Activitivity III.3: The paper list and the abstracts

THE PAPER LIST
PHASE II

1. Selişteanu D., Petre E., Răsvan V., 2007, Sliding Mode and Adaptive Sliding Mode Control of a Class of Nonlinear Bioprocesses, *International Journal of Adaptive Control and Signal Processing*, John Wiley & Sons, Ltd., cod DOI: 10.1002/acs. 973, Vol. 21, no. 8-9, October-November, 2007, pp. 795-822, ISSN: 0890-6327 [ISI – Web of Science].
2. Caraman S., Sbarciog M., Barbu M., Predictive Control of a Wastewater Treatment Process, *International Journal of Computers, Communications & Control*, Vol. II, No. 2, pp. 132-142, ISSN 1841 – 9836**,** 2007.
3. Petre E., Selişteanu D., 2007, Approximation of the Dynamical Model for a Class of Nonlinear Propagation Bioprocesses, *Rev. Roum. Sci. Techn.- Électrotechn. et Énerg.*, Bucarest, Romania, 52, 3, ISSN 0035-4066, acceptată pentru publicare. [INSPEC, BLD – British Library Direct]
4. Barbu, M., Caraman, S., Design of a Sliding-Mode Observer for a Biotehnological Process, *IFAC 10th Computer Applications in Biotechnology*, Preprints CD-ROM, Cancun, Mexic, 2007.
5. Barbu, M., Caraman, S., QFT Multivariable Control of a Biological Wastewater Treatment Process using ASM1 Model, *IFAC 10th Computer Applications in Biotechnology*, Preprints CD-ROM, Cancun, Mexic, 2007.
6. Selişteanu D., Petre E., Popescu D., Bobaşu E., 2007, High Frequency Control Strategies for a Continuous Bioprocess: Sliding Mode Control versus Vibrational Control (invited paper), *Proc. of the 13th IEEE/IFAC Int. Conf. on Methods and Models in Automation and Robotics MMAR 2007*, August 27-30, Szczecin, Poland, pp. 77-84, IEEE Conference Number 12459, ISBN 978-83-751803-2-9 (Abstracts), 978-83-751803-3-6 (CD). [Conf. IEEE/IFAC]
7. Petre E., Popescu D., 2007, A multivariable adaptive controller for a class of recycled depollution bioprocesses, *9th WSEAS Int. Conf. on Mathematical and Computational Methods in Science and Engineering (MACMESE'07)*, Nov. 5-7, 2007, Trinidad and Tobago, pp. 155-160, ISBN 978-960-6766-11-4.
8. Selişteanu D. Popescu D., Barbu C., On-line State Estimation and Identification of a Fed-Batch Bioprocess, *9th WSEAS Int. Conf. on Mathematical and Computational Methods in Science and Engineering (MACMESE'07)*, Nov. 5-7, 2007, Trinidad and Tobago, pp. 85-90, ISBN 978-960-6766-11-4.
9. Marin C., Petre E., Selişteanu D., 2007, Wastewater Biodegradation Process Identification. A Multilayer Approach via Distributions, *The 3rd WSEAS Int. Conf. On Cellular and Molecular Biology, Biophysics and Bioengineering – BIO'07*, Aug. 26-28, pp. 1-6, Vouliagmeni Beach, Athens, Greece, ISSN: 1109-2769, ISBN: 978-960-6766-03-9.
10. Şendrescu D., Petre E., Popescu D., Bobaşu E., 2007, Weighted Moments Based Identification of Continuous-Time Systems, *7th WSEAS Int. Conf. on Systems Theory and Scientific Computation (ISTASC'07)*, Aug. 24-26, Vouliagmeni, Athens, Greece, pp. 13-18, ISSN: 1790-5117, ISBN: 978-960-6766-01-5.
11. Petre E., Popescu D., Selişteanu D., 2007, Finite Dimensional Models of Nonlinear Distributed Parameter Bioreactors via Orthogonal Collocation, *8th Int. Carpathian Control Conference ICCC 2007*, May 24-27, Štrbské Pleso, High Tatras, Slovak Republic, pp. 548-551, ISBN 978-80-8073-805-1.

12. Barbu M., Caraman S., Decentralized Multimodel Control of a Wastewater Treatment Process with Activated Sludge, *Proceedings of the 16th International Conference on Control Systems and Computer Science (CSCS 16)*, Vol. 1, Pp. 49-54, ISBN 978-973-718-741-3, Bucuresti, 22-25 Mai 2007.

13. Caraman S., Barbu M., Arinton E., The Linearizing Control of a Wastewater Treatment Process with the Removal of Two Substrates, *Proceedings of the 16th International Symposium on Systems Theory (SINTES 13)*, Vol. 1, Pp. 66-71, ISBN 978-973-742-839-4, Craiova, 18-20 Octombrie 2007.

ABSTRACTS OF THE PAPERS
PHASE II

1.

Sliding Mode and Adaptive Sliding Mode Control of a Class of Nonlinear Bioprocesses

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Abstract: This work deals with some sliding mode and adaptive sliding mode control strategies for a class of nonlinear biotechnological processes. First, a dynamical sliding mode based feedback strategy is designed in order to ensure the asymptotic output stabilisation of nonlinear bioprocesses. The control law design is done by means of a combination between the exact linearisation approach and the sliding mode control. Second, an adaptive sliding mode control strategy is derived for this class of bioprocesses. In order to deal with the parametric uncertainties of the bioprocesses, the adaptive form of the sliding mode control law is designed by means of direct, overparameterised adaptive control techniques available for linearisable systems. The paper also presents the implementation of the proposed control strategies for two typical bioprocesses belonging to the studied nonlinear class. The first prototype process takes place into a Continuous Stirred Tank Bioreactor, and the second is a lipase production process that takes place inside a Fed-Batch Bioreactor.

2.

Predictive Control of a Wastewater Treatment Process

Sergiu Caraman, Mihaela Sbarciog, Marian Barbu

Abstract: The paper deals with the design of a predictive controller for a wastewater treatment process. In the considered process, the wastewater is treated in order to obtain an effluent having the substrate concentration within the standard limits established by law (below 20 mg/l). This goal is achieved by controlling the concentration of dissolved oxygen to a certain value. The predictive controller uses a neural network as internal model of the process and alters the dilution rate in order to fulfill the control objective. This control strategy offers various possibilities for the control law adjustment by means of the following parameters: the prediction horizon, the control horizon, the weights of the error and the command. The predictive control structure has been tested in three functioning regimes, considered essential due to the frequency of their occurrence in current practice.

3.

Approximation of the Dynamical Model of a Class of Nonlinear Propagation Bioprocesses

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Abstract: This paper deals with the order reduction of the dynamical models of a class of propagation bioprocesses. Since these bioprocesses are described by partial differential equations either for simulation but mainly for control, a possible method consists of approximation of their infinitely order associated models by finite order models. These approximate models consist of a set of ordinary differential equations obtained here by orthogonal collocation method. Since it is difficult to know the connections between the original distributed parameter model and its approximate version, our objective is to analyse the behaviour of both models to view their dynamical properties. Numerical simulations conducted in the case of a fixed bed reactor without dispersion are included to illustrate the dynamical behaviour of the two classes of models.

4.

Design of a Sliding-Mode Observer for a Biotechnological Process

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Abstract: This paper deals with the implementing of a sliding-mode observer for the lipase producing process using *Candida rugosa* yeast. It does consider a simplified model of the process, consisting in three equations, for the two substrates and the biomass. The sliding-mode observer has been designed on the basis of the equivalent control method. For the observer implementation it is necessary a state transformation that has to bring the process to the observable canonic form. The results obtained through numerical simulation show a good behaviour of the sliding-mode observer in the presence of the parameter’s uncertainties that interfere with the process.

5.

QFT Multivariable Control of a Biological Wastewater Treatment Process using ASM1 Model

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Abstract: This paper deals with the robust control of the wastewater treatment process, considered as a multivariable system, using QFT (Quantitative Feedback Theory) method. The wastewater treatment process is described by a simplified variant of ASM1 (Activated Sludge Model 1) model. Since the process is multivariable an analysis of the channel interaction, using RGA (Relative Gain Array) method, is done. According to this analysis two command channels can be emphasized. The process model was linearized in three functioning points (rain, normal and drought) and a robust controller, using QFT method, has been designed. The multivariable

control structure was validated through numerical simulation in every regime, the results of the effluent quality being according to the limits imposed by the law.

6.

A Multivariable Adaptive Controller for a Class of Recycled Depollution Bioprocesses

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Abstract: This paper presents the design and the analysis of a multivariable adaptive nonlinear control strategy for a class of depollution fermentation processes that are carried out in recycle bioreactors. The controller design is based on the input-output linearization technique. The resulted control method is applied in depollution control problem in the case of the activated sludge process for which dynamical kinetics are strongly nonlinear and not exactly known. More precisely, the problem of adaptive controlling of two reactant concentrations with two control inputs is considered and is illustrated by the mentioned process. Simulation results are included to evaluate the performances of the designed controller.

7.

High Frequency Control Strategies for a Continuous Bioprocess: Sliding Mode Control versus Vibrational Control

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Abstract: This paper deals with the design of two “high-frequency” nonlinear control strategies for a prototype of continuous bioprocesses. The prototype biotechnological process takes place into a Continuous Stirred Tank Bioreactor. This bioprocess is strongly nonlinear and furthermore the process parameters are highly uncertain. The proposed control strategies are the Sliding Mode Control and the Vibrational Control, which are high-frequency control techniques, obviously high-frequency relative to the natural frequency of the system. First, a sliding mode based feedback strategy is presented for the asymptotic output stabilization of the nonlinear system describing the bioprocess. The feedback control law is achieved using a combination between exactly linearization, sliding mode control, and generalized observability canonical forms. Second, a Vibrational Control is designed for the bioprocess. The Vibrational Control is an open-loop technique that does not requires measurements of states or disturbances. Comparisons between the nonlinear control methods are provided, and numerical simulations are included in order to test the behaviour and the performances of the proposed high-frequency nonlinear controllers.

8.

On-line State Estimation and Identification of a Fed-batch Bioprocess

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Abstract: This paper deals with the problem of on-line state estimation and identification for a fed-batch bioprocess, which is in fact a lipase production process that takes place inside a Fed-

batch Bioreactor. The lipase production process is highly nonlinear and, furthermore, the available on-line measurements are lack and the reaction kinetics is not perfectly known. Some on-line state estimation strategies based on extended Luenberger observer and asymptotic observer approach are proposed. The unknown kinetic parameters of the bioprocess are estimated by using a distribution based identification technique. The performance of the proposed estimation strategies is analysed using numerical simulation.

9.

Wastewater Biodegradation Process Identification; A Multi Layer Approach via Distributions

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Abstract: The paper extends the procedures of wastewater biodegradation process (WBP) identification, as have been first presented by the authors in [11], [12]. These procedures allow identification of all process parameters in both cases they are time constant or time variant. The identification problem is formulated as a condition to vanish the existence relation of the system. This relation is represented by functionals using techniques from distribution theory based on testing function from a finite dimensional fundamental space. As the WBP expresses rational dependences between parameters and some measurable variables, the main idea of these procedures is to use a hierarchical multi layer structure of identification, which allows obtaining string of linear algebraic systems of equations in the unknown parameters. The coefficients of these algebraic systems are functionals depending on the input and output variables evaluated through some testing functions from distribution theory. According to the proposed procedure, in the firs layer, only some state equations are evaluated throughout testing functions to obtain a set of linear equations in some parameters. The results of this first layer of identification are utilized for expressing other parameters by linear equations in the next layer. This process is repeated until all parameters are identified. The time variant laws are expressed as finite degree time polynomials whose parameters are included in the set of parameters to be identified. Applications for parameter identification of waste water biodegradation processes are presented. By examples, the potential of the method is revealed.

10.

Finite Dimensional Models of Nonlinear Distributed Parameter Bioreactors via Orthogonal Collocation

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Abstract: This paper deals with the order reduction of the dynamical models of a class of propagation bioprocesses. Since the dynamics of these processes are described by partial differential equations, especially for control purpose one method consists of approximation of their infinitely order associated models by finite order models. These models consist of a set of ordinary differential equations obtained here by orthogonal collocation method.

11.

Weighted Moments Based Identification of Continuous-Time Systems

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Abstract: In this paper we present an algorithm for continuous-time model identification from sample data using the weighted power moments of the output signal of a linear, time-invariant system. While most of the latest methods used in identification utilize a discrete-time model, the moments method is an alternative approach to directly identify a continuous-time model from discrete-time data. The method defines a set of relationships between the power series coefficients of a stable transfer function and the power moments of the output signal of this system. Based on these relations, an algorithm for off-line parameter identification is developed. The method is applied to identify the parameters of a real experimental platform.

12.

Decentralized Multimodel Control of a Wastewater Treatment Process with Activated Sludge

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Abstract: The paper deals with the multimodel control of a biological wastewater treatment process. Since the process is multivariable, the RGA (Relative Gain Array) method was used for the analysis of the channel influence. For the design of the control structure the process has been linearized in three main functioning points. For every functioning point a multivariable controller has been designed. The controller outputs were aggregated using a fuzzy block. The control structure was validated through numerical simulation, considering the general case when the functioning regimes alternate within the process.

13.

The Linearizing Control of a Wastewater Treatment Process with the Removal of Two Substrates

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Abstract: This paper deals with the identification of a biological wastewater treatment process with the removal of two substrates. The identification has been done on the basis of experimental data supplied by Arcelor-Mittal Steel Company. For the identification of the wastewater treatment process with two substrates a criterion of distance type among the experimental data and the model outputs has been used. For the process control a linearizing structure based on the linearizing command principle has been adopted. The linearizing control algorithm has been check in the case of parametric uncertainties (the variation of the maximum specific growth rate parameter).