

# DEPARTMENT OF COMPUTER AUTOMATION AND CONTROL E-2



Head:

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The Department of Computer Automation and Control is engaged in research, development, applications and education in the area of control technology. These activities are carried out in close cooperation with the Faculty of Electrical Engineering of the University of Ljubljana and the engineering company INEA. These three institutions make a consortium referred to as the “Technology vertical”, the aim of which is to merge expertise with knowledge transfer. To further stimulate cooperation with industry, a technology centre, referred to as the ConTech Centre, has been established within the Department.

### Basic and applied research

In the area of **process diagnosis**, part of our work was devoted to robust detection of sensor faults by means of statistical tests. This approach allows relatively reliable detection of faults

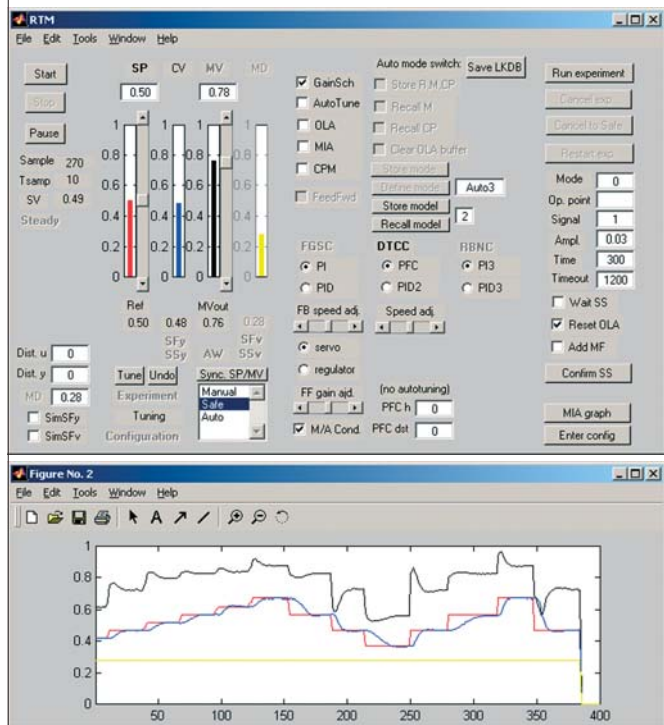
despite the presence of modelling errors. Another key topic of interest was mathematical modelling appropriate for use in process diagnosis. Results confirmed that it is relatively easy to develop models that enable reliable detection of faults. Isolation, however, requires much more complex models, which must reflect the physical background of the processes under consideration. Quite a substantial part of our activity was devoted to tailoring the methods developed to meet practical limitations, especially those related to fault detection in thermal processes and electrical drives. It is important to mention that many activities in the area of process diagnosis were carried out in close cooperation with research groups from Germany, Czech Republic and Hungary.

In the area of **(model-based) process control and optimization**, research was concerned with general purpose control methods. Many issues in predictive control, further refinements of the magnitude optimum multiple integration (MOMI) tuning method for PID controllers, and development of non-linear control algorithms have been addressed. More specifically, the design of non-linear controllers, combining fuzzy gain scheduling and velocity linearization, was successfully applied within a 5FP project. Promising results were also achieved in a case study related to the control of grinding mills in the cement industry.

Part of the research was related to mathematical modelling, simulation and control design for waste-water treatment processes, an area that has been of interest for quite some time. Extensive simulation studies were performed on mathematical models of the Wastewater treatment plant Domžale-Kamnik. In addition, control algorithms were developed for the benchmark problem, issued in an international (COST) project. In this framework a feed-forward feedback strategy was employed by using a simplified mathematical model of the plant in the feed-forward path.

In the area of **computer integrated production in process industry**, work has been progressing along three lines. The first regards domain engineering, where a simple tool for automatic translation of specifications into PLC code was developed. The second line focused

on problems of scheduling in production processes. The emphasis was on appropriate problem formulation and analysis of usability of the existing scheduling tools. The third line addressed non-technical



**Figure 1: Testing the prototype of the Run-Time Module containing advanced control algorithms in a MATLAB environment**

aspects of control technology. In particular, the role of “critical success factors” in implementing control/automation technology projects was extensively studied. A comprehensive study, including a historical overview of activities and suggestions for new research orientations in the area covered by IFAC TC “Social Impact of Automation” was carried out.

**2001 marked the 15<sup>th</sup> anniversary of our department. We are very glad that in this very year our co-worker Damir Vrančić was awarded the Jožef Stefan Golden Emblem Prize for his Ph. D. thesis, and that the Jožef Stefan Institute Roll of Honour was awarded to one of our main industrial partners Cinkarna, Celje.**

### R & D projects

Our traditionally well developed cooperation with industry was even intensified in 2001.

A substantial part of our activities was devoted to developing products and tools for control systems. The bulk of the work was done on advanced control algorithms in the frame of ASPECT – the 5FP project (Fig. 1). Final users of the product will be three SME's, one from Slovenia, one from Greece and one from Bulgaria.

Cooperation with companies INEA and MITSUBISHI EUROPE in the area of design and development of special-purpose HW and SW modules progressed further. The emphasis was on development of new and refinement of existing algorithms for controlling plastic extruders.

An important part of our work was focused on the design of process supervision and control systems. These entail the development of a supervision system for detecting faults on electrical motors (for the company DOMEL, Železniki); developing control systems in titanium dioxide production (for Cinkarna, Celje); enhancing the control systems for PVA glues production (for MITOL, Sežana); developing a supervision and fault detection system for the incineration unit at a tyre plant (SAVA, Kranj) and developing a control system for a stainless steel slitter line in ACRONI steel production plant (sub-contractor of SIP-MOBIL, Šempeter) (Fig. 2).

In addition, two feasibility studies for the possible introduction of control/information systems were performed, one for METAL company, Ravne na Koroškem, and the other for IUV, Vrhnika.

### Educational activities

Some members of the department give lectures and practical courses at the Faculty of Electrical Engineering, University of Ljubljana and the Polytechnic of Nova Gorica. They also act as supervisors of M.Sc and Ph.D. students. Special care was dedicated to post-qualification training for engineers from industry. In 2001, three one-week courses were organized in close co-operation with the Information Technologies Knowledge transfer Centre at the Institute.

### Some outstanding publications in the past three years

1. Gregor Dolanc, Stanko Strmčnik, Janko Petrovčič, NO<sub>x</sub> selective catalytic reduction control based on simple models. J. Process control. [Print ed.], 2001, vol. 11, pp. 35-51.
2. Đani Juričić, Olaf Moseler, Andrej Rakar. Model-based condition monitoring of an actuator system driven by a brushless DC motor. Control Engineering Practice. [Print ed.], 2001, vol. 9, pp. 545-554.
3. Damir Vrančić, Stanko Strmčnik, Đani Juričić. A magnitude optimum multiple integration tuning method for filtered PID controller. Automatica (Oxf.). [Print ed.], 2001, vol. 37, pp. 1473-1479.
4. Darko Vrečko, Nadja Hvala, Juš Kocijan, Mario Zec. System analysis for optimal control of a wastewater treatment benchmark. Water sci. technol., 2001, vol. 43, pp. 199-206.



UZ1 - ultrasonic distance measurement (uncoller diameter)  
 UZ2 - ultrasonic distance measurement (recoiler diameter)  
 UZ3 - ultrasonic distance measurement (exit loop level)  
 POT - potentiometer (entry loop level)  
 EM1 - DC drive - uncoller  
 EM2 - DC drive - recoiler  
 EM3 - DC drive - slitter  
 AM - AC drive - scrap dropper  
 IMP1 - inductive switch - angular velocity of uncoller motor  
 IMP2 - inductive switch - angular velocity of recoiler motor  
 IMP3 - inductive switch - angular velocity of slitter motor  
 IMP4 - inductive switch - angular velocity of scrap dropper motor

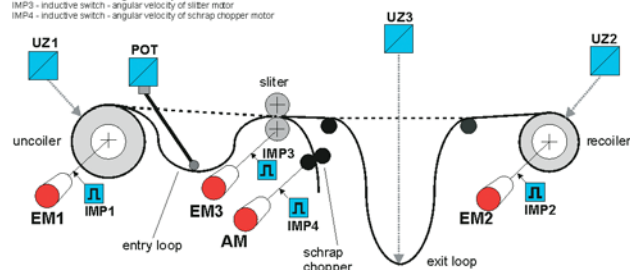


Figure 2: Control system for a stainless steel slitter line

### The most important technological achievement in the past three years

1. SPAC-20 – Co-processor for High-End Control and Special Process Applications (J. Petrovčič, J. Grom, M. Štrubelj)

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## PATENT

### Patent granted

- Matjaž Mikoš, Janko Petrovič, Mojca Escorza Spazzapan  
Postopek in naprava za merjenje elementov dinamike gibanja in sil, ki delujejo na posamezne delce v naravnem okolju, zlasti v prodnatih plavinah v vodotokih Ljubljana, Urad Republike Slovenije za intelektualno lastnino, 30.04.2001.

## THESES

### B. Sc. Theses

- Benjamin Čokan: The assessment of velocity-based linearization for non-linear control and state observer (Juš Kocijan)
- Miha Menard: Diagnostic system for a flue gas conditioning technological process (Andrej Rakar)
- Janez Petrič: The comparison of optimisation methods for biological wastewater treatment plants modelling (Juš Kocijan)
- Aleš Regent: Airing and shading control of the greenhouse (Damir Vrančič)
- Jože Rotar: Requirements definition for a building security system (Juš Kocijan)
- Sebastijan Zorzut: Realisation of a Control System for Gas separation Subprocess using Siemens SIMATIC PCS7 Development Environment (Giovanni Godena)

### M. Sc. Theses

- Gregor Bavdaž: The optimisation of mill systems operation in cement industry (Juš Kocijan)
- Robert Marinšek: Human-centered design of information technology with an example of human-machine interface for control of batch production (Janko Černetič, Stanko Strmčnik)

## MESS SUPPORTED RESEARCH AND DEVELOPMENT GRANTS AND CONTRACTS

- System for Electromotors Final Quality Checking  
Dr. Mina Žele

### Research program

- Computer Automation and Control  
Prof. Stanislav Strmčnik

## INTERNATIONAL PROJECTS

- Advanced Control Algorithms for Programmable Logic Controllers (PLCs) ASPECT; IST-1999-56407 (CRAFT), 5. FP  
EC; Dr. Zoran Marinšek, INEA d. o. o., Domžale, Slovenia  
Prof. Stanko Strmčnik
- Multi-Agent Control: Probabilistic Reasoning, Optimal Coordination, Stability Analysis and Controller Design for Intelligent Hybrid System  
MAC; HPRN-CT-1999-00107, (Research Training Network), 5. FP  
EC; Dr. Roderick Murray-Smith, University of Glasgow, Department of Computing Science, Glasgow, Great Britain  
Prof. Juš Kocijan
- Optimal Management of Waste - Water Systems  
COST 624, 3311-01-837046  
EC  
Dr. Nadja Hvala
- Analysis and Control of SBR Waste - Water Treatment Systems  
Prof. Stefano Marsili - Libeli, University of Florence, Department of Systems and Computers, Firenze, Italy  
Dr. Nadja Hvala
- Intelligent Hierarchical Control of Wastewater Treatment Plants  
Prof. Robert E. King, Computer Technology Institute, Patras, Greece  
Prof. Juš Kocijan
- Advanced Tools for Control and Monitoring of Complex Systems  
Dr. Tatiana Guy, Institute of Information Theory and Automation, Prague, Czech Republic  
Dr. Đani Juričič
- Nonlinear Model-based Condition Monitoring for Chemical and Process Industries  
Dr. Katalin Hangos, Computer and Automation Research Institute, Hungarian Academy of Sciences, Budapest, Hungary  
Dr. Đani Juričič

## NEW CONTRACTS SIGNED

- Testing set-up "Krogograf"  
Kolektor, d.o.o., Idrija  
Dr. Vladimir Jovan
- Prototype of a system for automatic control of electromotor's quality  
Domel, d.d., Železniki  
Dr. Mina Žele
- Control of metal sheet cutting line  
Sip Mobil, d. o. o., Šempeter v Sav. dolini  
Dr. Gregor Dolanc
- Computer subsystem for final control of vacuum cleaner motor based on vibration analysis  
Domel, d. d., Železniki  
Dr. Đani Juričič

## VISITORS FROM ABROAD

- King Robert, prof. dr., University of Patras, Greece, 11.1.2001
- Stathaki Anna, dr., Computer Technology Institute, Athens, Greece, 11.1.2001

3. Dmitrii G. Luchinsky, dr., Department of Physics, University of Lancaster, Lancaster, Great Britain, 12.4.2001
4. Juan Francisco Santa Pau Valls, Polytechnic University, Valencia, Spain, 9.7.-18.8.2001
5. King Robert, prof. dr., University of Patras, Greece, 9.-14.7.2001
6. Stathaki Anna, dr., Computer Technology Institute, Atene, Greece, 9-14.7.2001
7. Valentine-Guy Tatiana, Czech Academy of Sciences, Prague, Czech Republic, 15.-22.9.2001
8. Grancharova, Alexandra, dr., Bulgarian Academy of Sciences, Sofia, Bulgaria 26.9.2001
9. Palus Milan, dr., Czech Academy of Sciences, Prague, Czech Republic, 23.-31.10.2001
10. Juelich Jutta, Mitsubishi Electric Europe, Rattingen, Germany, 11.-12.12.2001
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## ORGANIZATION OF CONFERENCES AND MEETINGS

1. Production management and information systems: continuing education (specialisation) course in Control Technology, Ljubljana, February 12-16, 2001
2. Automation and information systems projects: continuing education (specialisation) course in Control Technology, Ljubljana, April 9-13, 2001
3. organization of the "Multi-agent control: probabilistic reasoning, optimal coordination, stability analysis and controller design for intelligent hybrid systems Summer School", Kranjska gora, September 16-21, 2001
4. Building blocks for computer automation: continuing education (specialisation) course in Control Technology, Ljubljana, October 15-19, 2001

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19. Gregor Kandare, B. Sc.
20. Dejan Tinta, B. Sc.
21. *Dr. Marko Valjavec, left 01.09.2001*
22. Darko Vrečko, B. Sc.
23. Sebastjan Zorzut, B. Sc.

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24. Giovanni Godena, B. Sc.
25. Dr. Zoran Marinšek\*\*\*
26. *Matjaž Šubelj, M. Sc., pause 31.12.1998*

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