UNIVERSITY of OULU

OULUN YLIOPISTO

SYSTEMS ENGINEERING LABORATORY

REPORT C

REPORT C33, June 2010

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UNIVERSITY of OULU
OULUN YLIOPISTO

SYSTEMS ENGINEERING LABORATORY
REPORT C

ACTIVITY REPORT

FROM

1.1.2007

TO

31.12.2009

REPORT C 33, JUNE 2010
EDITED BY HARRI AALTONEN

UNIVERSITY OF OULU
DEPARTMENT OF PROCESS AND ENVIRONMENTAL ENGINEERING
SYSTEMS ENGINEERING LABORATORY
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and information about the University of Oulu at
http://www.oulu.fi

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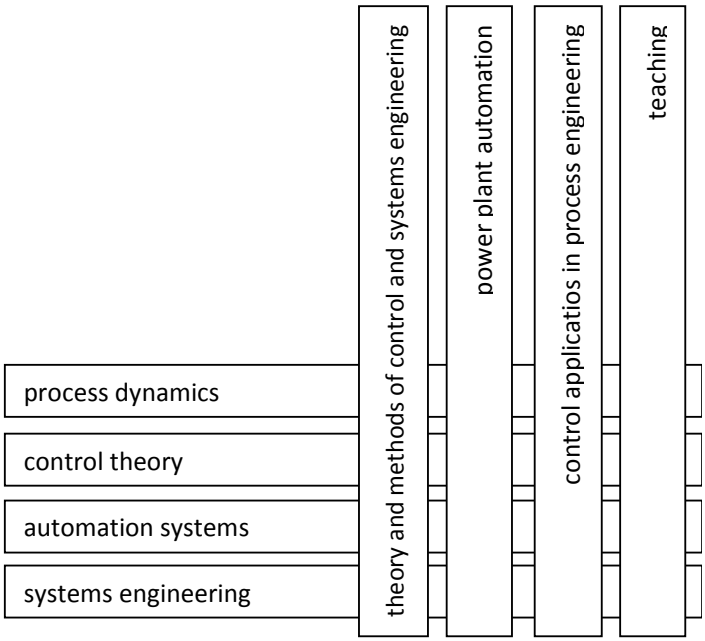
INTRODUCTION

The Systems Engineering Laboratory conducts research and teaches methods of control and systems engineering, and their applications in process automation. Laboratory's field of competence is in control of dynamic systems, and its applications in power plant and pulping automation. We are strong in, e.g., methods of artificial intelligence, experimental and grey-box modelling, monitoring and diagnosis of industrial processes and in non-linear process control methods. In addition, we are interested in advancement of education and research in our field.



The Laboratory teaches fundamentals of process automation, automation systems, control theory, methods of systems engineering, and power plant automation. The staff of the Laboratory consists of a professor, a lecturer, a laboratory engineer, teaching researchers and doctoral students.

The beginning of 2010 marked a new era in the Systems Engineering Laboratory. Professor Urpo Kortela retired after leading the laboratory for more than 20 years. The Systems Engineering Laboratory expresses its warmest thanks to professor Urpo Kortela for leading the way for successful applications of control engineering in the Finnish process industry.

Enso Ikonen started as the new professor in January 2010. During this change of shift, the description of the professorship was revised by the Department of Process and Environemental Engineering as 'theory and methods of control and systems engineering with applications, applications especially in energy engineering'. The laboratory is looking forward to fulfilling its role in the palette of the Department, and in promoting the distinguished sciences of process control and systems engineering.

in Oulu, 11 June 2010

Enso Ikonen
Professor, Head of the Laboratory

1 LABORATORY STAFF

In January 2010, the personnel of the laboratory were the following:

Professor:	D.Sc. (Tech.) Enso Ikonen
Docents:	D.Sc. (Tech.) Ljudmil Golemanov D.Sc. (Tech.) Tapio Heikkilä D.Sc. (Tech.) Enso Ikonen D.Sc. (Tech.) Jenő Kovács D.Sc. (Tech.) Kaddour Najim D.Sc. (Tech.) Urpo Kortela (Professor Emeritus)
Laboratory Manager:	M.Sc. (Tech.) Tapani Karjalainen
Lecturer:	Lic.Sc. (Tech.) Jukka Hiltunen
University Teachers:	Lic.Sc. (Tech.) Manne Tervaskanto (acting) M.Sc. (Tech.) Harri Aaltonen (acting)
Assistant:	M.Sc. (Tech.) Seppo Honkanen
Researchers:	D.Sc. (Tech.) Kimmo Leppäkoski M.Sc. (Tech.) Timo Ahvenlampi M.Sc. (Tech.) Laura Lohiniva
Diploma thesis Worker:	Student Markus Leinonen

Since there have been some changes, the whole list of persons who have worked in our laboratory during the years 2007-2009 is stated below.

Ikonen, Enso	D.Sc. (Tech.)	
	Head of the laboratory	
	Professor	1.1.2010 –
	Senior Assistant	1.8.2005 – 31.12.2009
	Docent	1.11.2001 –
	Academy research fellow, Academy of Finland	1.8.2000 – 31.7.2005
	Post doc researcher	1.4.1998 – 31.7.2000
	Senior assistant	1.4.1998 – (on leave)
Kortela, Urpo	D.Sc. (Tech.)	
	Emeritus professor	1.1.2010 –
	Professor	1.8.1988 – 31.12.2009
Ylinen, Raimo	D.Sc. (Tech.)	
	Emeritus professor	1.8.2003 –
	Professor	1.2.1996 – 31.7.2003
Kovács, Jenő	D.Sc. (Tech.)	
	Docent	1.9.2006 –
	Senior assistant	1.4.1998 – 31.12.2009 (on leave 20.8.2007-31.12.2009)
Hiltunen, Jukka	Lic.Sc. (Tech.)	
	Lecturer	1.7.1998 – (on leave 1.9.1999 – 31.12.2001)
Karjalainen, Tapani	M.Sc. (Tech.)	
	Laboratory manager	1.8.1975 –
Aaltonen, Harri	M.Sc. (Tech.)	
	Acting university teacher	1.1.2010 –
	Acting senior assistant	1.1.2004 – 31.12.2009
	Assistant	1.1.2002 – 31.12.2003
Ahvenlampi, Timo	M.Sc. (Tech.)	
	Researcher	1.1.2000 –
	Assistant	1.9.2009 – 31.12.2009
	Researcher	1.1.1999 – 31.8.2009
Harju, Mikko	Student	
	Diploma worker	1.10.2007 – 31.5.2008
Honkanen, Seppo	M.Sc. (Tech.)	
	Assistant	1.1.2005 –
	Senior assistant	1.1.2002 –31.12.2004

Kerkelä, Arja	Student	
	Diploma worker	1.9.2006 – 22.5.2007
Leinonen, Jukka	Student	
	Diploma worker	1.6.2006 – 30.3.2007
Leppäkoski, Kimmo	D.Sc. (Tech.)	
	Researcher	1.2.1996 –
Leinonen, Markus	Student	
	Diploma worker	29.9.2009 –
Lohiniva, Laura	M.Sc. (Tech.)	
	Researcher	20.11.2009 –
	Research Assistant	1.12.2008 – 19.11.2009
	Part time teacher	1.10.2008 – 30.11.2008
Mononen, Jari	M.Sc. (Tech.)	
	Assistant	1.1.2004 – 22.9.2007
	Researcher	1.1.2001 –31.12.2003
Myllylä, Hannu	Student	
	Research Assistant	1.11.2007 – 31.5.2008
	Assistant	1.9.2007 – -31.10.2007
Palosaari, Minna	M.Sc. (Tech.)	
	Research Assistant	1.11.2006 – 30.6.2007
Selek, István	M.Sc. (Tech.)	
	Researcher	1.1.2007 – 30.3.2009
Tervaskanto, Manne	Lic.Sc. (Tech.)	
	Acting university teacher	1.1.2010 –
	Acting senior assistant	1.6.2009 –31.12.2009
	Researcher	1.5.2009 –31.5.2009
	Acting senior assistant	1.9.2008 –30.4.2009
	Researcher	1.3.2008 –31.8.2008
	Acting senior assistant	1.2.2008 –29.2.2008
	Researcher	26.6.2000 – 31.1.2008
Uusitalo, Miika	Student	
	Research Assistant	8.10.2007 – 31.5.2008
Yli-Korpela, Antti	Student	
	Diploma worker	1.12.2008 – 30.9.2009

2 EDUCATIONAL ACTIVITIES

2.1 Undergraduate courses

Advanced control & systems engineering
The course introduces advanced tools for control engineering, such as predictive control, adaptive control, multivariable control and neuro-fuzzy systems, which are used in applications of non-linear process modelling, control, plant optimisation, monitoring and scheduling. The course consists of 30 lecture hours and 20 hours of class exercises and it has been held yearly during two five-week periods. The participants are fourth year students from the Departments of Process and Environmental Engineering, Electrical and Information Engineering, and Mechanical Engineering.

Lecturer: E. Ikonen
Class exercises: M. Tervaskanto

Examination value: 5,5 ECTS credits (2007, 2008), 5 ECTS credits (2009)

Contents:
- Identifying processes using linear and non-linear models
- Recursive least squares methods
- Parameter estimation
- Kalman filtering
- Neural networks
- Model-based control
- Predictive control
- Multivariable control
- Adaptive control

The course is based on chapters 1-2, 4, 7-8, chapters 6.1 and 9.1, and appendix B of the following book:
- Ikonen, E. and K. Najim, Advanced Process Identification and Control, Marcel Dekker Inc, 2002, 310 p.

Control system analysis
The study module gives basics in control and systems engineering, and about the application methods. The course consists of 24 lecture hours and 24 hours of class exercises and it has been held yearly during two five-week periods. The participants are third year students of the Departments of Process and Environmental Engineering.

Lecturer and class exercises: S. Honkanen

Examination value: 4 ECTS credits

Contents:
- History of control engineering
- Basic concepts of control and systems engineering, elements of control loops, open and closed loop systems

- Mathematical tools, matrix algebra, Laplace- and Z-transforms
- Use of differential and difference equations in description of process dynamics, transfer functions, block diagrams, impulse, step and frequency responses, state representation, solution of state equations, discretization, relationships between different model structures
- Performance specifications, stability, Routh-Hurwitz and Nyquist criteria, Jury's test, Bode diagram, Nichols chart
- Controllers and control algorithms

The course is based on lecture notes with references to the following books:

- Dorf, R. Modern Control Systems. Prentice-Hall 2005. 882 p.
- Ogata, K., Modern Control Engineering. Prentice-Hall 2002. 964 p.
- Phillips, C. and R.D. Harbor, Feedback Control Systems. Prentice-Hall 1988. 626 p.

Control system design

The study module gives a deeper insight view of basics in control and systems engineering especially for applications of automation technology. The course consists of 24 lecture hours and 24 hours of class exercises and it has been held yearly during two five-week periods. The participants are third year students of the Department of Process and Environmental Engineering.

Lecturer and class exercises: S. Honkanen

Examination value: 4 ECTS credits

Contents:

- Dynamic systems
- State-space representation of systems, solving state equations
- State-space control, controllability, observability and stability
- Root locus method
- Design and tuning of analog and digital controllers, compensators, feedforward control
- Control systems and their characteristics.
- Non-linear systems

The course is based on lecture notes with references to the following books:

- Dorf, R. Modern Control Systems. Prentice-Hall 2005. 882 p.
- Ogata, K., Modern Control Engineering. Prentice-Hall 1970. 836 p.
- Phillips, C. and R.D. Harbor, Feedback Control Systems. Prentice-Hall 1988. 626 p.

Control and systems engineering

The course deepens the basic knowledge of control and systems engineering especially for electrical applications. The course consists of 30 lecture hours and 20 hours of class exercises and it has been held yearly during two five-week periods. The participants are third year students of the Departments of Electrical and Information Engineering, and Physics (line of Biophysics).

Lecturer: S. Honkanen
Class exercises: H. Aaltonen

Examination value: 5 ECTS credits

Contents:

- Dynamic systems
- Models of processes
- Stability
- Design and tuning of feedback control
- Controllers and control algorithms
- Transient and steady-state response analyses
- Frequency-response analyses
- Tuning the controller using root locus
- Controllability and observability
- Compensators
- Non-linear systems
- Combined control systems

The course is based on lecture notes with references to the following book:

- Dorf, R. Modern Control Systems. Prentice-Hall 2005. 882 p.
- Ogata, K., Modern Control Engineering. Prentice-Hall 1970. 836 p.

Digital control theory

The course introduces computer controlled, sampled data systems and acquires the knowledge of designing and tuning discrete-time control systems. The course consists of 30 lecture hours and 20 hours of class exercises and it has been held yearly in autumns. The participants are fourth year students of the Departments of Process and Environmental Engineering, and Electrical and Information Engineering.

Lecturers: E. Ikonen, J. Kovács and M. Tervaskanto
Exercises: E. Ikonen, J. Kovács and M. Tervaskanto

Examination value: 5 ECTS credits (2007, 2008), 4 ECTS credits (2009)

Contents:

- Sampled data systems: sampling, Z transformation of signals
- Discrete-time modelling: difference equation, shift operator, pulse transfer function, polynomial and state-space description
- Analysis of discrete-time systems: z-plane, stability
- Discrete-time control design strategies: general RST structure, discrete-time PID control, various pole-zero placement control algorithms, minimum-variance control, model-based control, state-space design methods

The course is based on lecture notes with references to the book:

- Landau, I.D. and Zito, G., Digital Control Systems, design, identification and implementation. Springer Ferlag, 2006. 484p.

Fault Diagnosis and Process Performance Analysis

The course introduces the methods used in fault diagnostics and process performance analysis. The course consists of 30 hours of lecture and class exercises and it has been held yearly during two five-week periods. The participants are fourth year students from the Departments of Process and Environmental Engineering and Electrical and Information Engineering,

Lecturers: J. Hiltunen
Class exercises: T. Ahvenlampi

Examination value: 2 ECTS credits (2009)

Contents:

- Model- and data-based diagnostic methods
- Measurement validation
- Key figure calculation
- Clustering and classification
- Process performance assessment and follow-up
- Application examples

The course is based on lecture notes and laboratory exercises.

Introduction to Automation Engineering

The course introduces the architecture and documentation of digital automation systems. The course consists of 30 lecture hours and 15 hours of class exercises and it has been held yearly during two five-week periods. The participants are first year students of the Departments of Process and Environmental Engineering.

Lecturer: J. Hiltunen and K. Leiviskä (*
Class exercises: H. Aaltonen and. A. Sorsa (*

Examination value: 5 ECTS credits

Contents:

- Goal of automation in industrial production
- Functions of automation
- Specifications and documentation of instrumentation
- Principles of measurements, analysers and sensors, application, installation and purchase of different industrial instruments
- Introduction of characteristics, application and dimensioning of the final control elements such as actuators, positioners, valves and motors
- Automation system level, general features of DCS's and PLC's
- Implementation of automation
- Components, cables and protection and disturbances of process signals

The course is based on lecture and exercise notes.
(* Teaching persons from Control Engineering Laboratory

Laboratory exercises on control and systems engineering
The course consists of about 60 hours of laboratory exercises, which are carried out in one to three student groups. Exercises can be done during six five-week periods in each academic year.

Supervisors: K. Leppäkoski, H. Aaltonen, J. Mononen, and T. Karjalainen

Examination value: 2.5 ECTS credits

Contents:
- Introduction to basic terms and quantities of open and closed loop control.
- Tuning the PID controller with the simulator program
- Tuning the closed loop with relay feedback auto-tuning method
- Tuning the PID controller in the experimental facilities
- Getting familiar with a programmable logic controller.

Laboratory exercises of process engineering
Our laboratory offers two laboratory exercises, which are carried out in one to two student groups. Exercises can be done during six five-week periods in each academic year.

Supervisors: K. Leppäkoski, H. Aaltonen, L. Lohiniva and S. Honkanen

Examination value: 4 ECTS credits

Contents:
- Tuning the PID controller in the experimental facilities
- Getting familiar with a programmable logic controller

Manufacturing automation in electronics
The course consists of 30 lecture hours, 10 hours of class exercises and 20 hours of laboratory exercises and visits in industry and it has been held during spring semester. The participants are fourth year students of the Departments of Process and Environmental Engineering, Electrical and Information Engineering, and Mechanical Engineering (line of Mechatronics).

Lecturer and exercises: H. Aaltonen

Examination value: 5 ECTS credits (2008)

Contents:
- Components and manufacturing processes in electronics
- Cad of manufacturing and production
- Robots, manipulators and conveyors
- Sensors, actuators and logic control
- Machine vision
- Assembly automation

- Testing automation
- Material handling
- Quality control
- Control of material flows and production
- Production economy

The course is based on lecture notes.

Power plant automation

After participating in the course, the students are expected to have the basic knowledge about a) the structure and the operation of the thermal power plant and its automation system, b) the main behaviour of different units and the control philosophies applied. The course has been lectured every second year. The course consists of 30 lecture hours, 20 hours of class exercises and it has been held during every second spring semester. The class-room lectures and exercises are completed with power-plant simulator training, data acquisition via industrial-type automation system (metsoDNA) and field excursions to a local power plant.

Lecturers: J. Kovács, K. Leppäkoski
Class exercises: J. Mononen, E. Ikonen and H. Aaltonen

Examination value: 5 ECTS credits

Contents:

- Introduction to power plants (types, operation)
- Description of the main units (combustion, steam generation, power generation)
- Modelling of power plant units (static, dynamics models)
- Overall and local control strategies
- Automation systems
- Data collection and measurements
- PC-based and automation system control
- Environmental aspects, such as emission pollutions

The course material is based on lecture material and a collection of scientific articles published by the Systems Engineering Laboratory.

Process Automation Systems

The course introduces the architecture of digital automation systems in automation engineering, fieldbus and distributed controls systems (DCS). The course consists of 12 lecture hours, 4 hours of class exercises and excursions to various industrial plants. It has been held yearly during one five-week periods. The participants are second year students of the Departments of Process and Environmental Engineering.

Lecturer: J. Hiltunen
Class exercises: H. Aaltonen

Examination value: 3 ECTS credits

- Automation projects
- Functions of automation
- Data communications techniques in process automation
- Distributed control systems (DCS)
- Fieldbus systems

The course is based on lecture notes and laboratory exercises

Process Information Systems
The course introduces the factory and entire company-wide information systems where automation systems are part of a larger entity. The course consists of 30 hours of lecture and class exercises and it has been held during one five-week periods.

Lecturer: J. Hiltunen

Examination value: 5 ECTS credits (2009)

Contents:
- Purpose of information systems
- Technologies used in wide information systems
- Case study analyses

The course is based on lecture notes and student's presentation notes.

Software and calculation tools in control engineering
The course introduces design and analysis software used in automation. The course consists of 35 hours of lecture and class exercises. It is held during the first two five-week periods of the autumn semester. The participants are fourth year students of the Departments of Process and Environmental Engineering, and Electrical and Information Engineering.

Lecturer: E. Ikonen
Class exercises: H. Aaltonen

Examination value: 5 ECTS credits(* (2007), 3 ECTS credits (2008, 2009)

Contents:
- Modelling of continuous and discrete systems
- Simulation of continuous and discrete systems
- System analysis
- Design of feedback control systems
- Identification
- Monitoring and control software

The course is based on lecture notes.
(* Course name: Design software in automation

Special exercise on control and systems engineering
The purpose of the course is to solve independently an advanced task or problem in control and systems engineering. The course consists of about 50 hours of laboratory or theoretical exercises and it is carried out in groups of one to three students during the academic year.

Supervisors: J. Hiltunen and H. Aaltonen

Examination value: 2.5 ECTS credits

Contents:
- Variable topics in connection with research projects or education.

2.2 Postgraduate courses

Recipient Hydraulics and Surface Water Quality Modelling
The 5 degree course was organised as a joint operation with laboratory of water and environmental engineering in 2008. The section organised by the systems engineering laboratory consisted of one day seminar and exercises: Dynamical systems: Introduction to modelling, parameter estimation, analysis, and design.

Lecturer: Enso Ikonen
Exercises: Manne Tervaskanto

Examination value: 5 ECTS credits

3 LABORATORY FACILITIES

Computer resources

Each person at the Systems Engineering Laboratory has a personal computer with a Windows XP Workstation operating system. Some of the computers are equipped with the hardware and software required for on-line process measurement and control. The laboratory has a Windows Laboratory network and the computers are connected to a local Ethernet network. This network also provides entries into other networks such as FUNET (Finnish University Network), which connects the local networks of all the Finnish Universities to each other, the European-wide networks EARN (European Academic & Research Network), Eunet (European University Network) and the INTERNET.

PCs and laptop computers contain a number of software tools for data processing, process modelling and control design. For heavy calculations, it is possible to connect and use the computers in the Computer Service Centre of the University of Oulu, where several SUN-SPARC server systems with UNIX operating system exist. By the FUNET network, it is possible to access to the centre for scientific computing for using Cray supercomputers.

Facilities for experiments

Laboratory has several automation equipments for the student exercises. A Siemens Simatic S7 programmable logic controller controls water warming and metering equipment. A pilot-scale conductivity process with Foundation Fieldbus compatible equipments is controlled by DeltaV digital automation system.

In the plant hall of the Department of Process and Environmental Engineering, there is a pilot-scale pulp pumping and screening process system. This pilot plant is controlled by a metsoDNA automation system. Pilot-scale system is used for the education and research purposes.

4 RESEARCH

4.1 Novel Way to Control the Combustion of Various Biomasses (NOCOBI)

Project leaders:	Prof. Enso Ikonen 1.1.2010 –
	Prof. Urpo Kortela 1.1.2009 – 31.12.2009
Researchers:	D.Sc. (Tech.) Kimmo Leppäkoski
	M.Sc. (Tech.) Laura Lohiniva
	M.Sc. (Tech.) István Selek
Duration:	1.1.2009 –
Financing:	Academy of Finland

The increasing use of biomasses (peat, waste wood, bark, etc) causes the quality of fuels to be more heterogeneous. The properties and compositions of the fuels vary and therefore the properties of the ash vary as well. The combustion of different biomass fuel-mixtures easily results a growing deposition of ash on the inner surfaces of the boiler if the mixtures of fuel or process conditions are not optimal. New monitoring and control methods for biomass fueled boiler are developed in order to avoid fouling and slagging by utilizing modelling and novel measurement methods. A CFD model for predicting the fouling and slagging is developed. The model is based on the determination of the characteristic properties of the selected fuels and the determination of the main reactions. The optimal control values are found for the combustion of various biomasses. The optimal conditions are modeled based on information gathered from fuel and flue gas analysis by the novel CFD model. New monitoring and control methods, which utilize the novel measurement methods, are applied in combustion of biomasses. By applying the developed methods, the damages of fouling and slagging can be prevented or dampened. Consequently, the usability of the boiler in combustion of various biomasses is improved.

4.2 Modelling and Control of Continuous Cooking: Hardwood Cooking Approach

Project leader:	Prof. Urpo Kortela
Researchers:	D.Sc. (Tech.) Rami Rantanen
	M.Sc. (Tech.) Timo Ahvenlampi
	M.Sc. (Tech.) Esko Similä
	M.Sc. (Tech.) Minna Palosaari
	M.Sc. (Tech.) Miika Uusitalo
	Lic.Sc. (Tech.) Manne Tervaskanto
Duration:	1.1.2006 – 31.12.2008
Financing:	Academy of Finland

The project ‘Modeling and control of continuous cooking: hardwood cooking approach’ focused on the development of cooking models for the hardwood pulping in continuous cooking applications. Also the control of the cooking process was studied. The modeling of the cooking process is challenging due to the delays and nonlinearities in the process. Also the lack of measurements affects the modeling. The tests and modeling were applied using industrial data; laboratory scale analyses were not per-

formed in this study. The cooking models were developed for delignification and compaction. The models were tested in industrial mills and some of the models were implemented into the plant's automation system.

4.3 Mittaavan Käynnissäpidon Kehittämishanke 3, KUPI 3

Project leader: Prof. Enso Ikonen
Researchers: M.Sc. (Tech.) Timo Ahvenlampi
Duration: 1.12.2009 – 30.11.2012
Financing: EAKR

The project focuses on measurement based O&M solutions. One aspect is on integration of condition monitoring and process measurements to find new and better O&M solutions for industrial applications. The tasks include literature survey and case studies in co-operation with industrial and research institute partners.

4.4 Controlled Finite Markov Chains in Process Control (FICO)

Project leader: Prof. Enso Ikonen
Researchers: Prof. Enso Ikonen, Prof. K. Najim, Prof. E. Gomez-Ramirez
Duration: 2006 –
Financing: internal funding

This research concerns the role of finite state probabilistic dynamic models in process control design. The field of controlled finite Markov chains (CFMC) and the related stage-wise optimization techniques are commonly referred to as Markov decision processes (MDP). The MDP approach to process control can be seen as an extension of model predictive control (MPC), or model-based (optimal) process control, which has become increasingly popular in industrial applications of process control. With the advent of increased and reasonably priced computing power and memory resources, the applications of CFMC/MDP techniques has become feasible. Compared to current approaches for modelling, monitoring and control design, we expect the main strengths of such an approaches to be found in improved modelling of propagation of process uncertainties, availability of means for designing optimal controllers for non-linear uncertain dynamic systems, simplified learning from recorded process data, improved methods for exploitation of physical process models and simulation models in process control.

In our work in this field, we have examined the feasibility of process control design for various processes. We have also examined adaptive control based on local CFMC models. We now have built an understanding of the capabilities and limits of the MTM approach in several standard process control tasks, as well as an efficient software package for building and analysing models and controllers. The future work will be targeted towards realization of the potential benefits in handling of uncertainties.

4.5 Genealogical Decision Trees in Process Control

Project leader: Prof. Enso Ikonen
Researchers: Prof. Enso Ikonen, Prof. K. Najim, Prof. E. Gomez-Ramirez
Duration: 2004 – 2009
Financing: internal funding

This research concerns population based random search techniques in process monitoring, control and optimization. Particle filtering (PF) techniques are based on a gridless approximation of the conditional density of the state, given the observations. Particle filters have a number of attractive characteristics. In particular, they are non-parametric and can represent arbitrary distributions. Particle filters are today fairly commonly used in the area of nonlinear filtering, however industrial applications are less frequent in the area of process monitoring and control.

The GDT-based control approach is a random search technique for solving a sequential optimization problems. In our work, we have introduced these techniques for solving open-loop regulation and tracking control problems.

In addition, we have suggested a GDT-based approach for regulation. The essential idea was to use GDT optimization for solving off-line a number of predictive control problems. A finite set of initial states is then constructed from these simulations, for each of which an optimal control sequence has been computed; these trajectories are then used for setting up a controller. Based on our work, a number of GDT-based process control examples along with clear rules for tuning the algorithm parameters have been reported. We are now looking at engineering applications where the particular potential of the GDT-based control/regulation can be exploited. Also applications of 'conventional' PF-techniques in state estimation in the area of process monitoring and control are of our interest.

4.6 Behaviour of Fibre Suspension under Various Flow and Mixing Conditions

Project leader: Prof. Urpo Kortela
Researchers: M.Sc. (Tech.) Harri Aaltonen
Duration: 1998 –
Financing: internal funding

The piping in the approach flow system of a pulp and paper-mill can have a remarkable impact on paper quality. It can cause disturbance in the flow of stock – e.g., due to the position of bends and valves. Sensors that work well in ideal conditions may not be accurate in a pulp and paper-mill. Standards and recommendations given by manufacturers are the basis for the mounting of the sensors. These cannot cover all the practical situations. In particular, different flow interfaces are problematic.

The disturbances of pulp suspensions flow in pipe were tested in pilot plant at the Systems Engineering Laboratory. The effects of separate disturbances on the flow were determined by pressure measurements, tracer tests and pulsed ultrasound-Doppler anemometry. Consistency and velocity of the pulp suspension were the parameters in the process experiments. The results suggest that one way to reduce the calming distance is to install a new flow director upstream of the bends or valves. This consists of

metal sheets fastened inside, parallel to its axis, and can effectively neutralize the "corkscrew" effect without necessarily affecting the turbulence of the pulp flow.

4.7 Modelling and Analysis of Engineering Students Study Paths

Project leader: Docent Pirkko Remes
Researchers: M.Sc. (Tech.) Seppo Honkanen
Duration: 2006 – 2010
Financing: internal funding

In research of engineering studies the graduation processes of eight various groups of students were documented and analyzed. For validation of the data triangulation method was used. The accumulation of study attainments was calculated and, using the measured data, the graduation time models were created. A new method of modeling a non-linear study process by using a Matlab step response model was developed. The model is exact in the essential area of operation and can be used in any educational organization which considers following the process of graduation important.

In this research study attainments were examined and explained with the help of self-regulation test analyses. The test used in this research is based on a shortened version of Guglielmino´s Self Directed Learning Readiness test. It measures the student´s capability for autonomous learning. A connection between good success in studies and observed self-directive learning was noticed as early as during the second academic year.

The engineering study attainments were also compared to the study success in the upper secondary school. The results show that the students with satisfactory learning results in the upper secondary school did better than expected in their university studies. Instead, the students with better success in the upper secondary school than the group mentioned underachieved in their university studies. The students whose success was better than average during the first academic year were also better during the following years.

Examining the study attainments of the eight elementary courses during the three years of studies showed that about 46 percent of students passed the elementary courses in proper time. One year after the elementary courses had been given, 73 per cent of the students had passed them.

4.8 Novel evolutionary methods in engineering optimization-towards robustness and efficiency

Project leader: Prof. Urpo Kortela, Docent Jenő Kovács
Researchers: M.Sc. (Tech.) István Selek
Duration: 1.1.2007 – 30.3.2009
Financing: Fortum Säätiö

In industry there is a high demand for algorithms that can efficiently solve search problems. Evolutionary Computing (EC) belongs to a class of heuristics proven to be well suited to solve search problems, especially optimization tasks due to their flexibility, scalability and robustness. However, despite their advantages and the increasing popu-

larity, there are numerous open questions in this research area, many of them related to the design and tuning of the algorithms.

A neutral technique called Pseudo Redundancy, and related concepts such as Updated Objective Grid (UOG), are proposed to tackle the mentioned problem by making the evolutionary approach more suitable for "real world" applications while increasing its robustness and efficiency. The proposed UOG technique achieves neutral search by objective function transformation(s) resulting in several advantageous features: (a) Simplifies the design of an evolutionary solver by giving population sizing principles and directions to choose the right selection operator; (b) The technique of updated objective grid is adaptive without introducing additional parameters, therefore no parameter tuning required for UOG to adjust it for different environments, introducing robustness; (c) The algorithm of UOG is simple and computationally cheap; (d) It boosts the performance of an evolutionary algorithm on high dimensional (constrained and unconstrained) problems.

The theoretical and experimental results from artificial test problems clearly show the potential of the proposed technique. As the main outcome of the research an evolutionary method to compute (optimal) daily water pump schedules for the water distribution network of Sopron, Hungary was provided. The algorithm is currently working in industry.

5 THESES

5.1 For the degree of Bachelor of Science in Technology

2007 - 2009

Hansen-Haug, Tommi	Hienoaineen määrän ja laadun vaikutus uusiomassan paperiteknisiin ominaisuuksiin
Heikkilä, Milla	Venttiilin ominaiskäyrän laskenta DeltaV-simulointiympäristössä
Hirvelä, Kristian	Neliöpainon vaikutus fraktiokakkujen mittauksessa
Hultgren, Matias	Superkalanterin online-laatumittaukset päällystetyn aikakauslehtipaperin valmistuksessa
Lehto, Veli-Matti	Katalyyttimateriaalit kemikaalien tuotannossa
Manninen, Marko	Rullakuljetinjärjestelmän mitoituksen tarkastelu
Meriläinen, Tuomas	Deoksidaatiotasapainot ruostumattomassa teräksessä
Mikkonen, Jussi	Turvetuotanto ja turpeen asema energiana
Raiskio, Joni	Turbiinin säätö
Rantala, Jaakko	Palautevirtauksia sisältävän säiliösysteemin mallinnus ja simulointi
Visanko, Miikka	Korkeaintensiteettisekoituksen vaikutus kierrätysmassaan pulperoinnin jälkeen

5.2 For the degree of Master of Science in Technology

2007 - 2009

Eilola, Kari	Student recruiting strategy for Department of Process and Environmental Engineering (in Finnish)
Harju, Mikko	Implementation of multivariable control in DeltaV-environment (in Finnish)
Ijäs, Joni	Study of PAC-process modernization and evaluation of investments profitability (in Finnish)
Kerkelä, Arja	Preliminary research on the monitoring systems of operation and maintenance in the power plants (in Finnish)

Leinonen, Jukka	Influence of flow profile to metering point selecting (in Finnish)
Leppänen, Antti	Testing IMS in a mobile phone (in Finnish)
Lohiniva, Laura	Preliminary data analysis for investigation of fouling in two fluidized bed boilers (in Finnish)
Myllylä, Hannu	Control of impregnation conditions in CTMP-process (in Finnish)
Näppä, Sami	Pre-study for manufacturing guidance system (in Finnish)
Okkonen, Heli	Optimization of the filtration of talc concentrate at the Sotkamo plant (in Finnish)
Palosaari, Minna	Modelling hardwood delignification in conventional and modified kraft pulping processes
Tegelberg, Jari	The effect of reliability partial process on paper machine overall efficiency (in Finnish)
Uusitalo, Miika	Modelling of continuous kraft cooking and control of digester compaction degree (in Finnish)
Yli-Korpela, Antti	The effects of chip properties on impregnation process control (in Finnish)

Under progress

Leinonen, Markus	Development of management of technical information in the pilot factory of the Department of Process and Environmental Engineering

5.3 For the degree of Licentiate of Science in Technology

2007 - 2009

Under progress

Aaltonen, Harri	Mass Suspension Flow Disturbances Due to Friction of Different Fittings and Their Significance on the Reliability of Process Measurements

5.4 For the degree of Doctor of Science in Technology

2007 - 2009

Selek, István	Novel Evolutionary Method Engineering Optimization - Towards Robustness and Efficiency

Under progress

Ahvenlampi, Timo	Modelling and Control Of Pulping Processes: Clustering Approach
Heikkinen, Pasi	On-Line Identification of Dynamic Systems
Hietanen, Tero	Prediction of Production Rate and Pulp Properties in the Pressure Screening of the Mechanical Pulps
Hiltunen, Jukka	Description, Analysis and Synthesis - a New Structural Viewpoint on Education and Research in the Engineering Sciences
Hímer, Zoltán	Fuzzy/Neural Modelling Of Combustion using Multifuel in Fluidised Bed Boilers
Honkanen, Seppo	Modelling and Analysis of Engineering Students Study Paths
Järviluoma, Markku	Pose Estimation and Pose Uncertainty in Robotics
Lerssi, Iikka	Modelling and Control of Combustion Power Plant
Mononen, Jari	Identification and Modelling of the Combustion Process in a Thermal Power Plant
Paloranta, Matias	Advanced Control Methods for Fluidized Bed Boilers
Rantaiso, Raimo	Applying Machine Vision in Flotation Optimization
Tervaskanto, Manne	Performance Monitoring of Pulping Processes: Experimental Modeling Approach

6 PAPERS AND PUBLICATIONS

Articles in international scientific journals

Bene, J., **I. Selek**, Cs. Hos (2010). Neutral search technique for short-term pump schedule optimization. *Journal of Water Resources Planning and Management.* 136 (1), pp. 133-137.

Davidyuk, I., **I. Selek**, J. Duran and J. Riekki (2008). Algorithms for Composing Pervasive Applications. *International Journal of Software Engineering and Its Applications*. Vol. 2, No. 2, pages 71-94, April 2008.

Gómez-Ramírez, E., K. Najim and **E. Ikonen** (2007) Forecasting time series with a new architecture for polynomial artificial neural network. *Applied Soft Computing*, 7, pp. 1207-1216.

Ikonen, E. and K. Najim (2009) Multiple model based control using finite controlled Markov chains. *Cognitive Computation*, 1 (3), pp. 234–243.

Ikonen, E., E. Gómez-Ramírez and K. Najim (2009) Process regulation via genealogical decision trees. *Optimal Control Applications and Methods,* 30 (2), pp. 121 – 133. (published on-line 2008, DOI 10.1002/oca.848)

Ikonen, E. and K. Najim (2008) On-line optimization of replacement policies using learning automata. *International Journal of Systems Science*, 39 (3), pp. 237–249.

Najim, K., **E. Ikonen** and E. Gómez-Ramírez (2008) Trajectory tracking control based on a genealogical decision tree controller for robot manipulators *International Journal of Innovative Computing, Information and Control*, 4 (1), pp. 53-62.

Books or chapters in scientific books

Ikonen, E. and **J. Kovacs** (2007) Learning control of fluidized bed combustion processes for power plants. In: S. Kalogirou (Ed.), *Artificial Intelligence in Energy and Renewable Energy Systems*, Nova Publishers, 12, pp. 395-438. (invited) ISBN: 1-60021-261-1

Joronen, T., **J. Kovács** and Majanne, Y. (toim.) *Voimalaitosautomaatio.* SAS julkaisusarja nro 33. Helsinki, 2007. 276 p.. ISBN: 978-952-5183-32-0

Articles in preprints and proceedings of international meetings

Ahvenlampi, T., M. Liedes and T. Malmi (2009) Control of the impregnation vessel has big influences to the pulp quality. *Papermaking Research Symposium, 1-4 June, Kuopio, Finland* (CD-rom proceedings). 11 p.

Ahvenlampi, T., M. Liedes and T. Malmi (2009) Control of the impregnation vessel has big influences to the pulp quality. *Papermaking Research Symposium, 1-4 June, Kuopio, Finland* (Book of Abstracts).

Ahvenlampi, T. (2009) Modeling of alkali profile and inner flows in continuous cooking application Proceedings 15th International Symposium on Wood, Fiber and Pulping Chemistry (ISWFPC 2009), Oslo, June 15 – 18, 2009

Ahvenlampi, T. and **M. Palosaari** (2008) Comparison of hardwood delignification models in conventional cotinuous kraft cooking application. *The 27th IASTED International Conference on Modelling, Identification and Control* (MIC 2008), February 11 13, 2008, Innsbruck, Austria. 6 p.

Ahvenlampi, T. and **M. Uusitalo** (2008) Diagnosis of extraction screen plugging in continuous cooking application. *The 22nd annual European Simulation and Modelling Conference* (ESM'2008), October 27-29, 2008, Universite du Havre, Le Havre. 161-167.

Ahvenlampi, T. and **R**. **Rantanen** (2007) Enhancing Kappa number control in Down-flow Lo-Solids digester using diagnosis and modelling. *4th International Conference on Informatics in Control, Automation and Robotics* (ICINCO'07), 9-12 May 2007, Angers, France. 2007.

Ikonen, E. (2009) Gain scheduling control with Markov transition models. *The 7th IEEE International Conference on Control and Automation* (ICCA'09), 9-11 Dec 2009, Christchurch, New Zealand, 258-263.

Ikonen, E., **M. Tervaskanto** and K. Najim (2009) Analysis of students' study paths using finite Markov chains. *The 7th IEEE Intenational Conference on Control and Automation* (ICCA'09) , 9-11 Dec 2009, Christchurch, New Zealand, 1813-1818.

Ikonen, E., **K. Leppäkoski** and **U. Kortela** (2009) Model-based multivariable secondary air control using controlled finite Markov chains. *IFAC Power Plants and Power Systems Control* (PP&PSC'09), Tampere, 5-8 July 2009.

Ikonen, E. and **U. Kortela** (2008) Adaptive process control using controlled finite Markov chains based on multiple models. *17th IFAC World Congress*, 6-11 July 2008, Seoul, Korea, pp. 7919–7924.

Ikonen, E., K. Najim and **U. Kortela** (2007) State estimation and predictive control using finite Markov chains. *IFAC Workshop on Advanced Fuzzy and Neural Control* (AFNC'07), 29-30 Oct 2007, Valenciennes, France.

Ikonen, E. (2007) Model-based process control via finite Markov chains. *9'th IFAC Workshop on Adaptation and Learning in Control and Signal Processing (*AL-COSP'07), 29-31 Aug 2007, St-Petersburg, Russia. (available at open library http://lib.physcon.ru)

Ikonen, E. (2007) Process control using controlled finite Markov chains with an application to a multivariable hybrid plant. *4 th International Conference on Informatics in Control, Automation and Robotics* (ICINCO'07), 9-12 May 2007, Angers, France

Leppäkoski, K. and **H. Aaltonen** (2009). An implementation of compensation of interactions in a DeltaV automation system. The 15th Nordic Process Control Workshop Workshop (NPCW'09), Telemark University College, Porsgrunn, Norway, January 29-30, 2009. 6 p.

Leppäkoski, K. (2007) Gain scheduling control in a secondary air control system. *14th Nordic Process Control Workshop,* 23-25 August 2007, Espoo, Finland. CD-rom. 2007.

Palosaari, M. and **T. Ahvenlampi** (2007) Modelling hardwood delignification in continuous Downflow Lo-Solids cooking. European Simulation and Modelling Conference (ESM 2007), October 22-24, 2007, St. Julians, Malta. 2007. 227-229.

Savolainen, J., P. Kangas, **M. Tervaskanto, T. Ahvenlampi** and V. Hietanen (2007) Utilization of dynamic simulation in the improvement of a pulping process. *6th EUROSIM congress*, September 9-13, 2007, Ljubljana, Slovenia. Cd-rom. 2007.

Tervaskanto M. and **T. Ahvenlampi** (2009) Dynamic simulation and quality control in chemi-thermomechanical pulping. *Papermaking Research Symposium 2009*, Kuopio, Finland. CD-rom, 2007.

Tervaskanto, M., **E. Ikonen** and **T. Ahvenlampi** (2009) Refiner quality control in a CTMP plant. *The 7th IEEE International Conference on Control and Automation* (ICCA'09), 9-11 Dec 2009, Christchurch, New Zealand, 1266-1271.

Tervaskanto, M., **T. Ahvenlampi,** T. Harju and T. Sippus (2007) Shive content modeling and simulation of chemi-thermomechanical pulping. Tappi Engineering, Pulping and Environmental Conference '07, October 21-24, 2007, Jacksonville, Florida. 2007.

Uusitalo, M. and **T. Ahvenlampi.** (2008) Modelling of compaction and residence times in continuous cooking application. The 22nd annual European Simulation and Modelling Conference (ESM'2008), October 27-29, 2008, Universite du Havre, Le Havre, France. 44-50 p.

Articles in journals, preprints or proceedings of national meetings

Aaltonen, H. Kohinallisen painemittauksen käsittely Kalman-suotimella. Automaatio XVIII 2009, Hotelli Crowne Plaza, Helsinki, 17.-18.3.2009. SAS julkaisusarja nro 36 CD-rom.

Ahvenlampi, T., M. Liedes, T. Malmi and **E. Ikonen** (2009) Improved control of the cooking process reduces energy consumption in Kraft pulping. *EnePro Conference*, 3 Jun 2009, Oulu, Finland (long abstract), 120-122.

Ikonen, E. and **K. Leppäkoski** (2009) Artificial intelligence –based modeling and control of fluidized-bed combustion. *Energy Research at the University of Oulu – Proceedings of the EnePro conference*, 3 Jun 2009, Oulu, Finland (long abstract), 46-49.

Leppäkoski, K., **E. Ikonen**, **I. Selek**, **L. Lohiniva**, **U. Kortela**, E. Muurinen and M. Tiainen (2009) An interdiciplinary approach for improving power plant control. *EnePro Conference*, 3 Jun 2009, Oulu, Finland (long abstract), 44-45.

Leppäkoski, K., **A. Kerkelä** and **L. Lohiniva** (2009) Voimalaitosten käytönvalvonnan nykytilanne. *Automaatio XVIII 2009*, Hotelli Crowne Plaza, Helsinki, 17.-18.3.2009. SAS julkaisusarja nro 36 CD-rom.

Mononen, J. and **K. Leppäkoski** (2007) Voimalaitosautomaation opetus hyödyntää tutkimusprojektien tuloksia. *Automaatioväylä 2*, pp.14-16.

Articles published in laboratory series or other material

Aaltonen, H. (2009) Voimalaitosautomaatio-kurssin harjoitukset Historian Configuration in metsoDNA Automation System, 17 p. (exercise/lecture material)

Aaltonen, H. (2009). Säätö- ja systeemitekniikka-kurssin harjoitukset, 82 p. (exercise material)

Aaltonen, H. (2009). Prosessiautomaatiojärjestelmät-kurssin harjoitukset DeltaV-automaatiojärjestelmä, 20 p and Siemens Simatic S7- ohjelmoitava logiikka, 7 p. (exercise material)

Aaltonen, H. (2009) Automaatiotekniikan perusta-kurssin harjoitukset Valvomodemon materiaali, 10 p. (exercise/lecture material)

Ikonen, E. (2009) Voimalaitosautomaatio-kurssin harjoitukset metsoDNA:n PowerDemo –simulaattorilla, 27 p. (exercise/lecture material)

Ikonen, E. (2008) Power plant automation. In: Energy and air – sustainable energy and air pollution control, leaflet, University of Oulu, p 6. (abstract)

Ikonen, E. (2007) MGCM Matlab toolbox (Controlled finite Markov chains). Free to download at http://cc.oulu.fi/~iko/MGCM/MGCM.htm

Ikonen E. and **M. Tervaskanto** (2009) IEEE Control and Automation (ICCA'09), Christchurch, Uusi Seelanti. Automaatioväylä (submitted)

Ikonen, E. and **T. Ahvenlampi** (2007) *ICINCO 2007 Fourth International Conference on Informatics in Control Automation and Robotics*, 9-12.5.2007, Angers, Ranska. Automaatioväylä, 23, no 4, p 53.

Tervaskanto, M. (2007) Performance indexes for monitoring of pulping processes. – University of Oulu, Systems Engineering Laboratory. Report C nro 31. Oulu, 2007. 130 p.

Tervaskanto, M., **T. Ahvenlampi,** J. Savolainen, P. Kangas and T. Harju (2007). Kirjallisuuskatsaus lajittamon diagnostiikkaan ja säätöön. University of Oulu, Systems Engineering Laboratory. Raportti A nro 31. Oulu, 2007. 52 p.

7 PARTICIPATION TO CONFERENCES & MEETINGS

Enso Ikonen participated in

- The 7th IEEE Intenational Conference on Control and Automation (ICCA'09), 9-11 Dec 2009, Christchurch, New Zealand. (presentation + co-chair)
- IFAC Symposium on Power Plants & Power Systems Control, Tampere, 5-8 July 2009 (presentation + chairman)

- EnePro-Conference – Advancing Energy Research at the University of Oulu, 3 June 2009, Oulu, Finland. (presentation)
- 17th IFAC World Congress, 6-11 July 2008, Seoul, Korea (presentation + chairman)
- IFAC Workshop on Advanced Fuzzy/Neural Control (AFNC'07), 29-30 October 2007, Valenciennes, France (presentation + chairman)
- 4th International Conference on Informatics in Control, Automation and Robotics (ICINCO'07), 9-12 May 2007, Angers, France (presentation + chairman)

Harri Aaltonen participated in
- Automaatio XVIII 2009, Hotelli Crowne Plaza, Helsinki, 17.-18.3.2009. (presentation)
- EnePro-Conference – Advancing Energy Research at the University of Oulu, 3 June 2009, Oulu, Finland.

Timo Ahvenlampi participated in
- Proceedings 15th International Symposium on Wood, Fiber and Pulping Chemistry (ISWFPC 2009), Oslo, June 15 – 18, 2009 (presentation)
- The 27th IASTED International Conference on Modelling, Identification and Control (MIC 2008), February 11-13, 2008, Innsbruck, Austria (presentation)
- European Simulation and Modelling Conference (ESM 2007), October 22-24, 2007 (presentation)
- The 22nd annual European Simulation and Modelling Conference (ESM'2008) (presentation)
- Papermaking Research Symposium, 1-4 June 2009, Kuopio, Finland. (presentation)
- 4th International Conference on Informatics in Control, Automation and Robotics (ICINCO'07), 9-12 May 2007, Angers, France (presentation + chairman)
-

Kimmo Leppäkoski participated in
- Automaatio XVIII 2009, Hotelli Crowne Plaza, Helsinki, 17.-18.3.2009. (presentation)
- The 15th Nordic Process Control Workshop Workshop (NPCW'09) (presentation)
- 14th Nordic Process Control Workshop, 23-25 August 2007 (presentation)
- EnePro-Conference – Advancing Energy Research at the University of Oulu, 3 June 2009, Oulu, Finland.

Laura Lohiniva participated in
- EnePro-Conference – Advancing Energy Research at the University of Oulu, 3 June 2009, Oulu, Finland.

Manne Tervaskanto participated in
- The 7th IEEE International Conference on Control and Automation (ICCA'09), 9-11 Dec 2009 (presentation)
- Papermaking Research Symposium, 1-4 June 2009, Kuopio, Finland. (presentation)
- Tappi Engineering, Pulping and Environmental Conference '07, October 21-24, 2007, Jacksonville, Florida. (presentation)

8 VISITORS AND VISITS

VISITS

Enso Ikonen visited at the E.N.S.I.A.C.E.T. Toulouse (France), 24 – 28 Oct 2007

9 OTHER ACTIVITIES

Enso Ikonen

- a member of IFAC Technical Committee on Adaptive and Learning Systems, IFAC TC 1.2 (2006-2009, 2010-2012)
- a member of IFAC Technical Committee on Cognition and Control, IFAC TC 3.2 (2007-2009)
- a member of Suomen Automaatioseura ry (Finnish Society of Automation), 2004-
- a member of a preparatory committee for an Environmental Engineering Development Programme, University of Oulu (2008)
- a member of Working group for doctoral study development – JOPOKKI, University of Oulu (2009–)
- an evaluator for scientific journals
  - Computers & Chemical Engineering
  - IEEE Transactions on Control Systems Technology
  - International Journal of Technology, Modelling and Management
  - International Journal of Engineering, Science and Technology
  - Chemical Papers
  - International Journal of Environment and Pollution
  - Neurocomputing
- an evaluator of project proposals and books
  - Book proposal evaluation “Industrial Process Identification and Control Design”, Springer. (2009)
- a member of international program committees:
  - IEEE International Conference on Systems, Man, and Cybernetics (SMC2010), 10 - 13 Oct 2010, Istanbul, Turkey (2010)
  - IFAC Workshop on Adaptation and Learning in Control and Signal Processing (ALCOSP 2010), 26-28 Aug 2010, Antalya, Turkey (2009-2010)
  - 2nd IFAC International Symposium on Intelligent Control Systems and Signal Processing (ICONS'09), 21-23 Sept, Istanbul, Turkey, 2009 (2008)
  - 2nd IFAC International Symposium on Intelligent Control Systems and Signal Processing (ICONS'09), 21-23 Sept, Istanbul, Turkey, 2009 (2008)
  - 2nd IFAC International Symposium on Intelligent Control Systems and Signal Processing (ICONS'09), 21-23 Sept, Istanbul, Turkey, 2009 (2008)
  - Annual North American Simulation Technology Conference (NASTEC 2008), 13 - 15 August, Montreal, Canada (2008)
  - Suomen Automaatioseuran XVIII Automaatioseminaari, 17-18.3.2009, Helsinki (2008).
  - SIWN International Conference on Industrial Informatics and Systems Engineering (IISE 2008), 21-24 July 2008, Glasgow, U.K (2008)

  - 7th World Contress on Intelligent Control and Automation (WCICA08), 25-27 June, 2008, Chongqing, China. (2008)
  - 3rd IFAC Workshop on Advanced Fuzzy and Neural Control 2007 (AFNC 07), 29-30 October 2007, Valenciennes, France. (2007)
- a reviewer for international scientific conferences:
  - Conference on Control and Fault-Tolerant Systems (SysTol'10)
  - 2010 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2010)
  - 22nd Chinese Control and Decision Conference (2010 CCDC) 2010
  - IFAC Conference on Intelligent Control Systems and SignalProcessing (ICONS'09) 2009
  - IFAC Symposium on Power Plants and Power Systems Control (PP&PSC) 2009
  - Automaatio XVIII Seminaari 2009
  - IFAC Symposium on System Identification (SYSID'09) 2009
  - IFAC World Congress 2008
  - IFAC Workshop on Advanced Fuzzy-Neural Control 2007 (AFNC'07):
  - IFAC Adaptation and Learning in Control and Signal Processing (ALCOSP '07)
  - IEEE Symposium on Computational Intelligence and DataMining (CIDM 2007)

Urpo Kortela

- a member of the Board of the Fieldbus Division of the Finnish Society of Automatic Control
- a member of the organizing committee of the educational programme in Computer and Information Science at the University of Oulu
- a member of the Board of Fortum Foundation
- Manager of the North Finland Biomass Project 1994 –
- an evaluator for applications of several research projects and vacancies of Academy of Finland
- Docent in control engineering at Tampere University of Technology

Jenő Kovács

- a reviewer for IFAC Control of Power Plants and Power Systems 2009
- a member of Suomen Automaatioseura ry (Finnish Society of Automation), 1998-
- a boardmember of FSA Energy of Finnish Society of Automation, 2008-

Jukka Hiltunen

- a head of the Department of Process and Environmental Engineering (1.8.2006 -)
- a vice-head of the Department of Process and Environmental Engineering (1.1.2006-31.7.2006)
- a vice-chairman and a member of the Board of the Finnish Society of Automation

- a member of the Training Committee of the Finnish Society of Automation
- a member of the Department Council in the Department of Process and Environmental Engineering
- a chairman and a coordinator of the curriculum reform work group in the Department of Process and Environmental Engineering
- a representator of the Faculty of Technology in the University of Oulu in projects concerning technological education
- a chairman in the teaching development team in the Department of Process and Environmental Engineering

Harri Aaltonen

- a member of Suomen Automaatioseura ry (Finnish Society of Automation), 1998-

Timo Ahvenlampi

- a member of Suomen Automaatioseura ry (Finnish Society of Automation), 1998-

Manne Tervaskanto

- a part time teacher in the Oulu University of Applied Sciences
- a member of Suomen Automaatioseura ry (Finnish Society of Automation), 2000-

Bilateral Agreements and Erasmus exchange programs of the Systems Engineering Laboratory

- Ecole Nationale Supérieure des Ingénieurs en Arts Chimiques et Technologiques, Laboratoire de Contrôle des Procédés, Toulouse, France (E.N.S.I.A.C.E.T

- Budapest University of Technology and Economics, Hungary, Faculty of Mechanical Engineering, Department of Informatics and Management and Control

- Budapest University of Technology and Economics, Hungary, Faculty of Electrical Engineering, Department of Automation and Applied Information

- Budapest University of Technology and Economics, Hungary, Faculty of Electrical Engineering, Department of Measurement and Information Systems,

- Universidad Politecnica de Valencia, Spain, Dep.Ing. de Sistemas y Automatica

- University of Hannover, Germany, Institute of Automatic Control