

SLOVAK UNIVERSITY OF TECHNOLOGY
FACULTY OF CHEMICAL AND FOOD TECHNOLOGY

DEPARTMENT OF INFORMATION
ENGINEERING AND PROCESS CONTROL

ANNUAL REPORT

2002

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I PREFACE

Department of Information Engineering and Process Control has at the Faculty of Chemical and Food Technology of the Slovak University of Technology more than forty-year tradition. In the frame of the study branch Chemical Engineering and Process Control on the specialisation Process Control, it educates high-qualified specialists in the field of process control for design, implementation and processing of control systems.

Nowadays, process control with using microprocessor based control technique represents important and acknowledged scientific branch. This branch more and more influences the economic and social growth in the whole world and successively also in our country. The chemical, food and pharmaceutical industries with their technologies are no exceptions. No technology is able to be successful in the competition without optimisation and advanced control systems. In the connection with these facts, all our graduates have found their jobs without problems during the whole history of the department. It confirms also, that the education of the specialists in the process control has been very attractive and its significance is even growing. The graduates of the department do well not only in the firms and institutions oriented on design and supplying of control systems for various technologies but also in the bank sector and they found their own firms respectively.

Teaching and research activities of the department are oriented on process control, identification and modelling of systems, adaptive control, construction and testing of measuring apparatuses and equipment, automatic analysers and on development of software packages for intelligent control systems.

Prof. Ján Mikleš, PhD, DSc.

II INTRODUCTION

This report summarises the teaching and research activities at the Department of Information Engineering and Process Control at the Faculty of Chemical and Food Technology at the Slovak University of Technology during the period 1 January – 31 December 2002.

Department of Information Engineering and Process Control of the Faculty of Chemical and Food Technology of the Slovak University of Technology was constituted from the Department of Measuring and Control Technique of the Faculty of Electrical Engineering of the Slovak University of Technology in 1962. Because of the specific control problems of the processes and systems in the chemical and biochemical technology, the specialisation Process Control in the frame of the study branch Chemical Engineering and Process Control has been established. Students and postgraduate students have been educated since 1964. So far, more than three hundreds specialists and almost thirty PhD students have been graduated here and two professors and nine associated professors have been appointed.

The first head of the department was Prof. Daniel Chmúrny, PhD, DSc in 1962 – 1986. Prof. Ján Mikleš, PhD, DSc headed the department in 1986 – 1994. The head in 1995 – 1997 was Alojz Mészáros, PhD and Prof. Ján Mikleš, PhD, DSc has again headed the department since 1998.

Department of Information Engineering and Process Control is one of the 22 departments at the FCFT SUT, where the students obtain specialisation in various branches of chemical technology or chemical engineering. Approximately 1000 students are currently enrolled in the five-year program leading to the Ing. degree, which is equivalent to the M.S. degree.

III STAFF

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IV TEACHING AND RESEARCH LABORATORIES

IV.1 Teaching Laboratories:

Laboratory of Measuring Instruments and Techniques

Laboratory of Process Control

Laboratory of Gas Analysis

Computer Laboratory

IV.2 Research Laboratories:

Laboratory of Chemical Reactor Analysis and Control

Laboratory of Distillation Column Analysis and Control

Laboratory of Biochemical Process Analysis and Control

Laboratory of Modelling and Simulation

Laboratory of Computer Aided Design (Siemens – SIMATIC S-7 300)

V. EDUCATIONAL ACTIVITIES

V.1 Undergraduate Study

2nd semester (spring)

Informatics (1-2 h) Jelenčiak,
Ondrovičová, Šperka,
Vasičkaninová

5th semester (autumn)

Computer Based Data Processing (0-2 h) Čirka, Karšaiová,
Ondrovičová, Vasičkaninová

6th semester (spring)

Automatic Control Fundamentals (2-0 h) Bakošová, Fikar

Laboratory Exercises of Automatic
Control Fundamentals (0-2 h) Andrášik, Bakošová,
Danko, Fikar, Karšaiová,
Mészáros, Ondrovičová,
Vasičkaninová

Bachelor projects Bakošová, Danko, Mikleš,
Ondrovičová, Zemanovičová

7th semester (autumn)

Process Control (1-2 h) Mészáros

Process Dynamics (2-0 h) Bakošová

Operating Systems (1-1 h) Fikar

Control Devices and Systems (2-1 h) Danko

Computer Programs (1-2 h) Fikar

Laboratory Projects (0-8 h) Bakošová, Čirka,
Fikar, Karšaiová

8th semester (spring)

Optimisation (2-1 h) Dvoran

Control Theory I (2-2 h) Čirka, Mikleš

Laboratory Exercises
of Control Theory I (0-2 h) Mikleš

Experimental Identification (2-0 h) Fikar

Laboratory Project II (0-6 h) Čirka, Danko,
Dvoran, Mészáros

Modelling and Control of Polymerisation Processes	(2-2 h)	Dvoran
Process Dynamics	(2-0 h)	Bakošová
Laboratory Exercises of Process Dynamics	(0-1 h)	Bakošová
9 th semester (autumn)		
Control Theory II	(2-0 h)	Mészáros
Laboratory Exercises of Control Theory II	(0-2 h)	Mészáros
Intelligent Control Systems	(2-0 h)	Dvoran
Semestral Project	(0-10 h)	Dvoran, Karšaiová, Mészáros, Mikleš, Ondrovičová
CAD Systems	(2-0 h)	Karšaiová
Industrial Applications of Process Control	(2-0 h)	Mikleš
Control of Technological Processes	(1-2 h)	Bakošová
10 th semester (spring)		
Diploma Theses		Bakošová, Dvoran, Mészáros, Mikleš, Ondrovičová

V.2 PhD Study

Topics in Control Theory	(2 h)	Mikleš
Intelligent Control Systems	(2 h)	Dvoran
Modelling and Simulation of Processes	(2 h)	Mészáros
Software and Hardware of Control Systems	(2 h)	Danko

V.3 Course contents

V.3.1 Lectures

Automatic control fundamentals (2h/week, 6th semester)

Introduction to automatic control fundamentals. Modelling of special types of processes of chemical technology. Static and dynamic behaviour of controlled systems. Closed loop for control of technological processes. Controllers. Dynamic behaviour of closed loops. Stability of systems. Synthesis of

controllers. Control of special types of processes of chemical technology. Basic principles of devices and methods for measurement of technological quantities. Devices for control of technological processes.

Process Control (1h/week, 7th semester)

Introduction to process control. Mathematical models of linear and nonlinear continuous-time systems. Various forms of mathematical description of linear continuous-time systems and their connections. Input-output differential equation, transfer function, frequency-response function, state-space equation and its solution, mathematical description of systems with time delays. Responses of linear continuous-time systems: step, impulse and frequency responses, responses on arbitrary signals. Internal properties of linear continuous-time systems: stability, controllability, reachability, observability, properness, stabilisability. Feedback control loop. Basic types of controllers, quality of control, controller synthesis. Methods for controller synthesis. Mathematical models of linear discrete-time systems. Methods for discrete controller synthesis. Control of basic process units of chemical technology.

Process Dynamics (2h/week, 7th semester)

Basic approaches to process modelling. System classification according to accepted mathematical models. State-space and input-output models. Poles and zeros and their influence on process dynamics. Linearisation of nonlinear models. Nonlinear and linearised models of serially connected tanks, the static and dynamic behaviour. Dynamic behaviour of processes with heat exchange: tank heat exchangers with ideal mixing of media, tube heat exchangers, downstream and upstream cases. Dynamic behaviour of processes with material exchange: plate distillation columns, stuffed distillation columns, stuffed absorption columns. Dynamic behaviour of processes with chemical reactions: continuous-time stirred tank reactors, tube reactors without or with catalyst.

Operating Systems (1h/week, 7th semester)

Types of computers, basic hardware of computers, basic components and their classification, periphery equipment. Introduction to operating systems of computers. Multitasking, types of multitasking and their comparison. MS Windows, its versions and their comparison from the operating system point of view, configuration of MS Windows. Linux – operation system of UNIX-type, its installation and types. INTERNET and SANET nets. Communication tools telnet, elm, talk, ftp, gopher, www (lynx, netscape). LAN nets, their types and comparison. NetWare 3.x, 4.x, properties and philosophy. TCP/IP protocol, its configuration.

Control Devices and Systems (2h/week, 7th semester)

Continuous-time controllers, types and their static and dynamic behaviour. Discrete controllers, their dynamic behaviour and using in control loops. PC in the role of a controller. Servo-drives for electric and pneumatic control system. Control valves. Digital devices. Logic functions, electric devices for realisation of logic functions. Sequence loops. Hardware for control of technological processes. Analogue input modules, A/D, D/A converters. Digital input modules. Sources of inaccuracies in control loops.

Computer programs (1h/week, 7th semester)

MATLAB programming language: internal properties, variables, functions, data analysis, data visualisation, data storing, programming in MATLAB. Simulink simulation language: simulation schemes, block parameter settings, simulation parameter setting, block libraries, s-functions. MATLAB/Control toolbox: simulation and control of systems. Origin – graphic software, data processing, data visualisation, special functions. Word - text processor.

Optimisation (2h/week, 8th semester)

Static optimisation, classification of problems, goal functions, boundaries. Extremum without boundaries – analytical methods. Single-dimensional case, multi-dimensional case, Hess matrix. Conditions for extremum. Extremum with boundaries – linear boundaries, direct method, method of Lagrange multipliers. Extremum with boundaries – nonlinear boundaries, Kuhn – Tucker theorem. Non-gradient methods – Box-Wilson method, flexible simplex method, method of cyclic exchange of parameters. Gradient methods – Regula falsi method, Newton method, Broyde method, DFP method, PARTAN method. Convergence of gradient methods. Heuristic and learning methods, genetic algorithms. Linear, dynamic, nonlinear programming. Optimal and strategic decision-making. Large-scale optimisation tasks and their decomposition.

Control Theory I (2h/week, 8th semester)

Continuous-time systems, discrete systems. Pole-placement method. State-space approach. Deterministic state estimate. Dynamic output feedback. Connections between state and input-output approach to control design. Pseudo-state. Asymptotic observer. Control law based on an observer for deterministic problem. Fractional approach, set of all stabilising controllers. BIBO stability. Parameterisation of stabilising controllers. Bezaut equation. Dynamic optimisation. Principle of minimum. Fundamental theorem of the variation calculus. Necessary conditions for the optimal control. LQC problem. Kalman linear (L), quadratic (Q) controller. Euler-Lagrange equations. Optimal control. Matrix Riccati equation. Output control. LQ controller with integral properties.

LQ control. Connections between the state-space and input-output approaches. Spectral factorisation. LQ control and deterministic state estimation. Polynomial solution of the problem. PI controllers and LQ controller design. Optimal LQ tracking of SISO systems, input-output approach. State and parameter identification. LQ state controller, LQG input-output controller. H_2 feedback control. Solution by using of two generalised algebraic Riccati equations. Connection between LQG and H_2 control.

Experimental identification (2h/week, 8th semester)

The identification of dynamic systems from their step responses of the 1st and 2nd order, Strejc, Šalamon, Hudzovič, Söderström methods. Statistical identification methods. Classification of models for experimental identification. Least-square method, recursive least-square method, lemma about the matrix inversion, REFIL, LDFIL, LDDIF algorithms. Prediction error method and auxiliary variable method. Using of recursive identification methods for identification of multivariable and continuous-time systems. Aspects of the least square method and identification of static models, passive and active experiment. Correlation methods of identification, stochastic signals, correlation functions. Wiener-Hopf equation and its using for identification. Filtration and prediction of signals. State estimation and observability – Lueneberg observer, Kalman filtration. Using of identification for modelling and control of technological processes.

Modelling and Control of Polymerisation Processes (2h/week, 8th semester)

Principles of modelling of processes of chemical technology. Analytical and experimental approaches to modelling. Identification of static models based on the least square method. Recursive identification of discrete dynamic models. Analysis of synthesis, modification and production of polymers from the measurement and control point of view. Analysis of fibre production from the measurement and control point of view. Analysis of tire production from the measurement and control point of view. Analysis of processes of polygraphic technology from the control point of view. Analysis of processes of pulp and paper technology from the control point of view.

Control Theory II (2h/week, 9th semester)

Algebraic theory of linear control, mathematical basement. Using of algebraic theory for continuous-time and discrete controller design, pole-placement, dead beat. Adaptive control. Self-tuning adaptive systems, recursive identification. Continuous-time and discrete adaptive control. Model reference adaptive control systems (MRAS), principles, MRAS according to MIT, MRAS in the

sense of Ljapunov theory of stability. Predictive control. Robust control, H_2 and H_∞ control.

Intelligent Control Systems (2h/week, 9th semester)

Expert systems – knowledge based systems. Knowledge representation. Basic features of expert systems, structure and processing. Diagnostic expert systems. Planning expert systems. Expert systems based on rules, frames and logical programming. Programming tools for expert systems – programming languages LISP and PROLOG. Fuzzy systems. Basic principles of fuzzy sets and fuzzy logic. Fuzzy decision processes, fuzzy modelling and identification. Design procedures for fuzzy logic controllers. Rule based fuzzy controllers, model based fuzzy controllers. Neural nets. Basic principles of artificial neural nets (ANS). Representation of dynamic systems using feed-forward and feedback neural nets. System identification based on using of neural nets. Parameter estimation and neural net training. Controllers based on using of neural nets. Adaptive control based on using of neural nets, direct and non-direct. Genetic control algorithms. Control of textile production.

CAD systems (2h/week, 9th semester)

Classification of automatic control systems, types of control algorithms. Automatic control system design. Feedback control loops – simple, composed. Control loops for flow rate, pressure, level control. Control loops for heat exchangers, distillation, absorption, extraction columns, batch and continuous-time chemical reactors. MIMO control of distillation columns. Large-scale systems – analysis, modelling and control.

Industrial Application of Process Control (2h/week, 9th semester)

Introduction to industrial application of process control. Problems connected with control system design and control system application in practice. Hardware and software of industrial control systems, programming of industrial automata, data processing and visualisation. Control of a chemical reactor for a decomposition of H_2O_2 . Control of a binary plate distillation column. Solving of control problems for chemical industry.

Control of Technological Processes (1h/week, 9th semester)

Introduction to process control. Mathematical models of basic process units of chemical technology. Principles of control of technological processes. Methods for controller synthesis, types of control loops. Control of heat exchangers, controlled and action variables, control loops. Control of distillation and absorption columns, controlled and action variables, control loops. Control of chemical reactors, controlled and action variables, control loops.

V.3.2 Laboratory exercises

Informatics (2h/week, 2nd semester)

MS Windows 95 operating system. MS Excel as a tool for data processing, data processing by tables, data visualisation by graphs. MS Word – text processor.

Computer based data processing (2h/week, 5th semester)

MATLAB – Simulink as a tool for system simulation, MATLAB – Control toolbox. Filtration of signals, analogue and digital filters, MATLAB – Signal processing toolbox. MS Excel as a tool for data processing. Data processing by tables, data visualisation by graphs, analytical tools in MS Excel, statistics in MS Excel. Origin as a tool for data visualisation and processing.

Laboratory exercises of Automatic Control Fundamentals (2h/week, 6th semester)

MATLAB/Simulink as a simulation tool for LEACF. Laplace transform as a mathematical tool for LEACF. Input-output description of dynamic systems, transfer function, poles and zeros. Step responses and impulse responses of dynamic systems. Mathematical models and dynamic behaviour of processes of chemical technology. Feedback control. PID controllers and their properties in feedback control. Controller synthesis and control of processes of chemical technology.

Laboratory exercises of Control Theory I (2h/week, 8th semester)

Simulation of pole-placement method. State-space approach. State observer design for simple systems. Simulation of state feedback. Simulation of feedback control with a state observer. Design of a set of stabilising controllers for simple systems. Simulation of MIMO feedback systems by using of stabilising controllers. Simulation of feedback control by using of a LQ controller for simple serially connected tanks and for a chemical reactor. Synthesis of a PI controller, PI controller design by LQ method. Simulation comparison of a classic and a LQ PI controllers. Simulation of LQ control with deterministic state estimation. LQG state controller. Simulation of feedback control by a state-space LQG controller. LQG input-output controller. Adaptive control. Closed-loop identification. Closed-loop recursive identification. Simulation of adaptive control with recursive identification and with LQ/LQG controller. Adaptive control of serially connected tanks, adaptive control of a chemical reactor.

Laboratory exercises of Process Dynamics (1h/week, 8th semester)

Simulation of dynamic properties of systems in MATLAB/Simulink. Stability conditions and responses of systems on standard input signals. Transformation of state-space description to transfer function and vice-versa, transformation of higher order differential equation to a system of the 1st order differential equations. Analysis of static and dynamic properties of a system of serially connected tanks with/without interactions. Analysis of static and dynamic properties of a tube heat exchanger as a system with continuously distributed parameters. Modelling of a system with continuously distributed parameters, transformation of a system of partial differential equations to a system of ordinary differential equations by discretisation. Calculation of a steady-state of a plate distillation column, analysis of static and dynamic properties of a plate distillation column as a system with discretely distributed parameters. Analysis of static and dynamic properties of an exothermic continuous-time stirred tank reactor. Calculation of steady-states of chemical reactors, steady-state analysis of chemical reactors, linearisation of nonlinear models.

Laboratory exercises of Control Theory II (2h/week, 9th semester)

Algebraic theory of linear control. Control of the 2nd order continuous-time system by discrete controller. Self-tuning adaptive control system for the 2nd order linear system, discrete and hybrid approach. Model reference adaptive control (MRAC). Adaptation of static gain. MRAC for the 1st and 2nd order systems. MRAC in the sense of the Ljapunov theory of stability, application on the 1st order system. Predictive control.

VI. CURRENT RESEARCH ACTIVITIES

Research at the Department of Process Control is oriented to advanced control theory as so as to practical applications in control of processes of chemical technology.

VI.1 Main Research Areas

1. Modelling and Simulation (M. Bakošová, M. Karšaiová, A. Mészáros, J. Mikleš, M. Ondrovičová)

Modelling and simulation play an important role in the investigation of static and dynamic properties of chemical processes, units and systems. Most chemical systems are strongly non-linear and their simulation is

necessary for the control design as well as for the investigation of the overall control systems. The main aim of the research is to develop program packages for modelling and simulation of various kinds of models. During the last year a package for PC in Simulink and C-language was created.

2. System Identification (L. Čírka, M. Fikar, J. Mikleš)

System identification deals with problem of the parameter estimation of static or dynamic systems from observed input-output data. Among many topics of system identification, the following areas have been investigated in this project:

- a) nonparametric methods, correlation and spectral analysis
- b) recursive identification of Z-transform discrete-time models
- c) recursive identification of delta models which converge to their continuous-time counterparts
- d) identification in closed-loop

A program package IDTOOL has been developed for Simulink. This toolbox implements recursive LS algorithm LDDIF and provides blocks for continuous and discrete time parameter estimation.

3. Optimal Control Design (M. Fikar, J. Mikleš)

The main aim of this area is to develop a package of algorithms and program implementation of various known control design for a given plant. The research interests include single input-single output systems as well as multivariable dynamic systems. Control design covers strategies in discrete-time and continuous-time formulation. A program package is created in MATLAB/Simulink environment.

4. Adaptive Controllers (M. Bakošová, L. Čírka, M. Fikar, A. Mészáros, J. Mikleš)

Most of technological plants exhibit non-linear behaviour. To apply a successful control design to practical problems is a substantial effort. The processes are known to be modelled and controlled with serious difficulties caused by their non-linear behaviour, high order dynamics, and tendency to instability. Many of industrial processes must be considered as multivariable systems. In a great deal of available control design techniques it is often necessary to carry out the steps of modelling, identification and control design. Theory and implementation of adaptive control in technological systems have been the long-time research topics. The activities in the adaptive control have been concentrated to four main areas as follows:

- a) self-tuning control - characterised by repeating parameter estimation and control design
- b) model reference adaptive control based on the Lyapunov method
- c) decentralised adaptive control
- d) adaptive lambda-tracking

5. Neural Networks (A. Mészáros)

The aim of this research is to investigate two-layer hierarchical control structures for biochemical systems, integrated optimising algorithms for higher layers of hierarchical control structures, artificial neural-network models obtained by back-propagation for specified biochemical systems, design of a robust long-range constrained predictive control algorithms on the basis of ANN involving a stochastic approximation training algorithm, and development of a control system for our laboratory fermenter.

6. Fuzzy Control and Expert Systems (J. Dvoran, A. Vasičkaninová, A. Zemanovičová)

The aim of this research is to investigate fuzzy and neuro-fuzzy controllers. The usefulness of fuzzy control can be considered in two aspects. First, control offers a novel mechanism to implement such control laws that are often knowledge-based or even in linguistic descriptions. Second, fuzzy control provides an alternative methodology to facilitate the design of nonlinear controllers for such controlled plants that are uncertain and very difficult to cope with conventional nonlinear theory.

7. Predictive Control (M. Fikar)

Predictive control has been successful not only in academia but in industrial process applications as well. Its main drawbacks are the stability problems. The aim of this research is to enhance the basic input-output predictive methods. The problem is solved by means of the Youla-Kučera parameterisation of all stabilising controllers. Both finite and infinite horizon formulations are handled. Another approach is to assume that the loop is already controlled by a linear controller and to find the minimum number of control, or tracking error steps that leads to stable closed-loop behaviour. In all cases, it can be shown that the minimum number of steps is closely related to the number of unstable poles/zeros of the plant.

8. Dynamic Optimisation (M. Fikar)

Increased quality requirements in chemical and petrochemical industries call for more complicated and sophisticated control strategies. Moreover, there is a need to know the achievable limits of performance and speed of transient behaviour of processes. Optimal control theory is able to provide responses to these questions. In this research, changeover problems in multicomponent distillation are studied.

9. Process Control

The research of all research groups is focused on control applications for various types of chemical and biochemical processes.

VI.2 Research Projects in Slovak Republic

1. Development of advanced control methods for chemical reactors, distillation columns and other plants in chemical and food technology (Ján Mikleš)

The main goals of the project can be formulated in the following items:

- To derive mathematical models of chemical and biochemical processes: an exothermic reactor for decomposition of H_2O_2 , a tray distillation column and a stuffed distillation column for separation of binary mixtures, a warm-air drying chamber, a biochemical reactor.
- To develop methods and algorithms for system identification: closed-loop identification, identification based on artificial neural network, identification of physical system parameters from measured data.
- To investigate modern optimisation methods and algorithms for nonlinear high-order systems, especially for distillation columns and biochemical reactors.
- To investigate robust stabilisation and robust feedback control of multivariable systems.
- To develop adaptive control methods and adaptive control algorithms for systems of the chemical and food technology.
- To include principles of artificial intelligence (expert systems, fuzzy control, neuro-fuzzy control, artificial neural networks) into control structures for chemical processes.

- To investigate the predictive control method and to create control algorithms based on the Youla-Kučera parameterisation for solving unconstrained or constrained control problems.
- To verify all theoretical results on laboratory models chemical processes.
- To transform theoretical and experimental results into industrial conditions and to demonstrate benefits and advantages of advanced process control in chemical and food industry.

The most important results of the project are following:

- development of receding horizon iterative dynamic programming with discrete time models,
- using Youla-Kučera parameterisation in control design for decoupled control systems,
- design of a closed-loop identification method based on the Youla-Kučera parameterisation without model reduction,
- pH control in a laboratory fermenter.

2. Adaptive and Intelligent Control Strategies for Processes of Chemical/Biochemical Technology (Alojz Mészáros)

The main goals of the project can be listed as follows:

- Design of a new predictive, intelligent control strategy on basis of ANN, (the PID-ANN-P algorithm), and its simulation for linear and non-linear systems.
- Design of a new robust, intelligent control strategy on basis of ANN (the PID-ANN-R algorithm), and its simulation for linear and non-linear systems; without as well as in presence of noise and disturbances; without as well as with constraints on control.
- Testing the PID-ANN-R procedure on non-linear models of chemical processes.
- Design of adaptive λ -tracking control and its verification for non-linear SISO and MIMO systems.
- Implementation of control algorithms introduced using ANN (the PID-ANN, PID-ANN-P and PID-ANN-R algorithms) to computer control of laboratory fermenter LF-3; testing performance for real physical circumstances
- Implementation of control algorithms derived on basis of λ -tracking policy to direct computer control of laboratory distillation column.

- Computer control of laboratory distillation column using adaptive predictive approaches involving low order concentration gradient models.
- Selection of the most „successive“ algorithm from the methods proposed and its transformation into software module, suitable for industrial control application.

Original results obtained in the frame of the project are:

- adaptive intelligent PID controller using artificial neural networks (PID-ANN algorithm),
- robust intelligent controller using artificial neural networks (PID-ANN-R algorithm),
- continuous-time and discrete-time adaptive lambda-tracker for control of SISO or MIMO nonlinear chemical processes,
- ANN-based control system for data acquisition and control of a laboratory fermenter.

VI.3 International Scientific Programmes

1. LEONARDO No. RO/00/B/F/PP141028

Eurocompetencies Transfer in Vocational Guidance for Young Specialists in Bioscience Field

Coordinator at the FCFT STU: V. Bálež

Coordinator of the project: University Politehnica, Bucharest, Romania;

Participants: Ost European Centrum, University Hohenheim, Germany; Romanian Society of Biotechnology and Bioengineering, Bucharest, Romania; Research Institute for Chemistry, Bucharest, Romania; University Politehnica, Bucharest, Romania; Pluri Consultants SRL, Bucharest, Romania; University of Agronomic Sciences and Veterinary Medicine, Bucharest, Romania; CERA Foundation, Bucharest, Romania; Department of Chemical and Biochemical Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology, Bratislava, Slovakia; Department of Information Engineering and Process Control, Faculty of Chemical and Food Technology, Slovak University of Technology, Bratislava, Slovakia; Natural Resources Institute, University of Greenwich, Greenwich, Great Britain;

Period: November 2000 – November 2003

2. Project of Slovak – Czech Scientific Cooperation No. 112/189

Advanced Control Methods for Processes of Chemical and Food Technologies

Coordinator at the FCT STU: J. Mikleš

Participants: Department of Process Control, Faculty of Chemical Technology, Slovak University of Technology, Bratislava, Slovakia;
Department of Process Control and Computer Techniques, University of Pardubice, Pardubice, Czech Republic

Period: January 2000 – December 2001

VII. COOPERATION

VII.1 Cooperation in Slovakia

Department of Automatic Control Systems, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Bratislava

Department of Automation and Control, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Bratislava

Department of Automation and Measurement, Faculty of Mechanical Engineering, Slovak University of Technology, Bratislava

Institute of Informatics, Slovak Academy of Sciences, Bratislava

Department of Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Košice

Department of Management and Control Engineering, BERG Faculty, Technical University of Košice, Košice

Siemens, Inc., Bratislava

ProCS, Ltd., Šaľa

VII.2 International Cooperation

Department of Process Control and Computer Techniques, Faculty of Chemical Technology, University of Pardubice, Pardubice, Czech Republic

- Control system design
- Modelling and control of distillation columns

Department of Computing and Control Engineering, Institute of Chemical Technology, Prague, Czech Republic

- Control of biochemical reactors

Department of Control Theory, Institute of Information Technologies, Tomas Bata University, Zlín, Czech Republic

- Adaptive control
- Robust control
- Decentralized control

Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic, Prague, Czech Republic

- Adaptive control
- Predictive control

Trnka Laboratory for Automatic Control, Faculty of Electrical Engineering, Czech Technical University, Prague, Czech Republic

- Adaptive control
- Predictive control

LSGC-CNRS, Ecole Nationale Supérieure des Industries Chimiques (ENSIC), Nancy, France

- Dynamic optimisation of distillation columns
- Waste-water treatment plants

Ecole Nationale Supérieure des Ingénieurs de Génie Chimique-Chemin de la Loge (ENSIGC), Toulouse, France

- Neural networks
- Predictive control

Ruhr University, Bochum, Germany

- Closed-loop identification
- Predictive control

Technical University of Budapest, Budapest, Hungary

- Modelling of chemical processes

Technical University of Vienna, Vienna, Austria,

- Optimisation of combustion processes

University of Porto, Porto, Portugal

- Neural networks

VII.3 Membership in Domestic Organisations and Societies

Slovak Society of Cybernetics and Informatics, Bratislava (A. Mészáros, J. Mikleš)

Slovak Society of Chemical Engineering, Bratislava (M. Bakošová, J. Danko, J. Dvoran, M. Fikar, M. Karšaiová, A. Mészáros, J. Mikleš, M. Ondrovičová, A. Zemanovičová)

Slovak Union of Industrial Chemistry, Science-Technical Society, Bratislava (M. Bakošová, J. Danko, J. Dvoran, M. Fikar, M. Karšaiová, A. Mészáros, J. Mikleš, M. Ondrovičová, A. Vasičkaninová, A. Zemanovičová)

VII.4 Membership in International Organisations and Societies

International Federation of Automatic Control, Laxenburg, Austria (J. Mikleš)

European Federation of Biotechnology, Frankfurt, Germany (A. Mészáros)

The New York Academy of Sciences, New York, USA (A. Mészáros)

VIII. THESES AND DISSERTATIONS

VIII.1 Graduate Theses (MS Degree) for state examinations after five years of study (supervisors are written in brackets)

- Budošová M.: Analysis of possibilities for implementation of evolutionary algorithms. (J. Dvoran)
- Fulajtár J.: Optimal processing conditions of tray distillation columns. (J. Mikleš)
- Jančich J.: Optimal control of a chemical reactor. (J. Mikleš)
- Kamenická T.: Mathematical model and identification of a continuous-time stirred tank reactor. (J. Mikleš)
- Korbašová K.: Mathematical model of an equipment for glass melting. (J. Dvoran)
- Nagy J.: Control design of a laboratory distillation column using control system SIMATIC. (M. Ondrovičová)
- Nagy L.: Control system design for a small brewery. (A. Mészáros)
- Potančoková A.: Neuro-fuzzy control design for a chemical reactor. (J. Dvoran)
- Svetíková M.: Design of GUI for laboratory plant LTR 7000. (M. Fikar)
- Veliká J.: Adaptive lambda-tracking of a continuous-time stirred tank reactor for methanol synthesis. (M. Bakošová)

VIII.2 Dissertations (PhD.)

- Kožka Š.: Iterative identification of a system in the closed-loop. (J. Mikleš)

IX. PUBLICATIONS

IX.1 Journals (* registered in Current Contents)

- [1] Bachmann G., Hofbauer H., Zemanovičová A., Vasičkaninová A.: Determination of the calorific value of heterogeneous materials in a multi-kilogram capacity calorimeter. *Petroleum and Coal* 43 (3-4), 193-195 (2002).
- [2] Bakošová M., Ondrovičová M., Karšaiová M.: Decentralized Adaptive Control of Distillation Columns. *Selected Topics in Modelling and Control* 3, 132-137 (2002).
- [3] Bakošová M., Ondrovičová M., Karšaiová M.: Použitie metódy adaptívneho lambda-sledovania pre riadenie chemických reaktorov. Application of adaptive lambda-tracking method for control of chemical reactors (in Slovak). *AT&P Journal* 9 (4), 77-79 (2002).
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- [5] Čirka Ľ., Fikar M., Mikleš J.: A deterministic LQ tracking problem: Parameterization of the controller and the plant. *Journal of Electrical Engineering* 53 (5-6), 126-131 (2002).
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- [7] Čirka Ľ., Fikar M., Mikleš J.: A deterministic LQ tracking problem: Parameterization of the controller and the plant. *Selected Topics in Modelling and Control* 3, 38-44 (2002).
- [8] Čirka Ľ., Mikleš J., Fikar M., Jančich J.: Využitie YK parametrizácie v adaptívnom LQ riadení laboratórneho chemického reaktora. Application of YK parameterization in adaptive LQ control of a laboratory chemical reactor (in Slovak). *AT&P Journal* 9 (11), 82-83 (2002).
- [9]* Fikar M., Unbehauen H.: Youla-Kučera design of decoupled control systems. *Int. J. Control* 75 (3), 213-218 (2002).
- [10] Fikar M.: Informačné technológie pre vzdelávanie. Information technologies for education (in Slovak). *AT&P Journal* 9 (11), 5 (2002).
- [11] Halldorsson U., Fikar M., Unbehauen H.: Multirate approach to nonlinear predictive control. *Selected Topics in Modelling and Control* 3, 22-25 (2002).
- [12] Hofbauer H., Bachmann G., Zemanovičová A.: Určenie výhrevnosti a emisných charakteristík pri spaľovaní heterogénnych odpadových látok. Determination of the calorific value and emission characteristics at

- combustion of heterogeneous waste materials (in Slovak). AT&P Journal 9 (4), 82-83 (2002).
- [13] Kvasnica M., Fikar M., Mikleš J.: Robust control of a CSTR via static output feedback: An LMI approach. Selected Topics in Modelling and Control 3, 11-15 (2002).
- [14] Kvasnica M., Fikar M.: Solving LMI problems using LMI control toolbox. Selected Topics in Modelling and Control 3, 16-21 (2002).
- [15] Mészáros A., Andrášik A.: Robust and adaptive control in terms of neural networks. Selected Topics in Modelling and Control 3, 113-118 (2002).
- [16] Mészáros A., Andrášik A., Illeová V., Šperka L.: Identifikácia a riadenie pH s použitím neurónových sietí. Identification and pH control using neural networks (in Slovak). AT&P Journal 9 (4), 80-81 (2002).
- [17] Mikleš J.: Pre úspešnosť riadenia je mimoriadne dôležitá pripravenosť výroby na riadenie. Production awareness for control is extremely important for successful control (in Slovak). AT&P Journal 9 (4), 5 (2002).
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IX.2 Conferences (*International conferences)

- [1]* Andrášik A., Mészáros A., Šperka L. : Control of pH process using neural networks. In: Proc. 5th Scientific-Technical Conf. Process Control 2002. Kouty nad Desnou (Czech Republic), June 9-12, 2002. University of Pardubice, CD ROM R241b (2002).
- [2]* Bakošová M., Karšaiová M., Ondrovičová M.: Adaptive lambda-tracking using variable sampling rate. In: Proc. 5th Scientific-Technical Conf. Process Control 2002. Kouty nad Desnou (Czech Republic), June 9-12, 2002. University of Pardubice, CD ROM R052 (2002).
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