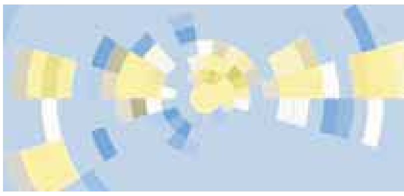
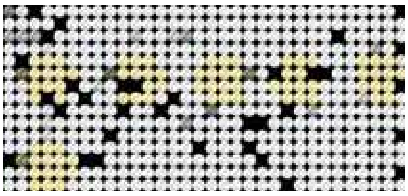
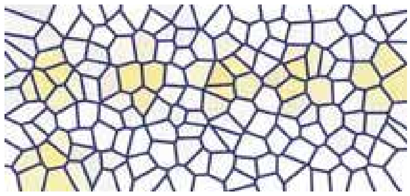
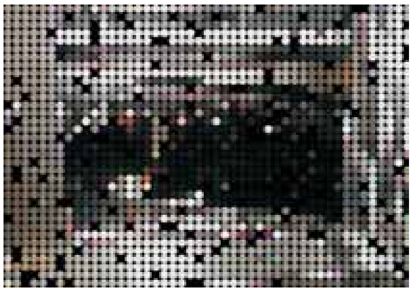
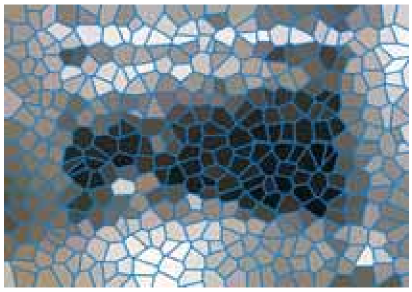
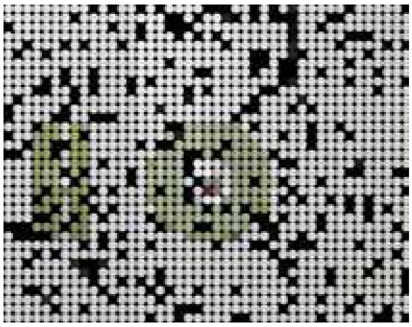
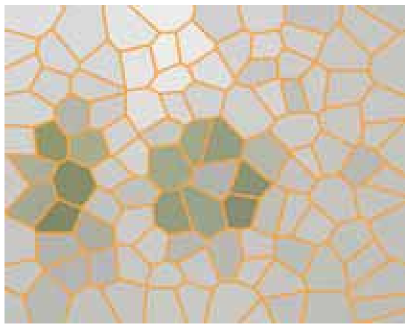
SNE SIMULATION NEWS EUROPE

Volume 16 Number 1 (SNE 46)

August 2006, ISSN 0929-2268

Journal on Developments and Trends in Modelling and Simulation

Membership Journal for Simulation Societies in EUROSIM

ARGESIM

SNE 16/1 (46), August 2006

Dear readers,

This is the second SNE issue with new layout, and we are glad, that we got positive reactions for changes in SNE layout and for opening the publication strategy of SNE. Together with this issue, we are proud to announce the first SNE Special Issue 'Parallel and Distributed Simulation Methods and Environments'. First born as idea in ASIM - ASIM Working Groups intend to publish alternately a Special Issue each year, the SNE Special Issues are open for all societies and conference organisers.

The Special Issues cause a change in numbering the SNE issues: this regular SNE issue, SNE 46, is now identified as SNE 16/1 (Volume 16, Number 1), the first Special Issue as SNE 16/2; the next regular SNE double issue (SNE 47/48) will be numbered SNE 16/3-4. This remembers, that we are running SNE since 16 years, and we thank our faithful readers.

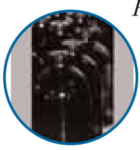
Together with the new layout, both editorial boards are being reorganised and will be enlarged for the future. We are also working on a new infrastructure for running an editorial office, together with tasks for SNE on the web.

We hope, the readers enjoy this issue, and the contributors appreciate the new editorial structure (more strict, but hopefully more efficient). Three Technical Notes and three Short Notes in this issue show the broad variety of modelling and simulation. The Technical Notes are special ones: based on a post-conference review procedure via Internet for contributions to MATHMOD 2006 Vienna, papers were selected for publication in SNE (to appear also in the next SNE issues). Furthermore, as first reaction on the ARGESIM / MATHMOD Yo-yo Challenge, the Techncial Note by Leon Zlajpah introduces into mechanical mysteries of Yo-yo control. The Comparison Section publishes an updated version of Comparison C13 'Crane and Embedded Control', reflecting the developments in this area of modelling and simulation; furthermore, seven comparison solutions concentrate on modelling issues and alternative approaches.

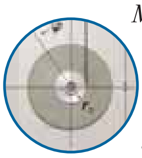
The News Section reports about progress in new structures for EUROSIM, and about activities in EUROSIM member societies and in Societes related to Modelling and Simulation. We thank all contributors, members of the editorial boards, and people of our ARGESIM staff for co-operation in producing this SNE issue.

Felix Breitenecker, editor-in-chief; Felix.Breitenecker@tuwien.ac.at

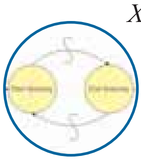
SNE 16-1 / SNE 46 in Five Minutes



Process Modelling in a Sterilisation Tunnel (TN) - presents modelling and simulation for temperature profiles in an industrial production process ***– page 3***



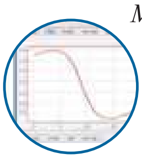
Modelling and Control of Yoyo (TN) – deals with the classical Yoyo toy: mathmatical models for control and for haptic interfaces, control strategies, and verification by a robot ***– page 9***



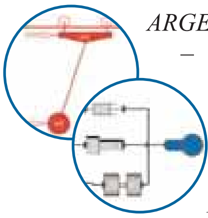
XML in DEVS (TN) – introduces XML as model basis for discrete event models for simulation via WWW and presents a prototype implementation ***– page 16***

Real-time Simulation with DSPs (SN) - reports about a connection of two DSPs, one identifying the plant, the other performing Kalman Filter and LQ control ***– page 21***

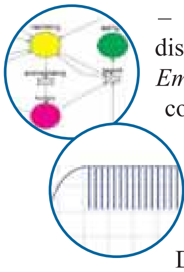
Simulation of Blood Glucose Regulation (SN) – presents MATLAB models glucose status together with a graphical interface for educational use ***– page 23***



Modelling and Control of a 2DOF - Robot (SN) – outlines modelling and simulation of a simple robot for E-learning of simulation and control via WWW ***– page 25***



ARGESIM Comparison Section – defines a revised benchmark C13 *Crane and Embedded Control* (implicit modelling, digital control, sensor action), followed by a sample solution with *Modelica/Dymola* ***– page 27***



– seven *Comparison Solutions* for discrete comparisons (*Dining Philosophers*, *Emergency Department*), continuous comparisons (*Switching States*, *SCARA Robot*) and general comparisons (*Cellular Automata*, *Identification*) show efficient implementations using MATLAB/Simulink, Dymola, DSOL/Java, Maxima and special Petri Net tools ***– page 31 - 38***

Book Reviews and *Journal News* – Eleven book reviews and one book news

Introduction of the SNE Special Issue *Parallel and Distributed Simulation Methods and Environments*

Call for next SNE Special Issue *Validation and Verification*

– page 39 - 47

Young Simulationists – introduction of simulationists from Germany and Austria ***– page 48***

EUROSIM Society Reports – 20 pages reports from EUROSIM societies, followed by 8 pages from International Societies and Groups (ECMS/SCS, MATHMOD, Modelica, etc.) and 2 pages *Industry News* in the *News Section*

Content

SNE Editorial Boards

SNE - Simulation News Europe – is advised by two Editorial Boards. The *SNE Editorial Board* is taking care on reviewing and handling of Technical Notes, Shortnotes, Software Notes, Book and Journal Review, and of Comparison and Benchmark Notes. The *SNE News Editorial Board* (News Section) is responsible for reports from EUROSIM, EUROSIM societies, International Societies, and for Industry News.

Editorial board

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Editorial Info - Impressum

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Scope: Information on development in modelling and simulation, comparisons and bechmarks on modelling and simulation, membership information for EUROSIM and Simulation Societies.

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Modelling the Human Blood Glucose Regulation - a MATLAB GUI for Educational Purposes

Andreas Ernst, Florian Judex, Juliane Höbarth, Vienna University of Technology; *efelo@fsmat.at*

This contribution presents a MATLAB GUI (Graphical User Interface) for controlling experiments with basic physiological models simulating the human blood glucose regulation. The GUI interfaces to three models, from simple glucose regulation by the kidney until more complex glucose regulation by the kidney and by the hormones insulin glucagone. The GUI is intended for educational purposes in medical and physiological engineering. Predefined parameter settings allow simulating classic diseases.

Introduction

In the course of [2] a software, more exactly a MATLAB GUI with basic physiological models from [1], for comparing and analysing different models for the blood glucose regulation was developed. In this work the models were also analysed for the properties of observability, controllability and stability, but we will not go into these details here.

The human body gets his energy from glucose (= sugar) which is extracted from carbohydrates. Hence the time of ingestion (= input of carbohydrates) and the time the glucose is needed is not the same and thus there are mechanisms in the body that can save glucose and also keep the glucose level in the blood constant. The storage of the energy (in liver, muscles and fat) can only happen when the glucose is transformed in glycogen. For this transformation the hormone insulin, which is produced in the pancreas, is needed. The antagonist of insulin is glucagon. It is also produced in the pancreas and is secreted when the glucose concentration in the blood falls under a certain level.

In the following three different models are presented which include different influencing factors mentioned above. Due to the developed software it is easily possible to compare these different models and see the effects of the neglected or included factors.

1 Basic Models

GLUKID model. GLUCID is a simple first order model for the blood glucose regulation by the kidney. All other system components involved in blood glucose regulation remain neglected. The disease *juvenile diabetes mellitus* (*type 1 diabetes*) justifies the design of a model based on blood glucose regulation by the kidney alone. In this type of diabetes the endocrine pancreas does no longer produce insulin. Dangerously high blood glucose concentrations may occur, which can only be removed from the blood by the kidneys over the urine.

INSUL model. In the model INSUL the blood glucose regulation is modelled only through the hormone insulin. It is a one-compartment model with an additional feedback loop. The compartment contains two substances, insulin and glucose. This results in a second order model with two states (Figure 1). In this model it is also possible, by setting parameters, to simulate *juvenile diabetes* where the pancreas is unable to produce insulin.

PANKID model. The model PANKID is the most complex model for blood glucose regulation discussed in [2]. It is a combination of the known models and represents the blood glucose regulation in the human body by the kidney, the hormone insulin and the hormone glucagone. The whole process of blood glucose regulation is extremely complex and even this model is a strong simplification. This model contains three state variables, the concentration of glucose, insulin and glucagon. The model is described through three first order linear ordinary differential equations - one for each substance.

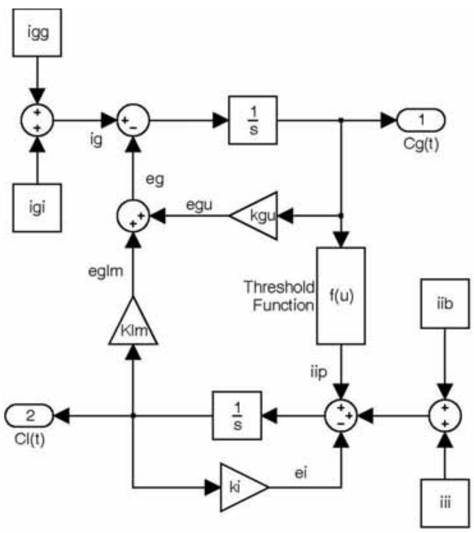

Figure 1: Simulink diagram of model INSUL.

The system analysis gives that the model is controllable and observable in all settings. All occurring parameters are due to physiological reasons ≥ 0 and thus the system is asymptotically stable.
In this model is it also possible, by setting appropriate parameters, to simulate several diseases like *juvenile diabetes mellitus*, liver diseases

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where the liver does not respond to glucagon in providing the blood with glucose or special types of tumours that secrete insulin constantly.

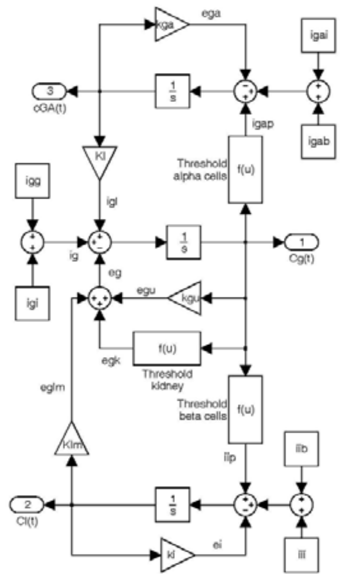

Figure 2: Simulink block diagram of the model PANKID

2 GUI - Graphical User Interface

The MATLAB GUI - developed with MATLAB standard features - offers menus for choosing models and setting parameters (Figure 3). In the pulldown menu the user can select one of the implemented models for glucose regulation. According to the chosen model it is possible to set parameter values in the appropriate fields.

If a user is not yet experienced with the parameter settings of the models, he can push the button *default setting* to obtain values to simulate a healthy person's blood glucose regulation. The GUI offers either to plot a graph with new parameter settings in an empty plotting window, or - by using the *Add Plot* button - to plot a graph with different settings in the same window, so that different parameter settings can be compared directly. Figure 4 and Figure 5 show results for model INSUL and for model PANKID.

Similar experiments (identical glucose input and insulin input into both models, additional glucagon input into PANKID model) show qualitative similar results for glucose concentration, but quantitative differences because of additional glucagon state in the PANKID model.

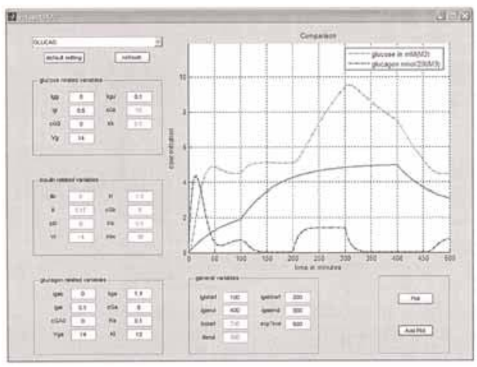

Figure 3: The MATLAB GUI.

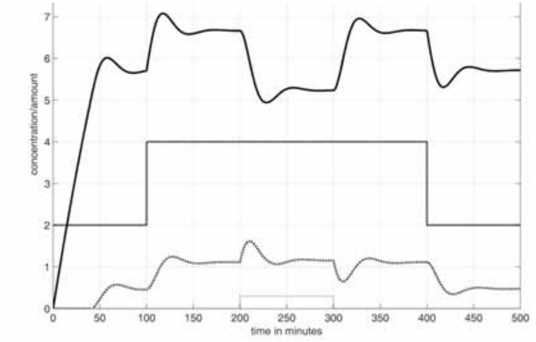

Figure 4: Results of model INSUL, glucose and insulin input.

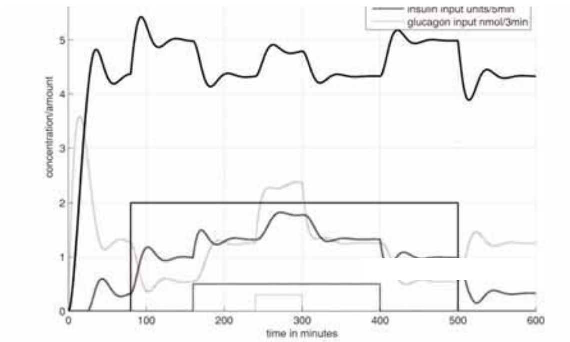

Figure 5: Results of PANKID, with glucagon dynamics.

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[1] R.P. van Wijk van Brievingh, D.P.F. Möller (Eds.): *A Workbench for Physiology and Biomedical Engineering*. Advances in Simu lation, vol.6, Springer, New York 1993.

[2] J. Höbart: *System Analysis in Terms of Observability, Controllability and Stability.* Diploma Thesis, Vienna University of Technology, 2005.

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