InMotion

Computer Modeling and Simulation in Engineering

N°4

A quarterly newsletter published by InMotion — a project funded by European Union's Erasmus+ programme

Oct 2017

InMotion Retaining in Partner Universities

InMotion Retaining Seri Iskandar, Malaysia

Partner universities prepared Program for retraining of teaching, technical and administrative personal, including training in:

- SAKAI;
- CMSE Training (RMD, Modelica, Simulink, Matlab, etc.);
- Usage of the modern educational technologies (Video lectures, Portfolios, etc.);
- Best didactic practice (Problem Based Learning Courses, Project Oriented Learning, Team Based Learning, Blended Learning);
- Educational Resources employed on pure CMSE courses.

The retraining was finished in September and the retrained personal work on the new syllabi, teaching and learning materials and eLearning modules.

In this issue:

Calendar of events

Past events

05-09.2017	Retraining of the personal in the partner universities
07-10.2017	Information workshops

Upcoming events

23 -25.10.2017	Project meeting in in Madrid.

Comparative study of tools for Computer Modeling and Simulation (CMS)

The most popular Modeling and simulation environments used in the CMSE field are – Rand model designer, MathWorks – Matlab, Dassault Systèmes – Dymola, Wolfram Research – Wolfram system.

Discrete-continuous (hybrid) dynamical systems are usually studied by engineers. Hybrid systems (HS) are characterized by continuous modes which instantly change each other. In this case, the use of analytical methods of research is often impossible, and the simulation becomes the only universal way of studying event-continuous behavior. Modern computer modeling and simulation software deal with HS, but they barely take into account one-sided events. That's why, when training the specialists, one should focus both on the nature of engineer problems solved, and on capabilities and limitations of computer modeling and simulation instrumental tools. A specialist must be aware of a huge variety of visual modeling and simulation environments, be able to use the tools which are most appropriate to solve a particular problem, to prove their choice and assess the correctness of the results obtained. A modern formalism, HS, can be effectively used by domain specialists via problem-oriented software applications for computer analysis. Examples of HS applications are automation, mechanics, chemical kinetics, electrical power systems, hydraulics and many others. Therefore, each software application should be domain-oriented, and meet certain general requirements.

Continued on page2

Comparative study of tools for CMS (continued from page 1)

The following key requirements can be singled out:

- domain user-friendly interface with support of certain, usually standard, languages for specification of computer models;
- advanced tools for editing graphical and/or textual program models with support of meaningful error diagnostics, and tools for effective analysis and transformation of the models for preparing the simulation;
- modern library of numerical algorithms and tools for simulation, particularly, including a set of classical and original numerical methods;
- visual graphical interpretation of the simulation results with the possibility to transform the data obtained.

A brief description of features of software applications:

Matlab uses Simulink environment with advanced graphical languages of block diagrams to analyze complex dynamical systems. A disadvantage is the redundancy of base blocks, many of which can be modeled as a composition of the others. An add-on, StateFlow, with graphical language of state diagrams (Harel statecharts) is used for studying discrete-continuous systems. Both graphical languages are interpreted in intermediate non-optimal code. The library of numerical methods is standard and is not tuned for specific problems from the mentioned class. The simulation results cannot be edited.

Dymola uses an object-oriented multidomain language Modelica. The Modelica language is universal. Therefore, large component libraries were created to solve domain-specific problems: mechanical, electrical, electronic, hydraulic, thermal, power components, as well as control components and special process-oriented components.

The both component modeling approaches – with oriented and non-oriented connections - are implemented in Modelica. A new graphical model can be built as a set of equations and/or a composition of already existing elements. Thus, there is no need to describe basic model elements. A user only specifies variables and parameters, write equations and build a model from the existing blocks.

Extensive capabilities of the Modelica language allow a user to fully describe basic components and to build hierarchical models. However, it can be considered as a disadvantage because of the cumbersomeness of textual descriptions. Another disadvantage is related to possible user's difficulties with hierarchical decomposition during creating and editing models of complex systems.

Wolfram system modeler fully supports the Modelica language as well. There are numerous domain-specific libraries with detailed documentation and examples. There is a feature of integration with Wolfram Mathematica, which supports extended hybrid models and differential-algebraic equations.

Rand model designer (RMD) implements object-oriented approach as well and contains the Modelica library. RMD generalizes the experience of Simulink and Modelica and strictly follows the UML standard, which is very important for educational purposes. From the analyzed modeling and simulation environments only RMD provides full support for models with variable structure, but it requires Windows OS, which should be noted as a disadvantage.

ISMA is a domain-oriented multi-language instrumental environment for modeling and simulation of HS. A distinctive feature of ISMA is a set of syntax-oriented domain language tools. Due to the purposefully chosen API-architecture, various symbolic and graphical languages and means of their implementation are easily added to the system. Also without reprogramming the whole system, new numerical and event-detection methods can be added. The domain-oriented concept lets use the system to solve electrical power engineering, chemical kinetics, electromechanics, automation problems and so forth. For each engineering area, the special domain-oriented language, which is as close as possible to typical engineering description, in a graphical or in a textual way, is developed and implemented.

Another feature of ISMA is that the library contains well-known numerical methods as well as the original methods, which take into account the stiffness, the dimensionality of problems and dynamics of the event-function during simulation of one-sided HS. User can transform the simulation results in ISMA.

Thus, the choice of modeling and simulation environment for educational purposes is related to the problems, which are faced by the students in the educational courses, and to the general idea of the educational program. As differential equations and state machines are almost standard for the input language of most of simulation tools, the theory of dynamical systems, basics of modeling and simulation should be taught using the language of mathematics, but not specific simulation tool language. For a basic mathematic modeling course, a teacher can use almost any mathematical package. In specialized courses, oriented on certain application area or on a detailed study of certain modeling approaches, a visual modeling and simulation environment, which supports necessary model types, is needed.

Current Activities

Modernising local infrastructure at the PC universities

The partner universities specified the composition of the equipment to be purchased and started the tendering procedure. The equipment includes:

- high-performance computing system and data storage devices for simulation of complex engineering problems;
- set of equipment for educational laboratory;
- network and communications equipment to support the functionality of OMSE Server;
- mobile devices for tests of the eLearning modules;
- videoconferencing equipment for communication with stakeholders, partners and research institutions;
- equipment for creation of multimedia and video educational resources;
- software packages for CMSE.

Installation of this equipment will support the development of TLM, eLearning activities and Virtual labs.

Information workshops.

SMTU

Prof. Vladimir Ryzhov (SMTU) participated in Round table of Stakeholders and Universities **«Staffing of the enterprises of oil/gas/chemical complex: issues of the development of engineering pedagogy»**, held in the framework of the international conference "SYNERGY-2017".

The round table is organized by the International Federation of Engineering Education Societies (IFEES), International Society for Engineering Training (IGIP), Society of European Engineering Education (SEFI), Association of Engineering Education of Russia (AEER), National Training Fund of the Russian Federation (NTF).

Within the framework of the Round Table presentations on the subject of practical-oriented methods and technologies for training of engineering staff in various universities were made, the issues of correspondence of the Federal State Educational Standards and Professional competences of industrial enterprises.

Prof. Vladimir Ryzhov proposed to hold a session of the network conference using high-resolution video-conferencing in November 2017.

The following topics were proposed for this session:

1. Technologies of project education in engineering training in the SMTU: development of robotic platforms for enterprises of the oil and gas chemical industry implementing projects on the sea shelf.
2. Experience of the international project InMotion: the introduction of new technologies for engineering staff training.
3. Kongsberg Digital AS/SMTU Project: virtual reality technologies for the oil and gas industry - training of development engineers and the practical use of simulator systems for staff retraining.

UTM

The InMotion UTM team was honorably invited to take part in UTM4.0 Industrial Revolution Exhibition. The InMotion booth was established under the framework of Erasmus+ project, InMotion: Innovative teaching

and learning strategies in open modeling and simulation environment for student-centered engineering education. The InMotion UTM team exhibited three-days in the UTM4.0 Industrial Revolution Exhibition to share information of InMotion project and arise the awareness of the InMotion program in accordance with the fourth industrial revolution, Industrie 4.0, to the stakeholders, where the visitors of this Exhibition includes Minister of Higher Education in Malaysia, officials from higher institutions, industry professional, academicians, students, and the public.

It was approximated more than 500 visitors from the ministry of Higher Education, other higher institution, industry, academia, and public to visit this exhibition. The UTM InMotion team share information of InMotion project to the stakeholders and the public and promote the potential impacts of InMotion to the development of Industrie 4.0 in the engineering education.

The UTM InMotion team displayed InMotion poster, SAKAI system, online course sample, and framework of cloud computing by using Simulink to the visitors / stakeholders. took place on June 21, 2017 in NSTU, Novosibirsk.

The SMTU-NSTU working meeting

took place on June 21, 2017 in NSTU, Novosibirsk.

V. Ryzhov monitored the state of the work of the NSTU according to the second period Work Plan. The results of the working meeting were:

- clarification of the work plan activities for the second period,
- harmonization of the review procedure for developed Sylabi, Curricula and TLM,
- coordination of the schedule of activities for the preparation for the «Open Summer School

(V. Ryzhov, SMTU and I.Reva, NSTU)

The SMTU-SPII RAS working meeting

on the implementation of the tasks of the second period of the InMotion project took place on August 22, 2017 in SPII RAS, St. Petersburg. The partners discussed similar issues as in the other meetings and specially the questions concerning

- coordination of the mini-projects topics list,
- clarification of the InMotion Network activities.

(V. Ryzhov, SMTU and B. Sokolov, SPII RAS)

The SMTU-SPbPU working Meeting

took place on September 05, 2017 in SPbPU, St. Petersburgю The partners discussed similar issues as in NSTU and planed joint participation in the International conference IMMOD-2017 (Modeling and Simulation. Theory and practice.), St. Petersburg

The SMTU-UNECON working meeting

The SMTU-UNECON (St. Petersburg State University of Economics) working meeting on the dissemination activities of InMotion project took place on October 12, 2017 in UNECON, St. Petersburg.

Within the framework of the meeting, the SMTU and UNECON were discussed the following questions:
- UNECON students and staff participation in «Open International Summer School», St. Petersburg, 25.06-09.07.2018
- interaction within InMotion Network,
- participation in the open network session of the key universities of JSC Gazprom (Session theme: Implementation of the modern methods and technologies of the engineering education).

As a result, the parties agreed:

- UNESON's participation in the «Open International summer school»
- UNESON's participation in network session conducted by SMTU (17.10.2017),
- UNESON's participation in events of InMotion Network.

SMTU-UNECON dissemination meeting (professor V. Ryzhov, assistant professor K. Safronov, SMTU and professor G. Fridman, UNECON)

New Syllabi for Engineering Curricula in CMSE

The Partner Universities from MY and RU developed new or upgraded the existing Syllabi for the engineering Curricula un their Universities.
The basic – fundamental Syllabi was developed by the SPbPU - the leading specialists in the field of CMS in engineering education with the assistance of the European partners from UL and UNED. The course "The basis of mathematical modeling" with light modifications is included as new Syllabi in the engineering curricula of all RU partner universities. The main elements of this course are also included in the upgraded courses of Malaysia Universities.
The course "Modeling and Simulation in Engineering using Modelica", suggested by UNED is included in the curricula of RU partner universities as elective course.
The course "Control Theory with Simulink", suggested by UL is included as elective course for Master degree in RU universities.
Some partner universities developed their own courses, that are suggested as elective disciplines for the students.

№	Course Name	ECTS	Level
1	Basic- Fundamental course: The basis of mathematical modeling	4	Bachelor
2	Modeling and Simulation in Engineering using Modelica	3	Bachelor
3	Virtual Modeling of Engineering Problems using RMD	3	Bachelor
4	Computer Modeling and Simulation of Dynamic Systems using Wolfram SystemModeler	3	Bachelor
5	Control Systems	5	Bachelor
6	Mathematical Modeling of Dynamical Systems	5	Bachelor
7	Technologies of computer modeling	4	Master
8	Control Theory with Simulink	4	Master
9	Modeling and simulation in OpenModelica	4	Master
10	Modeling and simulation of hybrid systems	2	Master
11	Dynamics of Marine Structures	5	Master

These Syllabi were evaluated by the project partners UNED, UL and SPIIRAS and by the external experts.
Now, the work on the new textbooks and other teaching and learning materials, including eLearning modules, virtual labs is going on.
The study according the new Syllabi will start in the Second semester of 2017-2018.

InMotion Project

Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein