
Associate Professor, PhD (1999). Charlotta has been at the department since 1993 except for 4 years (2000-2004) when she worked in industry.

Her main research interest is in Production Control, Batch Control Systems, Operations Management and Pedagogy.

Charlotta is the co-chair of the LCCC research program. She is also part of the management team for the research centers LCCC, PIC-LU and LISA.

Charlotta is serving as the Program Leader for Technology Management, a joint programme run by LTH and the School of Economics and Management at Lund University. During the year, she has been involved in a variety of courses.

Charlotta is spending the academic year 2013/2014 with Center for Entrepreneurship and Technology, Fung Institute, University of California, Berkeley, CA, USA.

Johnsson, Ola
MSc in Biotechnical Engineering, graduate student since August 2010. Works within the field of fermentation control, as a project within Process Industrial Centre Lund (PICLU) in cooperation with Novozymes A/S.

He spent 2013 performing experiments in production scale fermentation processes at Novozymes and developing models based on this. Presented a licentiate thesis titled "Extremum-seeking control in industrial-scale fermentation processes".

He has also taken PhD courses at the Dept of Automatic Control and the Dept of Chemical Engineering and participated in teaching courses given by the Dept of Automatic Control.

Khong, Sei Zhen
PhD. He joined the department as a postdoctoral researcher in August 2013.

His research interests are distributed analysis and control of heterogeneous networks, fundamental issues of robustness in feedback interconnections, and real-time optimisation via extremum seeking control.

Lidström, Carolina
MSc in Engineering Physics since May 2013.

She began her graduate studies at the department in June 2013. Her research area is within the field of positive systems.

During the fall of 2013, she was involved in the

development of, as well as a teaching assistant for, a new course titled Physiological Models and Computation.

Lindberg, Mikael
MSc and Tech. Licenciate, and have been with the department for 6 years (not counting parental leave) and he will present his PhD Thesis in resource management for cyberphysical systems during 2014.

He has been project supervisor for student projects in control, taught the basic course in process control and laboratory supervisor for the realtime systems course.

Linderoth, Magnus
PhD. During 2013 he finalized and defended his PhD thesis. He worked on force control and vision feedback for robots with applications in robotic assembly as a part of the ROSETTA project.

During 2013 he was involved in teaching of the Projects Course in Automatic Control.

Lindholm, Anna
PhD (2013). Anna has been at the department since 2009, and defended her PhD thesis *Hierarchical Scheduling and Utility Disturbance Management in the Process Industry* in October 2013. After the dissertation, she lectured the basic course in automatic control at Zhejiang University in China. During the year she has also been a teaching assistant of the Systems Engineering course.

Anna's research interests include process control, planning, scheduling, and disturbance management within the process industry, and she is involved in a project within the Process Industry Center (PIC). The project is conducted in collaboration with the Dept of Mathematics and the Dept of Management and Engineering at Linköping University, and the specialty chemicals producer Perstorp AB. The collaboration has resulted in several co-authored conference papers during the year.

Lovisari, Enrico
Enrico is a postdoc researcher at the Dept of Automatic Control since September 2012.

He has been working in collaboration with prof. Giacomo Como and Gustav Nilsson, and with prof. Ketan Savla from USC, on the topic of optimal routing policies in transportation systems. They have been able to show that there exist routing policies that depend on local information only and yet are able to maximally exploit the structural capacity of the network, and are moving forward to the design of such routing policies. Gustav Nilsson, who is now a PhD student at the department, will soon visit the NeCS team at INRIA Grenoble Rhone-Alpes to apply the developed theory on the real case-study of the Grenoble South Ring.

Enrico has organized with prof. Anders Rantzer a PhD level course on Distributed Control during Spring 2013.

Madjidian, Daria
Daria has a MSc in Electrical Engineering (2005). Between 2006 and 2008 he worked for Solvina in Gothenburg, Sweden and Caxem Inc. in Montreal, Canada.

Since 2008 he is a PhD Student at Dept of Automatic Control.

His research interests are control theory, with emphasis on distributed control, coordination and optimization, as well as application of control theory to wind energy systems.

Maggio, Martina
Postdoctoral researcher since January 2012, PhD education at Politecnico di Milano.

Her research interests is control of computing systems and cloud control.

Magnusson, Fredrik
M.Sc. in Engineering Mathematics (2012), Ph.D. student since February 2012. Fredrik's research regards numerical and symbolic algorithms for solution of non-convex dynamic optimization problems and is a part of the research area Modeling Support for Design and Verification of LCCC.

He was a teaching assistant in the advanced mathematical modeling course during the spring and the multivariable control course during the fall, and also supervised a Master's thesis.

Mannesson, Anders
Lic. Tech., graduate student since June 2010. He joined the department after working 4 years as analog ASIC designer in the electronics industry. He is now working together with Prof. Bo Bernhardsson on improving positioning and radio channel estimation within the ELLIIT project.

His main research topics involves estimation, statistical signal processing, and optimization. In June, he defended his licentiate thesis called *Joint Pose and Radio Channel Estimation*.

During the spring semester, he was a teaching assistant for the undergraduate course in nonliner control. During the fall semester, he was on parential leave from the department.

Mirkin, Leonid
Guest professor since August 2012. His research intersts are sampling and sampling-data systems, time-delay systems, distributed control.

He was sharing his time between Lund University and Technion in Haifa, Israel and returned in August 2013.

Nilsson, Anders
PhD (2006), Research Engineer since 2010. Spends most of the time looking after the department computers and their software.

With a past at the department of computer science developing compiler and runtime system for real-time Java, he also tries to squeeze in some time for research. Recently this has meant being involved in the EU FP7 PRACE and SMERobotics projects, trying to use compiler technology knowledge and tools for managing formal knowledge and ontologies with the goal to make industrial robots easier to use.

Nilsson, Gustav
MSc in Engineering Physics. PhD student at the department since September 2013. Works with modeling and control of traffic networks under supervision of Giacomo Como.

He has also been involved in teaching the basic control course.

Nilsson, Ingrid
Finance officer at the department since 2009. Ingrid is mainly responsible for the financial transactions at the department such as bookkeeping, budget managing and balancing of the books. Another big task is administration of research projects and reporting to the sponsors.

Nordh, Jerker
MSc in Engineering Physics, graduate student since August 2010.

During 2013 the teaching duties have been fulfilled by teaching in the Projects in Automatic Control course, the Multivariable Control course, superivision of one master thesis and two bachelor theses and some laboratory, examination and marketing responsibilities.

His research has been focused on non-linear estimation and the development of software to aid in its application to real world problems.

Olofsson, Björn
Tech. Lic, MSc in Engineering Physics, PhD student at the department since August 2010. He presented his Licentiate thesis, *Topics in Machining with Industrial Robots and Optimal Control of Vehicles*, in April 2013.

His research interests are in robotics and optimal control.

During the year, he has been active in two EU/FP7-projects, COMET and SMErobotics. In the former project, he was performing research on methods for increasing the position accuracy of machining tasks performed with industrial robots. In the latter project, methods for modeling and system identification related to task execution with industrial robots are investigated. Within the ELLIIT Excellence Center, he is investigating optimal control for mobile robots and vehicles in time-critical maneuvering situations.

He has participated in graduate courses within

control theory and mathematics and taken active part in the teaching at the department, both within the undergraduate engineering programs and by supervision of Bachelor and Master Thesis projects.

Perninge, Magnus
He has been a Post doc at the department since January 2013. He works in the ICTPSI project, where he is working on emergency voltage control in power systems.

During 2013 he supervised one MSc student (Mikael Henriksson).

During 2013 he also started preparing the PhD course in Optimal control that he will give during Period 3 of the academic year 2013/2014.

Rantzer, Anders
Professor of Automatic Control since 1999 and coordinator of the Linnaeus center LCCC since the start 2008. 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 2013, he was teaching the course "FRTN10 Multivariable Control" at the MSc level and "FRT100F Distributed Control" at the PhD level.

Rasmusson, Monika
Financial administrator at the department since August 2011. As a part of a team, her work includes reimbursements, travel bills, reporting projects among other administrative tasks.

Late autumn, she was partly steping in for Lizette, who reduced her working hours at Automatic Control.

Robertsson, Anders
Professor (2012), Associate professor (2007), "Docent" (2005), Research Associate (May 2003), PhD (1999). Excellent Teaching Practitioner (ETP) in 2007.

His main interest is in nonlinear control, robotics and control of computing systems.

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, ELLIIT network and the EU funded projects ROSETTA (FP-7), COMET (FP-7), MONROE (FP-7), PRACE (FP-7), SMErobotics (FP-7), Flexifab (FP-7). He has also been doing research on admission control in network nodes and control of server systems in cooperation with the Dept of Electrical and Information Technology, LTH, Lund University, Ericsson AB, Karlskrona and within the VR-funded CloudControl-project together with Umeå University.

He has lectured in the basic course on automatic control (FRT010), the project courses on automatic control (FRT090), applied robotics (MMKF15), on machine contruction (MMK150) and on electronics and sustainable development (ESSF05).

He has acted as advisor/co-advisor for (3+8) PhD students and several Master's Thesis projects.

Romero Segovia, Vanessa
Vanessa is a PhD student since September 2008.

Her current research interests are related to Adaptive Control, and to the design of measurement noise filters for PID an PI controllers, which can be used in process control applications.

Rubanova, Alina
Alina is a PhD student at the department since October 2009.

She is doing research as part of the project Active Control of Compressor Based on New Methods of Nonlinear Dynamic Feedback Stabilization in cooperation with Professor A Shiriaev, Umeå University.

Soltész, Kristian
PhD, at Automatic Control since 2008. Research project: LCCC seed project on closed-loop controlled anesthesia, supervised by Tore Hägglund.

During the spring Kristian has visited The University of British Columbia to follow up clinical trials within his research project. He has spent the remainder of the year working on three journal manuscripts and writing his PhD thesis. Since his defense in September, Kristian has been involved in research on automatic PID controller tuning.

Ståhl, Fredrik
Lic. Tech. (2012). Graduate student since 2008 (part-time 2008-2012).

His main research interests focus on modeling, identification and prediction of blood glucose dynamics.

During the autumn semester, Fredrik contributed to the development and in the teaching of the course "Physiological models and computations".

Stemmann, Meike
Tech. Lic., graduate student since November 2009.

Up to March 2013, she was active in the DIAdvisor project within the European FP7-ICT program, aiming at development of a blood glucose prediction and treatment advisory system for diabetic patients.

Since March 2013, she is working together with Anders Rantzer on control of energy usage in buildings within the ELLIIT project.

She was teaching assistant in the System Identification course in the spring and in the Predictive Control course in the autumn.

Sörnmo, Olof
Lic. Tech., PhD student since May 2010. Olof presented his Licentiate Thesis, *Control Strategies for Machining with Industrial Robots*, in May 2013.

His main research interests are within robotics and he is involved in the EU/FP7-projects COMET and SMErobotics. His research focuses mainly on improving machining processes performed with industrial manipulators. Topics include adaptive force control, mid-ranging control and iterative learning control.

During the fall 2013, Olof teached the basic course at Zhejiang University in Hangzhou, China.

Stolt, Andreas
Lic. Tech., graduate student since March 2010. Andreas main research focus is force controlled compliant assembly and sensor-less force control. He was working in the Rosetta project, which ended during the spring.

During the spring, he was a teaching assistant in the basic course.

Theorin, Alfred
Tech. Lic., PhD student at the department since January 2010.

His main research interests involve control languages and industrial automation and he is working on the Grafchart for Industrial Automation and LISA projects.

During the year he has defended his licentiate thesis and has worked to improve Grafchart and JGrafchart, mainly to add LabComm support.

During the spring he was a teaching assistant in the Market-driven Systems course. During the fall he was a teaching assistant in the Real Time Systems course as well as supervisor for a master's thesis.

Westin, Eva
PhD in French linguistics. Administrator at the department since 2008 and administrative coordinator from 2012. She handles the overall responsibility of human resources, guests and conferences. She also handles part of the process for research studies. Eva is the project administrator for the LCCC Linnaeus project. She is the co-supervisor of a PhD thesis in French linguistics at the Center of Languages and Literature (SOL) at Lund University.

Eva is part of the Equality group at the Faculty

of Engineering and works with these questions at the Department. She has, during 2013, taken a course on Gender in Academia at the same faculty.

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. His current interests are in the areas of process design and control and control of communication networks.

He is now emeritus professor at the department. Until March 31, 2013 he was temporarily Head Librarian for Lund University Library.

Xu, Yang
MSc in Automatic Control. PhD student at the department since June 2012.

His main research interests involve integrated scheduling and synthesis of networked embedded event-based control systems. He is involved in the ELLIIT project.

During this year he was a teaching assistant in Automatic Control course.

LOOKING BACK AT THE TECHNICAL TEAM OF RESEARCH ENGINEERS AT AUTOMATIC CONTROL

Rolf is friendly, helpful, thorough, keeping things in order and a practitioner who solves almost any problem - this is how his colleagues defines him.

Rolf Braun is also the most recent to retire from the department after more than 40 years of duty at the Faculty of Engineering (LTH) and Automatic Control.

Rolf was designing and building equipment for education, research and robotics. He was also handling hardware maintenance of computers, robotics and safety systems. He was planning for and supervising, maintenance and rebuilding of offices and labs – in short this concludes what Rolf has been doing over the years at Automatic Control. In the early nineties, during a couple of years, he was partly engaged by the union, as cashier. He has also been the safety representative at the Department

By the end of December, Rolf retired after having committed his professional life to LTH and Automatic Control. Now, he will spend his time with children and grandchildren, new projects in the house, travelling on ski- and hiking trips together with his wife, who has also recently retired.

Background

Rolf was brought up in Eslöv where his parents were gardeners and had their own plant nursery. He went to elementary school and did another 3 years studying at the technical school in Malmö. After finishing school he was directly employed at the department of nuclear physics for a year. He did his military service in Hässleholm. Still he has contact with some of his schoolmates from his school years in Malmö.

The year 1969, was a special year in many ways – as a 21-year-old he was offered an employment by Karl Johan Åström, Head of the Department and Head Professor at Automatic Control. At that time, PhD students were engaged as assistants for specific projects that normally summed up in defending their doctoral thesis. This year he met his wife to be and who still is.

A very strong interest in mechanics

Rolf's father was the one mending and fixing things that broke in the plant nursery. It might have been at that time that Rolf's interest in mechanics grew strong, later to include also electronics.

His interest in mechanics, to create things in wood and other materials as well as his perfection and ability to find solutions to any problem went hand in hand with what was needed at Automatic Control. By that time the department had 10 employees, all included. The atmosphere was open to experimental efforts and all kinds of problems were solved. Rolf has always felt that he could develop his work in an interesting way. He did not have to look for a job elsewhere, as he always found new challenges at Automatic Control.

The development over the years at Automatic Control.

During the seventies and eighties the department was like a big family, with different social activities that involved the entire families like canoeing, downhill skiing, skating etc. It was not any work from 8 to 5, more a lifestyle and more spontaneity influenced the work.

Rolf has always had a long-term view on how to develop the working environment. Many ideas have popped up, but many of them have not been durable over time, there have always been new ideas to challenge.

His jobtitle has changed over the years, but the work itself has developped to Rolf's advantage.

The current team

Leif Andersson, started 1970 and is still employed part time as a resource for the computer group.

Anders Blomdell, started 1988 and is one of the computer gurus. He is interested in almost anything and hence easily distracted.

Anders Nilsson, started 2010. He spends most

of the time looking after the department computers and their software.

Pontus Andersson, started in June 2012. He enjoys the possibility to combine theory and practice as well as working closely with undergradute and gradute students.

The latest one to join the group is Martin Holmstrand, who started in December 2013, mainly as a resource for the different projects in the Robotics lab.

The team of Research Engineers plays a crucial role in making things run smoothly. Together with the administrative group they form the hub of the the department.

AWARDS

Editor's Choice article
In the August edition of "Pediatric Anesthesia" the article *Robust closed-loop control of induction and maintenance of propofol anesthesia in children* was appointed Editor's Choice Article. The authors of this article were Nicholas West, Guy A. Dumont, Klaske van Heusden, Christian Petersen, Sara Khosravi, Kristian Soltesz, Aryannah Umedaly, Eleanor Reimer, J. Mark Ansermino.

LTH scholarship
Charlotta Johnsson received a scholarship from LTH for career development.

ACC 2013 Best Student Paper Award
Pontus Giselsson was one out of five finalists selected for the Best Student Paper Award for his paper *Optimal preconditioning and iteration complexity bounds for gradient-based optimization in MPC*. in 2013 American Control Conference in Washington D.C.

Kungliga Fysiografiska Sällskapet travel grant
Pontus Giselsson received a travel grant from Kungliga Fysiografiska Sällskapet for research visit to EPFL in Lausanne, and IMT Lucca in Spring 2013.

Fredrik Ståhl received a travel grant from Kungliga Fysiografiska Sällskapet to present the contribution *Model-Based Estimates of the Post-Prandial Response to Carbohydrate and Insulin and of the Carbohydrate-to-Insulin Ratio* at the 73:rd ADA Scientific Sessions, June 21 -25, Chicago, U.S.

Vetenskapsrådet research grant
Pontus Giselsson received a Research grant from Vetenskapsrådet for postdoctoral studies at Stanford University.

Färs & Frostas 2013 best dissertation award
Dr. Maria Henningsson received the Färs & Frostas Forskningspris 2013 best dissertation award for her PhD thesis *Data-Rich Multivariable Control of Heavy-Duty Engines*.

At the ACC 2013, two LCCC researchers were honored. Postdoc Laurent Lessard received the Hugo Schuck best paper award, while PhD student Pontus Giselsson was one of five student award finalists.

ASSIGNMENTS

BOARD MEMBER

Årzén, Karl-Erik
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 EMSIG Special Interst Group on Embedded Systems

Bernhardsson, Bo
Board member of LCCC

Como, Giacomo
Board member of LCCC

Eker, Johan
Member of the steering committee for the FP7 Network of Excellence HiPEAC.

Hägglund, Tore
Expert member in legal proceedings for patent at Svea Court of Appeal.

Johansson, Rolf
Board member of ROSETTA Project Management Board, 2009-2013
Board member of ROSETTA Project Scientific Board, 2009-2013

Johnsson, Charlotta
Board member in Technology Management Advisory Board at Lund University.
Board member at PTW at Högskolan Väst, Trollhättan, Sweden.
Board member at SESAM-Sverige, a network for industrial automation.
Board member at SmartFactory TU Kaiserslautern, Germany.
Board member of LCCC

Rantzer, Anders
Chairman of the Scientific Council for Natural and Engineering Sciences within the Swedish Research Council
Members of the Board of Electors to the Professorship of Engineering at Cambridge University
Member of the steering committee for the International Symposium on Mathematical Theory of Networks and Systems
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

MEMBER OF INTERNATIONAL PROGRAM COMMITTEE (IPC)

Årzén, Karl-Erik

Member of the Program Committe for RTSS 2013, The 34th IEEE Real-Time Systems Symposiumm Vancouver, Canada, Dec 3-6, 2013

Member of the Program Committee for 1st IEEE International Conference on Cyber-Physical Systems, Networks, and Applications (CPSNA), Taipei, Taiwan, August 19-20, 2013

Member of the Program Committe for the Third International Conference on Cyber-Physical Systems (ICCPS 2013), Philadelphia, PA

Member of the Program Committee for the International Workshop on Real-Time and Distributed Computing in Emerging Applications (REACTION 2013)

Program co-chair for the 8th IEEE International Symposium on Industrial Embedded Systems (SIES'2013), 19-21 June 2013, Porto, Portugal

Bini, Enrico

Member of the program committee of the 21st International Conference on Real-Time and Network Systems (RTNS) 2013, invited by Rob Davis, Emmanuel Grolleau;

Member of the program committee of the 19th International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA) 2013, Real-Time Systems track, invited by Chris Gill;

Member of the program committee of the 19th International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA) 2013, Ubiquitous Computing/Cyber-Physical Systems Track, invited by Jin Nakazawa;

Member of the program committee of the 19th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS) 2013, invited by Eduardo Tovar.

Eker, Johan

Member of the program committee for SIES 2013.

Hägglund, Tore

Member of IPC

Johansson, Rolf

IPC Member, Robotics: Science and Systems 2013 (RSS2013), June 24-28, 2013, Berlin, Germany

Associate Editor & IPC Member, The 7th IFAC International Symposium on Advances in Automotive Control (AAC2013), September 4-9, 2013, Tokyo, Japan

Co-chair & IPC Member, The 7th International Workshop on Innovation and Commercialization of Micro & Nanotechnology (ICMAN2013), 25-28 October, 2013, Taiyuan, Shanxi, China

Technical Associate Editor (TAE)—Automotive Control, IFAC World Congress 2014, 24-29 August 2014, Cape Town, South Africa

Maggio, Martina

Member of the Technical Program Committee for APRES 2013, the 5th Workshop on Adaptive and Reconfigurable Embedded Systems, Philadelphia, USA, April 8 - 13, 2013

Member of the Technical Program Committee for EUC 2013, the 11th IEEE International Conference on Embedded and Ubiquitous Computing, Zhangjiajie, China, November 13 - 15, 2013

Member of the Technical Program Committee and Publicity Chair for Feedback Computing 2013, the 8th International Workshop on Feedback Computing, San Jose, USA, June 25, 2013
Member of the Technical Program Committee for ReCoSoC 2013, the 8th International Workshop on Reconfigurable Communication-centric Systems-on-Chip, Darmstadt, Germany, July 10 - 12, 2013
Publicity chair for IPSN 2013, the 12th ACM/IEEE Conference on Information Processing in Sensor Networks, Philadelphia, USA, April 8 - 13, 2013
Publicity chair for ICAC 2013, the 10th International Conference on Autonomic Computing, San Jose, USA, June 26 - 28, 2013

Rantzer, Anders
Member of the IPC for European Control Conference, Zürich, 2013.
Member of the IPC for 4th IFAC Workshop on Distributed Estimation and Control in Networked Systems, Koblenz, September 2013.

OPPONENT AND MEMBER OF EXAMINATION COMMITTEE

Bernhardsson, Bo
Member of the examination committee for Zoran Sjanic, Automatic Control, Linköping.
Memebr of the examination committee for Adnan Prlja, Communication Theory, Lund.

Eker, Johan
Member of thesis committee for Sergiu Rafiliu, Linköping University, Dec 2013.

Johnsson, Charlotta
Member of Examination Committee for "A Simulation-Based Optimization Method for PLC Systems", Bo Svensson, Department of Signals and Systems, Chalmers University of Technology, Gothenburg, Sweden, April 13, 2012.

Maggio, Martina
Opponent for licentiate thesis of Nima Moghaddami Khalilzad, Mälardalen University, June 13th

Rantzer, Anders
Member of PhD examination committee for Onofrio Semeraro, KTH, Stockholm.

ADVISORY COMMITTEES AND WORKING GROUPS

Årzén, Karl-Erik
Member of the Norwegian committee on assessment of competence for the title of full professor in IT
Member of the Royal Swedish Academy of Engineering Sciences (IVA)

Johansson, Rolf
Member of IEEE EMBS Technical Committee (TC) for Biomedical Robotics
Member of Joint EMBS/RAS Advisory Committee on Biorobotics

Johnsson, Charlotta
Voting member in the standardisation committee ISA95 and an information member in the standardization committees ISA88 and ISA99.
Member in SIS and SEK and serves as the Swedish expert in the international IEC 62264 and ISO 22400 standards.

Rantzer, Anders
Member of evaluation committee for "Framtidens Forskningsledare" at the Swedish Foundation for Strategic Research.

OTHER ASSIGNMENTS

Årzén, Karl-Erik
Member of Research Board of Mathematics, Physics & Information and Communication Technology, Faculty of Engineering, Lund University
Member of the Executive Committee for the IEEE Computer System's Technical Committee on Real-Time Systems (TCRTS)
Associate Editor for Real-Time Systems Journal
Area Editor for the Leibniz Transactions on Embedded Systems (LITES)

Bini, Enrico
Program chair and organizer of the Workshop on Computation, Communication and Control, held within CPSWeek 2013, Philadelphia, PA, USA.

Como, Giacomo
Co-editor of the book Information and Control in Networks, published by Springer.

Eker, Johan
Reviewer of EU FP7 project applications, March 2013.
External reviewer for the ARTEMIS project PaPP, October 2013.
Co-organised satellite workshop at ISCAS 2013 in Beijing, May 2013.

Johansson, Rolf
Editor, Mathematical Biosciences, (Elsevier);
Associate Editor, International Journal of Adaptive Control and Signal Processing, (Wiley);
Associate Editor, Chinese Journal of Scientific Instrument, (China Instrument and Control Society);
Associate Editor, Automatic Control of Physiological State and Function;
Member of Editorial Board, Robotics and Biomimetics, (Springer)

Johnsson, Charlotta
Member in UN3 (utbildningsnämnd 3) at LTH.
Serving as the IFAC Liaison with IEC 65A
Editor of ISO 22400 Part 1.

Westin, Eva
Representative for Automatic Control in and member of the Equality group (JäLM) at the Faculty of Engineering.

LONGER VISITS

Johnsson, Charlotta
Fung institute, University of California, Berkeley, USA during August, 2013 and June 2014.
Zhejiang University, Hangzhou, China. Duration: September 7, 2013 – September 18, 2013 and October 12, 2013 – October 20, 2013.

Lindholm, Anna
Lecturer of FRT010 ”Automatic Control, Basic Course” at Zhejiang University, Hangzhou, China, for one month during the fall.

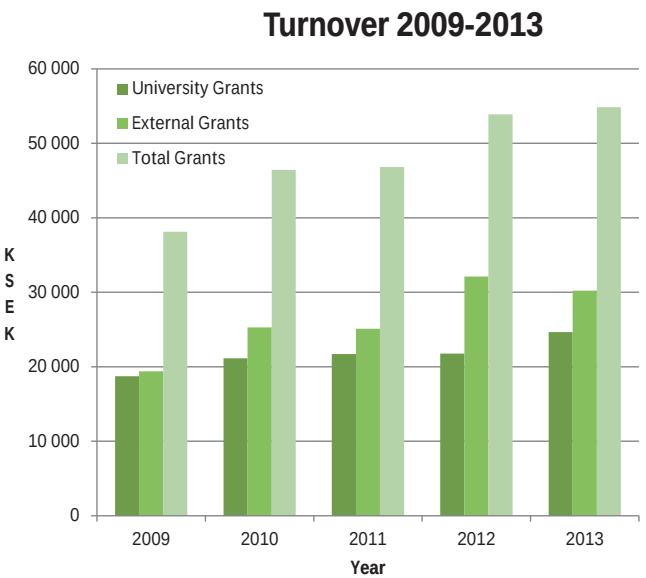
Economy

This chapter informs about Economy and Funding

ECONOMY

The turnover for 2013 was 54,8 MSEK, an increase by 1 MSEK since 2012. About 45% of the income comes from Lund University, and 55% from external grants. The distribution is shown below.

The activity and the number of employees have increased substantially in the last few years, mainly because of the Linnaeus grant "Lund Center for Control of Complex Engineering Systems" - LCCC, and "The Linköping–Lund Initiative on IT and Mobile Communication" - eLLIIT, funded by the Swedish Research Council. However, now the situation seems to have stabilized, the number of employees is about the same 2013 as 2012. The department participated in 6 projects funded by the European Union, EU, during 2013 and The Swedish Foundation for Strategic Research has also provided substantial support of the activities.



FUNDING

During 2013 we had the following grants:

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 – Resource Allocation and Control of Distributed Service Management Systems
VR – Information Dynamics over large-scale networks
VR – Feedback Based Resource Management for Embedded Multicore Platforms
VR – Simultaneous Movement Tracking and Radio Channel Estimation
VR – Event-based control components with performance bounds
VR – Active Control of Compressor Systems Based on New Methods of Nonlinear Dynamic Feedback Stabilization
VR – Scalable and Resource-Constrained Control Systems
VR – Cloud Control
VR – Remuneration for Anders Rantzers´ function as a Member of the Scientific Council for Natural and Engineering Sciences within the Swedish Research Council 2013-2015
VR – Power and temperature control for large-scale computing infrastructures
VR – Methods for control of large-scale dynamical systems
Energimyndigheten - Predictive Control and System Optimisation of Wheel Loaders
Vinnova – Line Information System Architecture, LISA
Vinnova-Saab – Adaptiv Control in Flying Vehicles
Vinnova- Control of batch processes in biotechnology and biopharma industry
SSF – Process Industrial Centre at Lund University, PICLU
SSF – Enabling GROwing Software Systems, ENGROSS
SSF – Productiv Flexibel Automation
SSF – Productiv Flexibel Automation, ProFlexa++
SSF – ICT platform for lasting infrastructure, ICT-PSI
SSF – Process Industrial Centre at Lund University, PICLU 2
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 – FP7 258769 Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future, COMET
EU – FP7 257462 Highly-complex and networked control systems, HYCON
EU – FP7 287787 The European Robotics Initiative for Strengthening the Competitiveness of SMEs in Manufacturing by integrating aspects of cognitive systems, SMErobotics
EU – FP7–SME-2013-606156-FlexiFab – Flexible fabrication of lightweight aluminium transport structures, FlexiFab
EU – FP7 285380 The Productive Robot Apprentice, PRACE
The Linköping–Lund Initiative on IT and Mobile Communication, ELLIIT
Marie Curie – Virtual Cyber-Physical Systems
Toyota Moter Corporation – Project on Nonlinear Model Reduction
SKB - Control of Stirwelding Process for Sealing
Vägverket –Estimation of Road Friction
Novozymes – Agreement on Co-financed PhD study

Emissions Control for Low Climate Impact, KCFP2
Emissions Control for Low Climate Impact, KCFP3
ACCM - Mechatronics
ABB AB - Force Control
PGS Americas Inc. – Marine Vibrators

The block grants from VR and some of the SSF 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, i.e. 5 years, we have a long-term internal research planning, and we are careful to bid on projects that fit into our research plan. This has proven efficient to match short-term funding, research planning and personnel.

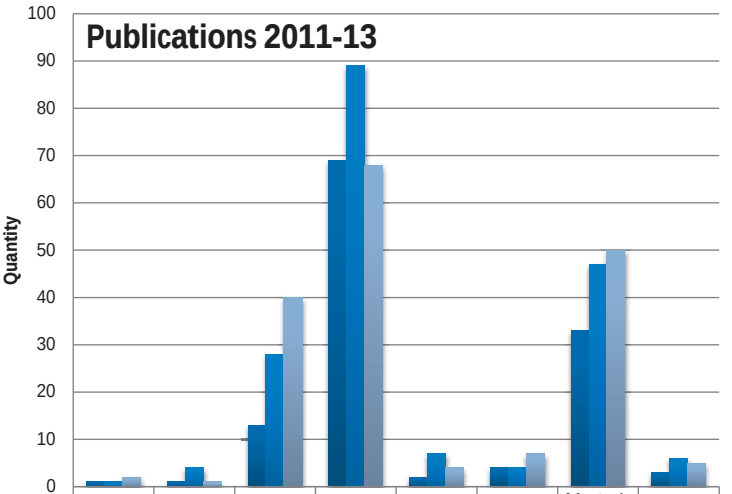
Appendix

This chapter contains a list of Publications, Seminars and Lectures given outside the department during 2013

PUBLICATIONS 2013

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
- Univesitetsbiblioteket Lund, Svenska Tryckavdelningen, Box 1010, SE-221 03 Lund
- Stockholms Universitetsbibliotek, Box 5039, SE-102 41 Stockholm
- Umeå Universitetsbibliotek, Box 718, SE-901 01 Umeå
- Uppsala Universitetsbibliotek, Box 510, SE-751 20 Uppsala



	Books	Book Contr	Articles	Conf Contr	PhD theses	Lic theses	Master's theses + TM	Techn reports
2011	1	1	13	69	2	4	33	3
2012	1	4	28	89	7	4	47	6
2013	2	1	40	68	4	7	50	5

BOOKS

Como, Giacomo; Bernhardsson, Bo; Rantzer, Anders (Eds.); *Information and Control in Networks,* Springer, 2013.

Leva, Alberto; Maggio, Martina; Papadopoulos, Alessandro Vittorio; Terraneo, Federico; *Control-Based Operating System Design,* IET, 2013. Accepted for publication.

BOOK CHAPTERS

Theorin, Alfred; Ollinger, Lisa; Johnsson, Charlotta; *Service-oriented Process Control with Grafchart and the Devices Profile for Web Services*; In Theodor Borangiu, Andre Thomas, Damien Trentesaux (Eds.): Service Orientation in Holonic and Multi-agent Manufacturing and Robotics, Springer, January 2013.

JOURNAL ARTICLES

Acemoglu, Daron; Como, Giacomo; Fagnani, Fabio; Ozdaglar, Asuman; *Opinion fluctuations and disagreement in social networks*; Mathematics of Operations Research, 38:1, pp. 1–27,2013.

Årzén, Karl-Erik; *Preface to special issue on adaptive embedded systems*; Real-Time Systems, 49:3, pp. 337–338,2013.

Chasparis, Georgios; Shamma, Jeff S.; *Network Formation: Neighborhood Structures, Establishment Costs, and Distributed Learning*; IEEE Transactions on Cybernetics, 43:6, pp. 1950–1962,2013.

Chasparis, Giorgios; Arapostathis, Ari; Shamma, Jeff S.; *Aspiration Learning in Coordination Games*; SIAM Journal on Control and Optimization, 51:1, pp. 465–490,2013.

Cho, Jang Ho; Son, Hyoung Il; Lee, Dong Gun; Bhattacharjee, Tapomayukh; Lee, Doo Yong; *Gain-Scheduling Control of Teleoperation Systems Interacting With Soft Tissues*; IEEE Transactions on Industrial Electronics, 60:3, pp. 946–957,2013.

Como, Giacomo; Savla, Ketan; Acemoglu, Daron; Dahleh, Munther A.; Frazzoli, Emilio; *Robust distributed routing in dynamical networks -- Part I: Locally responsive policies and weak resilience*; IEEE Transactions on Automatic Control, 58:2, pp. 317–332, December 2013.

Como, Giacomo; Savla, Ketan;Acemoglu, Daron; Dahleh, Munther A.; Frazzoli, Emilio; *Robust distributed routing in dynamical networks -- Part II: strong resilience, equilibrium selection and cascaded failures*; IEEE Transactions on Automatic Control, 58:2, pp. 333–348, December 2013.

Como, Giacomo; Savla, Ketan; Acemoglu, Daron; Dahleh, Munther A.; Frazzoli, Emilio; *Stability Analysis of Transportation Networks with Multiscale Driver Decisions*; Siam Journal on Control and Optimization, 51:1, pp. 230–252,2013.

Doan, Minh Dang; Giselsson, Pontus; Keviczky, Tamas; de Schutter, Bart; Rantzer, Anders; *A distributed accelerated gradient algorithm for distributed model predictive control of a hydro power valley*; Control Engineering Practice, 21:11, pp. 1594–1605,2013.

Giselsson, Pontus; Doan, Dang; Keviczky, Tamas; de Schutter, Bart; Rantzer, Anders; *Accelerated gradient methods and dual*; Automatica, 49:3, pp. 829–833, January 2013.

Giselsson, Pontus; Rantzer, Anders; *On feasibility, stability and performance in distributed model predictive control*; IEEE Transactions on Automatic Control, January 2013.

Gerber, Tobias; Theorin, Alfred; Johnsson, Charlotta; *Towards a seamless integration between process modeling descriptions at Business and Production levels - work in progress*; Journal of Intelligent Manufacturing, 2013.

Hägglund, Tore; *A Unified Discussion on Signal Filtering in PID Control*; Control Engineering Practice, 21:8, pp. 994–1006, August 2013.

Hamon, Camille; Perninge, Magnus; Söder, Lennart; *A Stochastic Optimal Power Flow Problem With Stability Constraints - Part I: Approximating the Stability Boundary*; IEEE Transactions on Power Systems, 28:2, pp. 1839–1848,2013.

van Heusden, Klaske; Ansermino, J. Mark; Soltesz, Kristian; Khosravi, Sara; West, Nicholas; Dumont, Guy A.; *Quantification of the variability in response to propofol administration in children*; IEEE Transactions on Biomedical Engineering, 60:9, pp. 2521–2529,2013.

van Heusden, Klaske; Dumont, Guy A.; Soltesz, Kristian; Petersen, Christian L.; Umedaly, Aryannah; West, Nicholas; Ansermino, J. Mark; *Design and clinical evaluation of robust PID control of propofol anesthesia in children*; IEEE Transactions on Control Systems Technology, 2013.'

Johnsson, Charlotta; Erlingsdottir, Gudbjörg; Nilsson, Fredrik; Nilsson, Carl-Henric; Alsen, Göran; *Metacognition and Learning Journals in Higher Education*; International Journal of Economics and Management Engineering, 3:4, pp. 152–159,2013

Johnsson, Ola; Andersson, Jonas; Lidén, Gunnar; Johnsson, Charlotta; Hägglund, Tore; *Feed rate control in fed-batch fermentations based on frequency content analysis*; Biotechnology Progress, 29:3, pp. 817–824, June 2013.

Jonsson, Marie; Stolt, Andreas; Robertsson, Anders; von Gegerfelt, Sebastian; Nilsson, Klas; *On force control for assembly and deburring of castings*; Production Engineering, 7:4, pp. 351–360,2013.

Khong, Sei Zhen; Nesic, Dragan; Tan, Ying; Manzie, Chris; *Unified frameworks for sampled-data extremum seeking control: Global optimisation and multi-unit systems*; Automatica, 2013.

Khong, Sei Zhen; Nesic, Dragan; Manzie, Chris; Tan, Ying; *Multidimensional global extremum seeking via the DIRECT optimisation algorithm*; Automatica, 49:7, 2013

Kristalny, Maxim; Madjidian, Daria; Knudsen, Torben; *On Using Wind Speed Preview to Reduce Wind Turbine Tower Oscillations*; IEEE Transactions on Control Systems Technology, 21:4, pp. 1191–1198,2013.

Levinson, Yaron; Mirkin, Leonid; *L^2 Optimization in Discrete FIR Estimation: Exploiting State-Space Structure*; SIAM Journal on Control and Optimization, 51:1, pp. 419–441,2013.

Liao, Hsien-Hsin; Widd, Anders; Ravi, Nikhil; Jungkunz, Adam F.; Kang, Jun-Mo; Gerdes, J. Christian; *Control of recompression HCCI with a three region switching controlle*r; Control Engineering Practice, 21:2, pp. 135–145,2013.

Lindholm, Anna; Giselsson. Pontus; *Minimization of economical losses due to utility disturbances in the process industry*; Journal of Process Control, 23:5, pp. 767–777, June 2013.

Lindholm, Anna; Johnsson, Charlotta; *Plant-wide utility disturbance management in the process industry*; Computers and Chemical Engineering, 49, pp. 146–157, February 2013.

Lovisari, Enrico; Garin, Federica; Zampieri, Sandro; *Resistance-Based Performance Analysis of the Consensus Algorithm over Geometric Graphs*; SIAM Journal on Control and Optimization, 51:5, pp. 3918–3945,2013.

Maggio, Martina; Hoffmann, Henry; Santambrogio, Marco Domenico; Agarwal, Anant; Leva, Alberto; *Power Optimization in Embedded Systems via Feedback Control of Resource Allocation*; IEEE Transactions on Control Systems Technology, 21:1, pp. 239–246,2013

Perninge, Magnus; Hamon, Camille; *A Stochastic Optimal Power Flow Problem With Stability Constraints - Part II: The Optimization Problem*; IEEE Transactions on Power Systems, 28:2, pp. 1849–1857,2013.

Perninge, Magnus; *Approximating the Loadability Surface in the Presence of SNB-SLL Corner Points*; Electric Power Systems Research, 96, pp. 64–74,2013.

Perninge, Magnus; Söder, Lennart; *Irreversible investments with delayed reaction: an application to generation re-dispatch in power system operation*; Mathematical Methods of Operations Research, 2013.

Rodríguez, C.; Guzmán, José Luis; Berenguel, Manuel; Hägglund, Tore; *Generalized feedforward tuning rules for non-realizable delay inversion*; Journal of Process Control, 23:9, pp. 1241–1250,2013.

Sen, Nevroz; Alajaji, Fadi; Yüksel, Serdar; Como, Giacomo; *Memoryless multiple access channel with asymmetric noisy state information at the encoders*; IEEE Transactions on Information Theory, 59:11, pp. 7052–7070,2013.

Soltesz, Kristian; Hahn, Jin-Oh; Hägglund, Tore; Dumont, Guy A.; Ansermino, J. Mark; *Individualized closed-loop control of propofol anesthesia: A preliminary study*; Biomedical Signal Processing and Control, 8:6, pp. 500–508, November 2013.

Sootla, Aivar; Sou, Kin Cheong; Rantzer, Anders; *Parametrized model reduction based on semidefinite programming*; Automatica, 49:9, pp. 2840–2844,2013.

West, Nicholas; Dumont, Guy A.; van Heusden, Klaske; Petersen, Christian; Khosravi, Sara; Soltesz, Kristian; Umedaly, Aryannah; Reimer, Eleanor; Ansermino, J. Mark; *Robust closed-loop control of induction and maintenance of propofol anesthesia in children*; Pediatric Anesthesia, 23:8, pp. 712–719, August 2013.

Word, Daniel; Kang, Jia; Laird, Carl; Åkesson, Johan; *Efficient Parallel Solution of Large-Scale Nonlinear Dynamic Optimization Problems*; Journal of Computational Optimization and Applications, 2013.

CONFERENCE CONTRIBUTIONS

Aminifar, Amir; Eles, Petru; Peng, Zebo; Cervin, Anton; *Control-Quality Driven Design of Cyber-Physical Systems with Robustness Guarantees*; In 2013 Design, Automation & Test in Europe (DATE), Grenoble, France, March 2013.

Aminifar, Amir; Eles, Petru; Peng, Zebo; Cervin, Anton; *Stability-Aware Analysis and Design of Embedded Control Systems*; In International Conference on Embedded Software (EMSOFT 2013), Montreal, Canada, September 2013.

Aminifar, Amir; Bini, Enrico; Eles, Petru; Peng, Zebo; *Designing Bandwidth-Efficient Stabilizing Control Servers*; In 2013 IEEE Real-Time Systems Symposium, Vancouver, Canada, December 2013.

Årzén, Karl-Erik; *Experiences of a CPS Course on Embedded Control*; In First Workshop on Cyber-Physical Systems Education (CPS-Ed), Philadelphia, Pennsylvania, USA, April 2013.

Bartolini, Davide Basilio; Cattaneo, Riccardo; Durelli, Gianluca; Maggio, Martina; Santambrogio, Marco Domenico; Sironi, Filippo; *The Autonomic Operating System Research Project - Achievements and Future Directions*; In Design and Automation Conference (DAC 2013), Austin, TX, USA, June 2013.

Bernhardsson, Bo; *Using a Gaussian Channel Twice*; In 2013 IEEE International Symposium on Information Theory, Istanbul, Turkey, July 2013.

Berntorp, Karl; Robertsson, Anders; Årzén, Karl-Erik; *Rao-Blackwellized Out-of-Sequence Processing for Mixed Linear/Nonlinear State-Space Models*; In 16th International Conference on Information Fusion, Istanbul, Turkey, July 2013.

Berntorp, Karl; Olofsson, Björn; Lundahl, Kristoffer; Bernhardsson, Bo; Nielsen, Lars; *Models and Methodology for Optimal Vehicle Maneuvers Applied to a Hairpin Turn*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Biegel, Benjamin; Madjidian, Daria; Spudic, Vedrana; Rantzer, Anders; Stoustrup, Jacob; *Distributed Low-Complexity Controller for Wind Power Plant in Derated Operation*; In 2013 IEEE Multi-Conference on Systems and Control, Hyderabad, India , August 2013.

Ceriani, Nicola Maria; Zanchettin, Andrea Maria; Rocco, Paolo; Stolt, Andreas; Robertsson, Anders; *A constraint-based strategy for task-consistent safe human-robot interaction*; In 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, November 2013.

Cescon, Marzia; Johansson, Rolf; Renard, Eric; *Low-complexity MISO models of T1DM glucose metabolism*; In Asian Control Conference (ASCC2013), Istanbul, Turkey, June 2013.

Cescon, Marzia; Johansson, Rolf; Renard, Eric; *Individualized empirical models of carbohydrate and insulin effects on T1DM blood glucose dynamics*; In 2013 IEEE Multi-Conference on Systems and Control, Hyderabad, India , 2013.

Cescon, Marzia; Stemmann, Meike; Johansson, Rolf; *Impulsive Predictive Control of T1DM Glycemia: an In-Silico Study*; In 2012 ASME Dynamic Systems and Control Conference, Fort Lauderdale, FL, USA, October 2013.

Cescon, Marzia; Johansson, Rolf; *Meal and insulin effects on blood glucose dynamic modeling*; In Diabetes Technology Meeting 2013, San Francisco, USA, October 2013.

Chasparis, Georgios; Maggio, Martina; Årzén, Karl-Erik; Bini, Enrico; *Distributed Management of CPU Resources for Time-Sensitive Applications*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Chasparis, Georgios; Rantzer, Anders; Jörnsten, Kurt; *A Decomposition Approach to Multi-Region Optimal Power Flow in Electricity Networks*; In 2013 European Control Conference, Zürich, Switzerland, June 2013.

Como, Giacomo; Lovisari, Enrico; Savla, Ketan; *Throughput optimal distributed routing in dynamical flow networks*; In 52nd IEEE Conference on Decision and Control, Florence, Italy, December 2013.

Giselsson, Pontus; *Output feedback distributed model predictive control with inherent robustness properties*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Giselsson, Pontus; *Optimal preconditioning and iteration complexity bounds for gradient-based optimization in model predictive control*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Giselsson, Pontus; *A generalized distributed accelerated gradient method for distributed model predictive control with iteration complexity bounds*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Hamon, Camille; Perninge, Magnus; Söder, Lennart; *Applying stochastic optimal power flow to power systems with large amounts of wind power*; In Bulk Power Systems Dynamics and Control Symposium IX (IREP 2013), Rethymnon, Greece, August 2013.

Hast, Martin; Åström, Karl Johan; Bernhardsson, Bo; Boyd, Stephen P.; *PID Design By Convex-Concave Procedure*; In 2013 European Control Conference, Zürich, Switzerland, July 2013.

Hoffmann, Henry; Maggio, Martina; Santambrogio, Marco Domenico; Leva, Alberto; Agarwal, Anant; *A Generalized Software System for Accurate and Efficient Management of Application Performance Goals*; In International Conference on Embedded Software (EMSOFT 2013), Montreal, Canada, September 2013.

Johansson, Rolf; Cescon, Marzia; Ståhl, Fredrik; *Continuous-time model identification using non-uniformly sampled data*; In IEEE AFRICON 2013 Conference, Mauritius, September 2013.

Khong, Sei Zhen; Tan, Ying; Nesic, Dragan; Manzie, Chris; *On sampled-data extremum seeking control via stochastic approximation methods*; In Asian Control Conference (ASCC2013), Istanbul, Turkey, June 2013.

Khong, Sei Zhen; Nesic, Dragan; Tan, Ying; Manzie, Chris; *Trajectory-based proofs for sampled-data extremum seeking control*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Khong, Sei Zhen; Cantoni, Michael; *Time-varying generalisations of the gap and v-gap metrics induce the same topology in continuous time*; In 2013 European Control Conference, Zürich, Switzerland, July 2013.

Khong, Sei Zhen; Cantoni, Michael; Manton, Jonathan H.; *A gap metric perspective of well-posedness for nonlinear feedback interconnections*; In 2013 Australian Control Conference, Perth, Australia, November 2013.

Khong, Sei Zhen; Cantoni, Michael; *Time-Domain Nu-Gap Robustness Analysis for Shift-Invariant Systems*; In 52nd IEEE Conference on Decision and Control, Florence, Italy, December 2013.

Kihl, Maria; Elmroth, Erik; Tordsson, Johan; Årzén, Karl-Erik; Robertsson, Anders; *The Challenge of Cloud Control*; In 8th International Workshop on Feedback Computing, San Jose, CA, USA, June 2013.

Klein, Cristian; Maggio, Martina; Årzén, Karl-Erik; Hernández-Rodriguez, Francisco; *Introducing Service-level Awareness in the Cloud*; In 2013 ACM Symposium on Cloud Computing, Santa Clara, CA, October 2013.

Larsson, Per-Ola; Casella, Francesco; Magnusson, Fredrik; Andersson, Joel; Diehl, Moritz; Åkesson, Johan; *A Framework for Nonlinear Model-Predictive Control Using Object-Oriented Modeling with a Case Study in Power Plant Start-Up*; In 2013 IEEE Multi-Conference on Systems and Control, Hyderabad, India , August 2013.

Lehmann, Christian; Olofsson, Björn; Nilsson, Klas; Halbauer, Marcel; Haage, Mathias; Robertsson, Anders; Sörnmo, Olof; Berger, Ulrich; *Robot Joint Modeling and Parameter Identification Using the Clamping Method*; In IFAC Conference on Manufacturing Modelling, Management and Control (MIM2013), Saint Petersburg, Russia, June 2013.

Lessard, Laurent; *Optimal Control of a Fully Decentralized Quadratic Regulator*; In 50th Annual Allerton Conference on Communication, Control, and Computing (Allerton), Monticello, IL, 2013.

Lessard, Laurent; Kristalny, Maxim; Rantzer, Anders; *On Structured Realizability and Stabilizability of Linear Systems*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Lindberg, Mikael; *Feedback-based Cooperative Content Distribution for Mobile Networks*; In The 16th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems, Barcelona, Spain, November 2013

Linderoth, Magnus; Robertsson, Anders; Johansson, Rolf; *Color-Based Detection Robust to Varying Illumination Spectrum*; In IEEE Workshop on Robot Vision (WoRV) 2013, Clearwater Beach, Florida, USA, January 2013.

Linderoth, Magnus; Stolt, Andreas; Robertsson, Anders; Johansson, Rolf; *Robotic Force Estimation Using Motor Torques and Modeling of Low Velocity Friction Disturbances*; In 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, November 2013.

Lindholm, Anna; Johnsson, Charlotta; Quttineh, Nils-Hassan; Lidestam, Helene; Henningsson, Mathias; Wikner, Joakim; Tang, Ou; Nytzén, Nils-Petter; Forsman, Krister; *Hierarchical scheduling and utility disturbance management in the process industry*; In IFAC Conference on Manufacturing Modelling, Management and Control (MIM2013), Saint Petersburg, Russia, June 2013.

Lindholm, Anna; Giselsson, Pontus; Quttineh, Nils-Hassan; Lidestam, Helene; Johnsson, Charlotta; Forsman, Krister; *Production scheduling in the process industry*; In 22nd International Conference on Production Research, Foz do Iguaçu, Brazil, July 2013.

Lindholm, Anna; Nytzén, Nils-Petter; *Hierarchical production scheduling in the process industry*; In 18th Nordic Process Control Workshop, Oulu, Finland, August 2013.

Lorenzo, Stella; Bagagiolo, Fabio; Bauso, Dario; Como, Giacomo; *Opinion dynamics and stubbornness through mean-field games*; In 52nd IEEE Conference on Decision and Control, Florence, Italy, December 2013.

Lundahl, Kristoffer; Berntorp, Karl; Olofsson, Björn; Åslund, Jan; Nielsen, Lars; *Studying the Influence of Roll and Pitch Dynamics in Optimal Road-Vehicle Maneuvers*; In 23rd International Symposium on Dynamics of Vehicles on Roads and Tracks, Qingdao, China, August 2013.

Madjidian, Daria; Kristalny, Maxim; Rantzer, Anders; *Dynamic Power Coordination for Load Reduction in Dispatchable Wind Power Plants*; In 2013 European Control Conference, Zürich, Switzerland, July 2013.

Maggio, Martina; Bini, Enrico; Chasparis, Georgios; Årzén, Karl-Erik; *A Game-Theoretic Resource Manager for RT Applications*; In 25th Euromicro Conference on Real-Time Systems, ECRTS13, Paris, France, July 2013.

Nacci,Alessandro Antonio; Mazzucchelli, Matteo; Maggio, Martina; Bonetto, Alessandra; Sciuto, Donatella; Santambrogio, Marco Domenico; *morphone.OS: context-awareness in everyday life*; In 16th Euromicro conference on Digital System Design, Santander, Spain, September 2013.

Nielsen, Isak; Garpinger, Olof; Cederqvist, Lars; *Simulation based Evaluation of a Nonlinear Model Predictive Controller for Friction Stir Welding of Nuclear Waste Canisters*; In 2013 European Control Conference, Zürich, Switzerland, July 2013.

Nilsson, Carl-Henric; Johnsson, Charlotta, Helge Helmersson; *Evaluation of a Cross-Cultural, Cross-Faculty Course – iMDE international Market-Driven Engineering Using Traditional Course Evaluation and PERTEX*; In 22nd Nordic Academy of Management Conference 2013, Reykjavik, Iceland, 2013.

Ollinger, Lisa; Zuhlke, Detlef; Theorin, Alfred; Johnsson, Charlotta; *A Reference Architecture for Service-oriented Control Procedures and its Implementation with SysML and Grafchart*; In 18th IEEE International Conference on Emerging Technologies and Factory Automation, Cagliari, Italy, September 2013.

Olofsson, Björn; Lundahl, Kristoffer; Berntorp, Karl; Nielsen, Lars; *An Investigation of Optimal Vehicle Maneuvers for Different Road Conditions*; In 7th IFAC Symposium on Advances in Automotive Control, Tokyo, Japan, September 2013.

Panerati, Jacopo; Sironi, Filippo; Carminati, Matteo; Maggio, Martina; Beltrame, Giovanni; Gmytrasiewicz, Piotr; Sciuto, Donatella; Santambrogio, Marco Domenico; *On Self-adaptive Resource Allocation through Reinforcement Learning*; In NASA/ESA Conference on Adaptive Hardware and Systems (AHS-2013), Torino, Italy, June 2013.

Perninge, Magnus; Lavenius, Jan; Vanfretti, Luigi; *Approximating a Post-Contingency Stable Operation Region in Parameter Space through Time-Domain Simulation*; In Bulk Power Systems Dynamics and Control Symposium IX (IREP 2013), Rethymnon, Greece, August 2013.

Pettersson, Anders; Åström, Karl Johan; Robertsson, Anders; Johansson, Rolf; *Nonlinear Feedforward and Reference Systems for Adaptive Flight Control*; In 2013 AIAA Guidance, Navigation, and Control Conference, Boston, Massachusetts, USA, August 2013.

Rodríguez, C.; Guzmán, José Luis; Berenguel, Manuel; Hägglund, Tore; Normey-Rico, J.E.; *Diseño de controladores por Adelanto para Inversión de Retardo no realizable*; In XXXIV Jornadas de Automática, Terrassa, Spain, September 2013.

Romero Segovia, Vanessa; Hägglund, Tore; Åström, Karl Johan; *Noise filtering in PI and PID Control*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Rubanova, Alina; Robertsson, Anders; Shiriaev, Anton S.; Freidovich, Leonid; Johansson, Rolf; *Analytic Parameterization of Stabilizing Controllers for the Surge Subsystem of the Moore-Greitzer Compressor Model*; In 2013 American Control Conference, Washington DC, USA, June 2013.

Savla, Ketan; Lovisari, Enrico; Como, Giacomo; *On maximally stabilizing adaptive traffic signal control*; In 51st Allerton Conference on Communication, Control and Computing, Monticello, Illinois, 2013.

Savla, Ketan; Como, Giacomo; Dahleh, Munther A.; Frazzoli, Emilio; *Distributed resilient control of network flows under deterministic cascade dynamics*; In 52nd IEEE Conference on Decision and Control, Florence, Italy, December 2013.

Sironi, Filippo; Maggio, Martina; Cattaneo, Riccardo; Del Nero, Giovanni; Sciuto, Donatella; Santambrogio, Marco Domenico; *ThermOS: System Support for Dynamic Thermal Management of Chip Multi-Processors*; In 22nd International Conference on Parallel Architectures and Compilation Techniques (PACT), Edinburgh, Scotland, September 2013.

Soltesz, Kristian; Dumont, Guy A.; Ansermino, J. Mark; *Assessing Control Performance in Closed-loop Anesthesia*; In 21st Mediterranean Conference on Control and Automation, Platanias-Chania, Crete - GREECE, June 2013.

Sörnmo, Olof; Olofsson, Björn; Robertsson, Anders; Johansson, Rolf; *Adaptive Internal Model Control for Mid-Ranging of Closed-Loop Systems with Internal Saturation*; In 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, November 2013.

Ståhl, Fredrik; Johansson, Rolf; Renard, Eric; *Investigation of the relationship between elevated levels of insulin antibodies and prolonged insulin action*; In 6th International Conference on Advanced Technologies and Treatments for Diabetes, Paris, France, February 2013.

Ståhl, Fredrik; Johansson, Rolf; Renard, Eric; *Model-Based Estimates of the Post-Prandial Response to Carbohydrate and Insulin and of the Carbohydrate-to-Insulin Ratio*; In American Diabetes Association 73rd Scientific Sessions, Chicago, IL, June 2013.

Stenmark, Maj; Stolt, Andreas; *A System for High-Level Task Specification Using Complex Sensor-Based Skills*; In Robotics: Science and Systems (RSS) 2013 Workshop on Programming with Constraints, Berlin, Germany, June 2013.

Stenmark, Maj; Malec, Jacek; Nilsson, Klas; Robertsson, Anders; *On Distributed Knowledge Bases for Small-Batch Assembly*; In Cloud Robotics Workshop, 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, November 2013.

Stolt, Andreas; Linderoth, Magnus; Robertsson, Anders; Johansson, Rolf; *Robotic Assembly of Emergency Stop Buttons*; In 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems, Tokyo, Japan, 2013.

Talebian, Kousha; Soltesz, Kristian; Dumont, Guy A.; Ansermino, J. Mark; *Clinical Assessment of Control Performance in Closed-Loop Anesthesia*; In Anesthesiology 2013 Annual Meeting, San Francisco, CA, October 2013.

Yaqoob, Muhammed Atif; Tufvesson, Fredrik; Mannesson, Anders; Bernhardsson, Bo; *Direction of Arrival Estimation with Arbitrary Virtual Antenna Arrays using Low Cost Inertial Measurement Units*; In IEEE ICC 2013 Workshop on Advances in Network Localization and Navigation, Budapest, Hungary, June 2013.

PHD THESES

Cescon, Marzia: *Modeling and Prediction in Diabetes Physiology*; PhD Thesis ISRN LUTFD2/TFRT--1099--SE, Department of Automatic Control, Lund University, Sweden, November 2013.

Linderoth, Magnus: *On Robotic Work-Space Sensing and Control*; PhD Thesis Department of Automatic Control, Lund University, Sweden, November 2013.

Lindholm, Anna: *Hierarchical Scheduling and Utility Disturbance Management in the Process Industry*; PhD Thesis Department of Automatic Control, Lund University, Sweden, October 2013.

Soltesz, Kristian: *On Automation in Anesthesia*; PhD Thesis ISRN LUTFD2/TFRT--1096--SE, Department of Automatic Control, Lund University, Sweden, September 2013.

LICENTIATE THESES

Johnsson, Ola: *Extremum-seeking Control of Industrial-scale Fermentation Processes*; Licentiate Thesis ISRN LUTFD2/TFRT--3264--SE, Department of Automatic Control, Lund University, Sweden, October 2013.

Mannesson, Anders: *Joint Pose and Radio Channel Estimation*; Licentiate Thesis ISRN LUTFD2/TFRT--3263--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Olofsson, Björn: *Topics in Machining with Industrial Robots and Optimal Control of Vehicles*; Licentiate Thesis ISRN LUTFD2/TFRT--3259--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Pettersson, Anders: *Augmenting L1 Adaptive Control of Piecewise Constant Type to Aerial Vehicles;* Licentiate Thesis ISRN LUTFD2/TFRT--3262--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Sörnmo, Olof: *Control Strategies for Machining with Industrial Robots*; Licentiate Thesis ISRN LUTFD2/TFRT--3261--SE, Department of Automatic Control, Lund University, Sweden, May 2013.

Stemmann, Meike: *Predictive Control of Diabetic Glycemia;* Licentiate Thesis ISRN LUTFD2/TFRT--3258--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Theorin, Alfred: *Adapting Grafchart for Industrial Automation*; Licentiate Thesis ISRN LUTFD2/TFRT--3260--SE, Department of Automatic Control, Lund University, Sweden, May 2013.

MASTER'S THESES

Arnsby, Joakim; Kjellsson, Mårten: *Analysis and design of a new control system for aerodrome azimuthal guidance – The SAGA*; Master's Thesis ISRN LUTFD2/TFRT--5920--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Backebjörk, Robin; Johansson, Ida: *Can a knowledge Sharing Model be Built for the Construction Industry? - A Case Study of Knowledge Management at Skanska UK*. TM.

Bagge Carlson, Fredrik: *Intuitive Robot Programming by Demonstration*; Master's Thesis ISRN LUTFD2/TFRT--5918--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Bergström, Mattias; Hollmén, Astrid; Mordenfeld, Josefine: *Undvik att fela, informationsdela - Interorganisatorisk informationsdelning under dynamiska marknadsförhållanden*. TM.

Borgdén, Martin; Svanström, Viktor; Zhao, Jinlan: *The Existance and Management of Local Assortment in Multinational Corporations - A case study at Delaval*. TM.

Brandt Wåhlberg, Michaela; Sterner, Johan: *Samverkan på bostadsmarknaden - En studie om möjliga samverkansformer mellan allmännyttiga bostadsbolag och privata fastighetsbolag på bostadshyresmarknaden*. TM.

Brange, Kajsa; Lindqvist, Elin: *How can Idea Campaigns Generate Ideas to Trigger Innovation? A Case Study at E.ON*. TM.

Cairén, Patrik: *Position Accuracy with Dual Motor Control for a Gantry-Tau Robot*; Master's Thesis ISRN LUTFD2/TFRT--5913--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Denbaum, Melissa; Lindström Petter: *Customer Integrated Transport - Evaluating a New Transport Solution at Tetra Pak Korea*. TM.

Fahlén, Lars; Jägerstad, Martin: *MES - Vågar Ekonomichefen Investera?*. TM.

Hansson, Sebastian; Romell, David: *Sjukvården är KAS - Patientcentrerat förändringsarbete i ett komplext adaptivt system*. TM.

Henriksson, Mikael: *Use of Semidefinite Optimization in Emergency Power System Control;* Master's Thesis ISRN LUTFD2/TFRT--5927--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Holmberg, Ewa; Moflag, Ida: *Identification and Categorization of Order Qualifiers and Order-Winners in Knowledge Intensive Business Services*. TM.

Holmstrand, Martin; Silverbåge, Kristina: *Stiffness Compensation and External Control of Gantry-Tau Robots*; Master's Thesis ISRN LUTFD2/TFRT--5911--SE, Department of Automatic Control, Lund University, Sweden, January 2013.

Ingesson, Gabriel; Sandberg, Helena: *Speed control of a peristaltic blood pump*; Master's Thesis ISRN LUTFD2/TFRT--5908--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Johnsson, Anna: *Nonlinear Model Predictive Control for Combined Cycle Power Plants*; Master's Thesis ISRN LUTFD2/TFRT--5926--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Knutsson, Henrik; Pettersson, Michael: *Reduction of Undesired Range Shifting in an Agricultural Continuously Variable Transmission*; Master's Thesis ISRN LUTFD2/TFRT--5917--SE, Department of Automatic Control, Lund University, Sweden, May 2013.

Lantz, Matilda; Oskar Weijden: *Software Ecosystem Governance and Participation - a Case Study at Axis Communications AB*. TM.

Lennernäs, Björn: *A CasADi Based Toolchain For JModelica.org*; Master's Thesis ISRN LUTFD2/TFRT--5919--SE, Department of Automatic Control, Lund University, Sweden, June 2013.

Lidström, Carolina: *Network Analysis of the Molecular Layer Interneurons in the Cerebellum*; Master's Thesis ISRN LUTFD2/TFRT--5916--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Lissinger, Erik; Jönsson, Johannes: *Innovation measurement in a strategy context - how to increase innovativeness through measurement*. TM.

Mattachini, Paolo: *Wind Speed Prediction Models and Their Use in Wind Turbine Control*; Master's Thesis ISRN LUTFD2/TFRT--5909--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Mohammad, Shahad; Hönig, Siri: *Jakten på noll arbetsolyckor - En utopi eller ett nåbart mål?* TM.

Moldén, Anders; Haraldsson, Christoffer: *Success factors of Nordic manufacturing companies - manufacturing for the future*. TM.

Nilsson, Gustav: *A multi-commodity dynamical model for traffic networks*; Master's Thesis ISRN LUTFD2/TFRT--5925--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Petersson, Emma; Runesson, Linda: *Quality - a Consequence of Organizational Culture*. TM.

Praceus, Julian: *Modeling of wind and turbulence for a high-fidelity flight simulation model*; Master's Thesis ISRN LUTFD2/TFRT--5922--SE, Department of Automatic Control, Lund University, Sweden, 2013.

Sjögren, Astrid; Nilsson, Martina: *Komplexa e-tjänster i hälso- och sjukvården - Vården, resurser och förutsättningar för utvärdering*. TM.

Sundén, Erik; Holmberg, Erik: *Ett hållbart miljonprogram - Faktorerna bakom en lyckad renovering och energieffektivisering av miljonprogrammet*. TM.

Svensson, Linus; Söderlund, Petter: *Delays in Axis IP Surveillance Cameras*; Master's Thesis ISRN LUTFD2/TFRT--5923--SE, Department of Automatic Control, Lund University, Sweden, August 2013.

Tapper, Jimmy; Torstensson, Anton; Nordell, Maja: *Svinn av frukter - Fallet ICA grossist*. TM

Torstensson, Erik: *Comparison of Schemes for Windup Protection*; Master's Thesis ISRN LUTFD2/TFRT--5915--SE, Department of Automatic Control, Lund University, Sweden, March 2013.

Tunhag, Johan: *Design of a Torque Control Strategy for Enhanced Comfort in Heavy Trucks*; Master's Thesis ISRN LUTFD2/TFRT--5921--SE, Department of Automatic Control, Lund University, Sweden, June 2013.

Wodzynski, Peter: *Requirements Analysis of Using Object-Orientation in Filling Machine Systems*; Master's Thesis ISRN LUTFD2/TFRT--5924--SE, Department of Automatic Control, Lund University, Sweden, 2013.

TECHNICAL REPORTS

Berntorp, Karl: *Derivation of a Six Degrees-of-Freedom Ground-Vehicle Model for Automotive Applications*; Technical Report ISRN LUTFD2/TFRT--7627--SE, Department of Automatic Control, Lund University, Sweden, February 2013

Klein, Cristian; Maggio, Martina; Årzén, Karl-Erik; Hernández-Rodriguez, Francisco: *Introducing Service-level Awareness in the Cloud*; Technical Report ISRN LUTFD2/TFRT--7641--SE, Department of Automatic Control, Lund University, Sweden,2013.

Nordh, Jerker; Berntorp, Karl: pyParticleEst – *A Python Framework for Particle Based Estimation*; Technical Report ISRN LUTFD2/TFRT--7628--SE, Department of Automatic Control, Lund University, Sweden, March 2013

Rantzer, Anders; Åkesson, Johan; Workshop: *Systems Design meets Equation-based Languages;* Technical Report ISRN LUTFD2/TFRT--7638--SE, Department of Automatic Control, Lund University, Sweden,2013.

Rasmusson, Monika; Robertsson, Anders: *Activity Report 2012*, *Department of Automatic Control;* Technical Report ISRN LUTFD2/TFRT--4040--SE, Department of Automatic Control, Lund University, Sweden, July 2013.

SEMINARS AT THE DEPARTMENT

January

10 - Master's Thesis Presentation: *Stiffness compensation and external control of Gantry-Tau robots;* Martin Holmstrand; Kristina Silverbåge

10 - *Novel perspectives on stability of time-delayed systems (TDS) and practical implications;* Nejat Olgac, Mechanical Engineering Department, University of Connecticut, Storrs, USA Tuesday

15 - *Hyperbolic Embedding to the Rescue in Communication Network Control;* John S. Baras, University of Maryland, USA

25 - *Control Theoretic Perspectives in Systems and Synthetic Biology;* Vishwesh Kulkarni, University of Minnesota, USA

February

21 - Master's Thesis Presentation: *Comparison of schemes for windup protection;* Erik Torstensson

March

5 - *A Stochastic Control Approach to Include Transfer Limits in Power System Operation;* Magnus Perninge, Dept. of Automatic Control, LTH, Lund University
6 - *Control with asymptotic behaviour constraints via model matching stabilization;* Maxim Kristalny, Technion, Israel
7 - Master's Thesis Presentation: *Overhead Localization of Mobile Robots;* Mikael Borg,
19 - *An invitation to exponential time graph algorithms;* Thore Husfeldt, Dept of Computer Science, Lund University
20 - *Rule-based demand side management of heat pumps in low energy neighbourhoods;* Roel De Coninck, KU Leuven, Belgium
21 - Master's Thesis Presentation: *Reduction of undesired range shifting in an agricultural CVT;* Henrik Knutsson; Michael Pettersson,
21 - Master's Thesis Presentation: *Requirements Analysis of Using Object-Orientation in Filling Machine Systems;* Peter Wodzynski
22 - Licentiate seminar: *Predictive Control of Diabetic Glycemia;* Meike Stemmann, Dept of Automatic Control, LTH, Lund University
22 - *Finite Horizon MPC for Systems in Innovation Form – Tuning and Closed-Loop Performance of Stochastic Systems;* John Bagterp Jørgensen, DTU, Denmark
26 - *Introduction Presentation by Johan Eker;* Johan Eker, Ericsson Research

April

2 - *Algorithms for Unequally Spaced Fast Laplace Transforms;* Fredrik Andersson
4 - *Using semidefinite programming to find invariants for automatic reasoning tools;* Nikos Aréchiga, CMU - Toyota
4 - *Typical-Case Analysis of Mixed-Critical Real-Time Systems;* Sophie Quinton, TU Braunschweig
9 - Master's Thesis Presentation: *Presentation of SURF project: Diffeomorphism Based Motion Planning for Bootstrapping Vehicles and Robots;* Adam Nilsson
11 - *Model reduction for nonlinear systems by incremental balanced truncation;* Bart Besselink, KTH
16 - Licentiate seminar: *Topics in Machining with Industrial Robots and Optimal Control of Vehicles;* Björn Olofsson, Dept. of Automatic Control, LTH, Lund University
16 - *Modeling and Control of Hybrid and Discrete Event Systems - A Unified Approach;* Bengt Lennartson
22 - *Some real world examples of modeling and control from the chemical industry;* Krister Forsman, Perstorp AB and Dept. of Chemical Engineering, NTNU
23 - *Temporal Logic Model Predictive Control;* Ebru Aydin Gol, Boston University
23 - *Formula-free finite abstractions for linear temporal verification of Stochastic Hybrid Systems;* Ilya Tkachev, TU Delft
24 - *Rewarding Probabilistic Hybrid Automata;* Ernst Moritz Hahn, Oxford University
24 - *Using Statistical Model Checking for Power Scheduling in Nanosatellites;* Erik Ramsgaard Wognsen, Aalborg University
25 - *Distributed Model Predictive Control: Theory and Algorithms;* Pontus Giselsson, Dept. of Automatic Control, LTH, Lund University
29 - Master's Thesis Presentation: *Intuitive Robot Programming by Demonstration;* Fredrik Bagge Carlson
30 - *Intrinsic Dimension Estimation Using the Concentration Phenomenon;* Kerstin Johnsson, Centre for Mathematical Sciences

May

14 - *Research at the Division of Energy and Building Design;* Maria Wall, Dept. of Architecture and Built Environment, LTH, Lund University
14 - Master's Thesis Presentation: *Network Analysis of the Molecular Layer Interneurons in the Cerebellum;* Carolina Lidström
14 - Master's Thesis Presentation: *pyICTools - Development of a Python-based Software for Control Theory Visualization;* Thomas Klintberg
17 - *Control of bilateral teleoperation systems;* Cho Jang Ho, Dept. of Automatic Control, LTH, Lund University
20 - Licentiate seminar: *Adapting Grafchart for Industrial Automation;* Alfred Theorin, Dept. of Automatic Control, LTH, Lund University
21 - *Process Control: A practical view from the industry;* Ola Slätteke, Grontmij
27 - Licentiate seminar: *Control Strategies for Machining with Industrial Robots;* Olof Sörnmo, Dept. of Automatic Control, LTH, Lund University

June

11 - Licentiate seminar: *Augmenting L1 Adaptive Control of Piecewise Constant Type to Aerial Vehicles;* Anders Pettersson, Dept. of Automatic Control, LTH, Lund University & SAAB Dynamics AB
11 - Master's Thesis Presentation: *Design av dynamisk momentreglering för komfortabel framdrift av fordon;* Johan Tunhag
11 - *Network Resilience against Epidemic Spread;* Kimon Drakopoulos, MIT, USA
14 - *Memory Controllers for Real-Time Embedded Systems;* Benny Åkesson, Eindhoven University of Technology
17 - Licentiate seminar: *Joint Pose and Radio Channel Estimation;* Anders Mannesson, Dept. of Automatic Control, LTH, Lund University
24 - Master's Thesis Presentation: *Integration of Modelica models with CasADi;* Björn Lennernäs
26 - Master's Thesis Presentation: *Modellering och implementering av vind och turbulens för en High-Fidelity flygsimuleringsmodell;* Julian Praceus
28 - Master's Thesis Presentation: *Delays in Axis IP surveillance cameras;* Linus Svensson; Petter Söderlund

July

2 - Master's Thesis Presentation: *Analysis and design of a new control system for aerodrome azimuthal guidance;* Joakim Arnsby; Mårten Kjellsson
5 - *From dynamic binding to dynamic allocation: QoS-driven adaptation in the Cloud;* Antonio Filieri, University of Stuttgart, Germany

August

12 - Master's Thesis Presentation: *Evaluation of Galil DMC-4080 as a Controller of Stewart Platform;* Christer Engblom
13 - Master's Thesis Presentation: *Iterative Learning Control for Milling with Industrial Robots in Advanced Manufacturing;* Thomas Daun
16 - Master's Thesis Presentation: *Nonlinear Model Predictive Control for Combined Cycle Power Plants;* Anna Johnsson
19 - Master's Thesis Presentation: *A multi-commodity dynamical model for traffic networks;* Gustav Nilsson

30 - Master's Thesis Presentation: *Quadcopter control using Android-based sensing;* August Bjälemark; Hannes Åman Bergkvist

September

3 - Licentiate seminar: *A Software Framework for Implementation and Evaluation of Co-Simulation Algorithms;* Christian Andersson, Centre for Mathematical Sciences & LCCC, Lund University and Modelon AB

5 - *Physarum Can Compute Shortest Paths: Convergence Proofs and Complexity Bounds;* Vincenzo Bonifaci, IASI-CNR, Roma, Italy

6 - *Research on Haptics at Keio University;* Kouhei Ohnishi, Keio University, Department of System Design Engineering, Kohoku, Yoko

13 - Defence Of Doctoral Dissertation: *On Automation in Anesthesia;* Kristian Soltész, Dept. of Automatic Control, LTH, Lund University

17 - *Cooperative learning in a congestion game;* Fabio Fagnani, Politecnico di Torino, Italy

October

2 - Master's Thesis Presentation: *Use of Semidefinite Optimization in Emergency Power System Control;* Mikael Henriksson

9 - *Time-Optimal Path Following for Robots with Convex-Concave Constraints;* Frederik Debrouwere, KU Leuven

11 - *Advances in Mixed-integer Programming Methods for Chemical Production Scheduling;* Christos Maravelias, University of Wisconsin-Madison, USA

11 - Defence Of Doctoral Dissertation: *Hierarchical Scheduling and Utility Disturbance Management in the Process Industry;* Anna Lindholm, Dept. of Automatic Control, LTH, Lund University

15 - *Joint spectral characteristics: a tale of three disciplines;* Raphael Jungers, FNRS and UCLouvain, Belgium

17 - *Control and safety systems for propulsion and gas handling on LNG/C "Liquified Natural Gas Carriers";* Claes Paulsson, Kockumation AB; Andreas Madsen, Kockumation AB

18 - Licentiate seminar: *Extremum-seeking Control of Industrial-scale Fermentation Processes;* Ola Johnsson, Dept. of Automatic Control, LTH, Lund University

21 - Master's Thesis Presentation: *Nouvel Insulin Delivery Profiles for Mixed Meals in Basal-Bolus and Closed-Loop Artificial Pancreas Therapy for Type 1 Diabetes Mellitus;* Asavari Srinivasan

29 - *Predictable dynamics of opinion forming for social networks with antagonistic interactions;* Claudio Altafini, SISSA-ISAS Trieste, Italy

November

5 - *Delay Pattern Co-Design in Decentralized H2 Optimal Control Using Convex Optimization;* Nikolai Matni, Caltech, USA

6 - *Hierarchical Decentralized Control for Networked Dynamical Systems Towards Glocal Control;* Shinji Hara, The University of Tokyo, Japan

12 - *Characterisation of Urban Vehicular Networks;* Björn Landfeldt, EIT Dept., Lund University

13 - Master's Thesis Presentation: *Modeling and Control of a Parallell Kinematic Robot;* Kristofer Rosquist

19 - *Bandit Optimisation with Large Strategy Sets and Applications;* Alexandre Proutiere, KTH, Stockholm

20 - *Chance-constrained optimization for power systems operation under uncertainty;* Camille Hamon, KTH, Stockholm
21 - *Surviving the Upcoming Data Deluge: A Systems and Control Perspective;* Mario Sznaier, Northeastern University, Boston, USA
22 - Defence Of Doctoral Dissertation: *On Robotic Work-Space Sensing and Control;* Magnus Linderoth, Dept. of Automatic Control, LTH, Lund University
26 - *Robust estimation under the integral quadratic constraint (IQC) framework;* Chung-Yao Kao, Dept. of Electrical Engineering, National Sun Yat-Sen University, Taiwan
28 - *Predictor-based subspace identification in continuous-time, with application to rotorcraft dynamics;* Marco Lovera, Politecnico di Milano, Italy
29 - Defence Of Doctoral Dissertation: *Modeling and Prediction in Diabetes Physiology;* Marzia Cescon, Dept. of Automatic Control, LTH, Lund University
29 - *The Artificial Pancreas;* Roman Hovorka, University of Cambridge, Cambridge, UK

December

3 - *Economic MPC - for Production Optimization of Oil Reservoirs;* John Jørgensen, DTU, Copenhagen, Denmark
6 - *Faithful Implementations of Distributed Algorithms and Control Laws;* Takashi Tanaka, MIT, USA
9 - Master's Thesis Presentation: *Estimation of dialysis treatment efficiency by means of system identification;* Johan Larsson
9 - Master's Thesis Presentation: *Navigation and Autonomous Control of a Hexacopter in Indoor Environments;* Johan Fogelberg
16 - *Control of Wind Turbines: Accomplishments and Continuing Challenges;* Lucy Pao, University of Colorado, USA
17 - Master's Thesis Presentation: *Designing and Implementing a Model-Scale Platoon without Absolute Positioning;* Axel Keskikangas , Gustav Sällberg
17 - *Network Flow Resilience under Cascading Failures;* Ketan Savla, University of Southern California, USA
18 - Master's Thesis Presentation: *Distributed Model Predictive Control of Load Frequency for Power Networks;* Christian Fogelberg
18 - Master's Thesis Presentation: *Physical Parameter Identification Using Haptic Device without a Force Sensor;* Tomohiro Nakano
19 - Master's Thesis Presentation: *Modellering och reglering av en oktakopter;* Henrik Ohlsson; Hrvoje Corluka

LECTURES BY STAFF OUTSIDE THE DEPARTMENT

Årzén, Karl-Erik

Feedback Computing: Feedback-based resource management in embedded systems, GIPSA-lab, Grenoble, France, Feb 22, 2014.
Analysis and Simulation of Embedded Control Performance using Jitterbug and TrueTime, University of Maryland, College Park, MD, April 12, 2014.
LCCC – Linneaus Environment at Lund University, MathWorks Research Faculty Summit, Boston, MA, Jun 1, 2014
Embedded Control Systems, Zhejiang University, Hangzhou, China, Nov 6, 2014.
Analysis and Simulation of Embedded Control Performance using Jitterbug and TrueTime, Zhejiang University, Hangzhou, China, Nov 7, 2014

Åström, Karl Johan

Feedback Fundamentals; Carrier Syracuse, NY, May 6-10.

Early Development of Automatic Control in Sweden; ACCESS, Linneaus Center, KTH, Stochholm, June 28.

Reflections on Engineering Research; Accelerated Careers Workshop, KTH, Stockholm, June 29.

Loopshaping from Bode to Glover; 2nd Workshop on Control of Uncertain Systems: Modelling, Approximation and Design. Cambridge, UK, September 24

Control Computing and Communication; NSF CPS Week, Arlington, VA, October 17.

Controls - A Perspective; Tribute to George Giralt, Toulouse, France, October 28.

Event Based Control; LAAS-CNRS Toulouse, France, October 29.

Bernhardsson, Bo

Matematiken i en mobiltelefon, Sonja Kovalevsky-dagarna, Umeå, Nov 15th, 2013

Bini, Enrico

Optimal Sampling for Linear Control Systems, invited presentation at Technical University Munich, invited by Samarjit Chakraborty, August 26th.

Hägglund, Tore

Detection, diagnosis, and compensation of friction incontrol valves. UNED, Madrid, April 16.

Increased production at Sandvik Process Systems after control improvements. Find-IT, Sandviken, Sweden, November 20.

Johansson, Rolf

Industrial Robots and Work-Space Sensing, 2013 RoSEC Winter School, RoSEC (Robotics Specialized Education Consortium) & Hanyang University, Seoul, Korea, 10 January 2013. Invited Lecture.

Robotic Obstacle Avoidance and Work-Space Force Interaction, 2013 RoSEC Winter School, RoSEC (Robotics Specialized Education Consortium) & Hanyang University, Seoul, Korea, 10 January 2013. Invited Lecture.

Low-complexity MISO Models of T1DM Glucose Metabolism, Asian Control Conference (ASCC 2013), Istanbul, Turkey, 26 June 2013.

Force Controlled Robotic Assembly without a Force Sensor, Workshop on Advanced Robotics for Intelligent Manufacturing in Conjunction with Launch of SIMTech-NUS Joint Labs, Faculty of Engineering, National University of Singapore, Singapore, 23 July 2013. Invited Lecture.

Force Controlled Robotic Assembly without a Force Sensor, Singapore Singapore Institute of Manufacturing Technology (SIMTech), Singapore, 31 July 2013. Invited Lecture.

Nonlinear Feedforward and Reference Systems for Adaptive Flight Control, AIAA Guidance, Navigation, and Control (AIAA GNC 2013) Conference August 19-22, 2013, Boston, MA, USA, 21 August 2013.

Individualized Empirical Models of Carbohydrate and Insulin Effects on T1DM Blood Glucose Dynamics, 2013 IEEE Multi-conference on Systems and Control (MSC2013), Hyderabad, India, 28 August 2013.

Continuous-Time Model Identification Using Non-Uniformly Sampled Data, IEEE AFRICON 2013 Conference, Mauritius, 10 September 2013.

Robotic Work-Space Sensor Fusion and Control, The 7th International Workshop on Innovation and Commercialization of Micro & Nanotechnology (ICMAN2013), Taiyuan, Shanxi, China, 26 October 2013. Invited Lecture.

Rantzer, Anders

Distributed Control of Positive Systems — Towards a Scalable Control Theory, Umeå University, Sweden, February 13, 2013.

On optimal control of heat and power flow, Invited lecture at Institite for Mathematics and its Applications, University of Minnesota, USA, June 14, 2013

Distributed Control of Positive Systems — Towards a Scalable Control Theory, LIDS, Massachusetts Institute of Technology, USA, June 24, 2013.

Scalable Control of Monotone Systems, Invited lecture at SADCO Workshop on optimal and model predictive control, University of Bayreuth, Germany, September 13, 2013.

Scalable Robustness Analysis Using Integral Quadratic Constraints, Invited lecture at 2nd Workshop on Control of Uncertain Systems, Cambridge University, United Kingdom, September 23, 2013.

Scalable Control of Monotone Systems, Invited seminar at ETH, Zürich, Switzerland, November 25, 2013.

Separable Lyapunov Functions for Monotone Systems, 52nd IEEE Conference on Decision and Control, Florence, Italy, December 12, 2013.

Robertsson, Anders

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ISRN LUTFD2/TFRT--4041--SE
ISSN 0280–5316