InMotion

Computer Modeling and Simulation in Engineering

N°6

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May 2018

InMotion project meeting in Johor Bahru

The attendants to the meeting were welcomed by Shuhaimi Mansor - the dean of Faculty of Mechanical Engineering and staff members of UTM that participate in InMotion project.

In this issue:

Calendar of events

Past events

16 -18.04.2018	Project meeting in Johor Bahru

Upcoming events

23.6.2018 - 08.7.2018	Summer school in St. Petersburg

New teaching and learning materials

The partners are working on fundamental textbooks in CMSE for Bachelors and Masters and special textbooks for different simulation tools, such as RMD, Modelica, Simulink, ISMA and Wolfram System Modeller.

In this issue, we present **"CONTROL-ORIENTED MODELLING AND SIMULATION: METHODS AND TOOLS"** by: Maja Atansijević-Kunc, Sašo Blažič, Gašper Mušič, Borut Zupančič.

Modelling and simulation have a very long tradition in control engineering. For the complex control systems design the corresponding mathematical model development and its computer simulation are extremely useful and represent a high added value. Furthermore, modelling and simulation can be efficiently used also in the process of the design and validation of control methods. Although there are many sophisticated design approaches with a high level of theory, most engineering approaches have always been based on simulation-based experimentation. Beside mentioned, modelling and simulation can be efficiently used in some other areas which are usually not in the focus of control systems design: for the safe start-up and shutdown of the processes in industrial plants, for the operators training and their decisions support and in many other issues.

Widespread digitalization of systems opens new challenging problems related to systems analysis and design, involving discrete event dynamics. Modelling and simulation can be used to address these challenges.

Just as we cannot imagine control systems design without modelling and simulation, we cannot imagine modelling and simulation without powerful software tools. It is well known that Matlab with the simulation toolbox Simulink and many other toolboxes is the most frequently used environment especially in the academic society but more and more also in industrial companies.

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InMotion project meeting in Johor Bahru (continued from page 1)

After the welcome speech, UTM-OER Manager Nurbiha A Shukor presented the eLearning Technologies that are used in UTM. Special attention was paid to the aspects of student -centered technologies and development of MOOCs.

Nurbiha A Shukor, presenting e the development of Blended Learning Open Source Science and Mathematics Studies (BLOSSOMS) lessons emphasizing on Science, Technology, Engineering and Mathematics subject in UTM

The meeting was continued with the presentation of the new Text books developed for the InMotion project.

Yuri Senichenkov (SPbPU) presented the new fundamental textbook "Mathematical modeling of complex dynamical systems" and a problem book for this course. Kirill Rozhdestvensky (SMTU) presented textbook Wolfram SystemModeler and Mathematica for engineering applications, Evgeni Popov (NSTU) presented the textbooks "Fundamentals of event-continuous systems simulation theory", Maja Atanasijević-Kunc (UL) presented text book "CONTROL-ORIENTED MODELLING AND SIMULATION: METHODS AND TOOLS and problem book.

Maria Ponomarenko (SPIIRAS) presented a report on Quality Assurance of the project activities. The teaching and learning materials (TLM) are already evaluated at the internal level – in the universities. They are also evaluated by SPIIRAS, UNED and UL. The next step is to give the TLM for the external evaluation by the experts. To organize this works the work plan was suggested and adopted.

The partners discussed Evaluation of learning environment and educational materials according the feedback from study period.

On the second day of the meeting the Inmotion team gave a UTM Public Lecture:

- Dissemination of Erasmus+ InMotion Project Igor Novopashenny (UniHB);

- Organization of education in Faculty of Electrical Engineering UL Maja Atanasijević-Kunc
- Modeling of Marine applications in SMTU Kirill Rozhdestvensky (SMTU)

The second day was finished with the cultural program – visit to Kampung Sungai Melayu - a true hidden gem, a small village built around a mangrove swamp and river which houses a diverse ecosystem of flora and fauna.

This area is a haven for birdwatchers, sporting both local and migratory birds such as hornbills, eagles and storks.

New teaching and learning materials (continued from page 1)

So the main idea of the book is to present some interesting and important areas in control (automation) which are inevitably connected with computer modelling and simulation engineering (CMSE) and to present the problem solving approach using Matlab and Simulink through many examples.

Second chapter deals with the most frequently used presentations of models. Two general presentations are introduced first, namely parametric and non-parametric models. The emphasis is given to the descriptions usually used in the analysis and design of control systems: differential equations, transfer functions and state space description. The second part of this chapter introduces Control System Toolbox which is indispensable in the presentation of mathematical models inside Matlab environment, during analysis, and also for control design of dynamic systems.

Third chapter is devoted to simulation. The basic approaches, how the mathematical models are converted into simulation models (programs, schemes) are presented. The concept of digital simulation is briefly introduced: conversion of parallel structures into sequential, numerical integration and sorting of model equations. This chapter introduces Simulink, simulation toolbox in Matlab, which can essentially unburden the user in solving mathematical models of dynamic systems. Three important simulation experiments are illustrated through several examples: parametrization, optimization, and linearization. These types of experiments are very frequently used in the phase of model(s) development, as well as in control design procedures.

Fourth chapter focuses to modelling for the purpose of dynamic systems control, or more precisely to experimental modelling also called system identification. The goal of identification is to determine system model based on available measurement data. Only the parametric identification methods of linear time invariant models are discussed in this book. Strejc's method is based on excitation with step test signals. It is very simple but only suitable for a relatively small class of processes. Model tuning methods are based on optimisation. The main part of the chapter is devoted to system identification based on linear regression. The main idea here is similar as in the case of model tuning methods but it does not involve optimisation and its problems. Rather, parameter estimation is done via analytical solution of

a linear system of equations. Due to its simplicity and its flexibility this approach is very often used in practice.

Fifth chapter is an introductory chapter to control systems. It deals with basic control concepts. We introduce open and closed loop control, control in the operating point, reference tracking mode and disturbance rejection mode, steady state behaviour and stability of control systems.

Sixth chapter briefly describes most usually used industrial control algorithms. First the extended block diagram of the control system is presented. Then the types of industrial controllers are itemised. The emphasis is given to the continuous proportional-integral-differential (PID) controllers. The role of all terms is explained and illustrated with several examples in Matlab-Simulink and also in Dymola-Modelica environments. Difficulties with the derivative term implementation are discussed. As design (tuning) techniques tuning rules (Ziegler-Nichols open loop tuning, Ziegler-Nichols closed loop tuning known also the oscillation method, Chien-Hrones-Reswick method) and computer optimization are presented and illustrated with several examples. The chapter concludes with the presentation, how PID controller can be efficiently realised with digital algorithm. Two examples demonstrate the efficiency of Matlab-Simulink and Dymola-Modelica environments for the implementation of the discrete PI control of the electrical motor angular velocity.

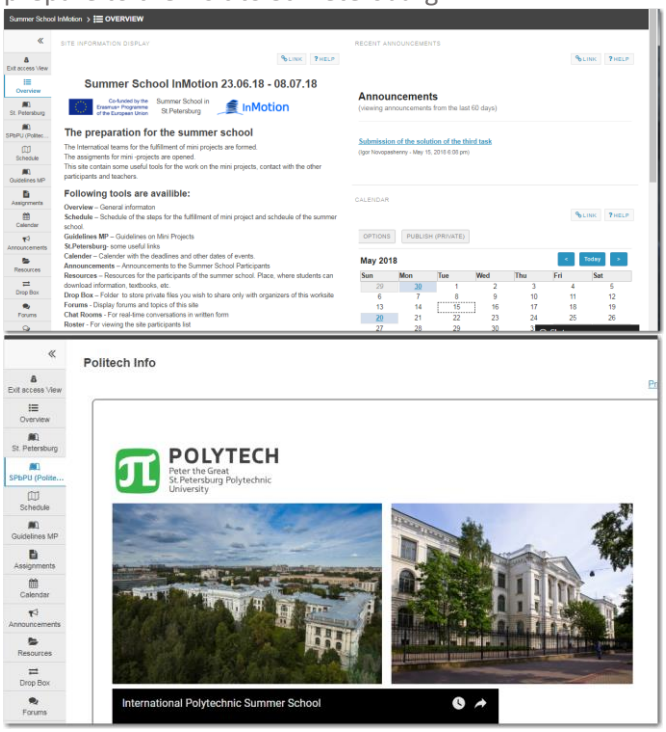
Seventh chapter includes an introduction to discrete event systems and related simulation methods.

In contrast to predominantly continuously evolving systems described in previous chapters, many man-made systems including control systems exhibit dynamics, which is manifested through sudden discontinuous changes related to events. Examples of such systems include manufacturing and assembly lines in production facilities, transport systems on ground, water and in the air, military decision and command systems, as well as computer systems and digital communication networks. With ubiquitous digitalization the importance of these systems is rising and so are the needs for suitable analysis and design tools. Discrete event modelling and simulation tools can be used in many stages of system analysis and design, improving the understanding of discrete event systems and facilitating their construction, control, and optimization. The chapter includes introduction to discrete event systems and related topics from probability theory, and presents different approaches to discrete event simulation (event scheduling, activity scanning, process oriented simulation). The last part deals with queuing systems and with introduction of Matlab SimEvents library and corresponding simulation examples.

Current Activities

Preparation for the summer school in St. Petersburg

The students started work on mini projects for the summer school, therefore a special site in OMSE was developed for communication between the students and teachers. Students got the tasks, submit their solutions, communicate between each other and prepare to the visit to St. Petersburg.



The preparation the International Student Summer School is going on in accordance with the working plan of InMotion project. The summer school will take place in Saint Petersburg from 23rd June 2018 to 9th July2018.

The organizers of the Summer School - Russian Universities - the SPbPU, the SMTU, the NSTU are carrying out organizational work related to the monitoring of the implementation of joint mini-projects by international student teams, as well as arranging a visit of students and teachers from universities of Germany, Slovenia, Spain and Malaysia to St Petersburg, and detailed preparation of the Summer School Program.

Students of partner universities are implementing their mini-projects in CMS environments, that are used in the learning process at their universities. As part of this work, students from different countries communicate each other using OMSE.

The NSTU as the organizer of mini-projects contest is monitoring implementation of the assignments, given

to students, using OMSE. The NSTU team analize, assess and make recommendations on the works posted on the OMSE by students of partner universities. They developed templates for students presentations, contact the university curators of mini-projects from partner universities and coordinate teamwork within international student teams.

Host universities from St Petersburg - SPbPUand SMTU are preparing the program of the Summer School, coordinating it with the European universities and universities from the partner countries.

The two-week Summer School program includes:

- acquaintance with the host universities and with organization of educational process in them;
- lectures and practical classes on CSM-packages for solving applied engineering problems by professors from universities participating in the InMotion-project, as well as lessons on using collaborative OMSE platform by students and teachers as a part of hybrid learning process;
- conducting master-classes on the use of computer mathematics packages;
- presentation of training materials, developed by teachers in order to support
- educational process on CMSE disciplines;
- practical meetings with specialists at enterprises and in organizations of St Petersburg, whose activity is related to computer modeling of various engineering tasks and processes ;
- meeting with the specialists of the non-academic partner of the project - SPIIRAS;
- presentation of collective mini-projects performed by international student teams; determination of the best works, recommended for publication in the refereed journal;
- participation of teachers and students in the international conference in the field of computer and mathematical modeling, organized by the SPbPU ;
- cultural program, related to acquaintance with St Petersburg;
- intercultural communication of students from different countries, participating in the Summer School;
- holding round tables with the stakeholders on implementation of the InMotion project;
- conducting surveys of students and teachers, involved in the learning process on CMSE disciplines, in order to analyze achievements and objectives set in the framework of the project.

InMotion Project

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