Scientific Conference of Young Researchers 2018

18th Scientific Conference of Young Researchers

May 14th, 2018
Herľany, Slovakia

Proceedings from Conference

Faculty of Electrical Engineering and Informatics
Technical University of Košice

TECHNICAL UNIVERSITY OF KOŠICE

Co-Organizers

Sponsors

18th Scientific Conference of Young Researchers
of the Faculty of Electrical Engineering and Informatics
Technical University of Košice

Proceedings from Conference

Published: Faculty of Electrical Engineering and Informatics
Technical University of Košice
Edition I, 272 pages, number of CD Proceedings: 50 pieces

Editors: prof. Ing. Alena Pietriková, CSc.
Ing. Lukáš Galko
Ing. Emília Pietriková, PhD.

ISBN 978-80-553-2972-7

Program Committee of 18th Scientific Conference of Young Researchers of the Faculty of Electrical Engineering and Informatics, Technical University of Košice

General chair:	Prof. Ing. Liberios Vokorokos, PhD.
Editorial board chairman:	Prof. Ing. Alena Pietriková, CSc.
Proceeding reviewers:	Prof. Ing. Roman Cimbala, PhD. Prof. Ing. Iraida Kolcunová, PhD. Prof. Ing. Ján Paralič, PhD. Prof. Ing. Daniela Perduková, PhD. Prof. Ing. Alena Pietriková, CSc. assoc. Prof. Ing. Ján Gamec, CSc. assoc. Prof. Ing. Ján Genči, PhD. assoc. Prof. Ing. Kristína Machová, PhD. assoc. Prof. Ing. Ján Papaj, PhD. assoc. Prof. Ing. Jaroslav Porubän, PhD.

Organization Committee of 18th Scientific Conference of Young Researchers of the Faculty of Electrical Engineering and Informatics, Technical University of Košice

Members:	Prof. Ing. Alena Pietriková, CSc. Ing. Ivana Olšiaková Ing. Emília Pietriková, PhD. Ing. Peter Čech Ing. Lukáš Galko Ing. Juliana Ivančáková Ing. Patrik Jacko Ing. Irena Jadlovská Ing. Miroslav Jaščur Ing. Lukáš Kruželák Ing. Stanislav Slovák Ing. Miroslav Sokol Ing. Ľuboš Suchý Ing. Alojz Šoltýs
Contact address:	Faculty of Electrical Engineering and Informatics Technical University of Košice Letná 9 042 00 Košice Slovak Republic

Foreword

Dear Colleagues,

SCYR (Scientific Conference of Young Researchers) is a Scientific Event focused on exchange of information among young scientists from Faculty of Electrical Engineering and Informatics at the Technical University of Košice – series of annual events that was founded in 2000. Since 2000, the conference has been hosted by FEI TUKE with rising technical level and unique multicultural atmosphere. The 18^{th} Scientific Conference of Young Researchers (SCYR 2018), conference of Graduates and Young researchers, was held on 14^{th} May 2018.The primary aims of the conference, to provide a forum for dissemination of information and scientific results relating to research and development activities at the Faculty of Electrical Engineering and Informatics has been achieved. Approx. 100 participants, mostly by doctoral categories, were active in the conference.

Faculty of Electrical Engineering and Informatics has a long tradition of students participating in skilled labor where they have to apply their theoretical knowledge. SCYR is opportunities for doctoral and graduating students use this event to train their scientific knowledge exchange. Nevertheless, the original goal is still to represent a forum for the exchange of information between young scientists from academic communities on topics related to their experimental and theoretical works in the very wide spread field of a wide spectrum of scientific disciplines like informatics sciences and computer networks, cybernetics and intelligent systems, electrical and electric power engineering and electronics.

18^{th} Scientific Conference of Young Researchers at the Faculty of Electrical Engineering and Informatics, Technical University of Košice (SCYR 2018) was organized in a beautiful village Herľany. The Conference was opened in the name of dean prof. Ing. Liberios Vokorokos, PhD. by the vicedean of faculty, prof. Ing. Alena Pietriková, CSc. In her introductory address she noted the importance of the Conference as a forum for exchange of information and a medium for broadening the scientific horizons of its participants and stressed the scientific and practical value of investigations being carried out by young researchers.

Traditionally, the program includes two parallel sessions:

- Electrical & Electronics Engineering
- Information Technologies

with approx. 100 technical papers dealing with research results obtained mainly in university environment. This day was filled with a lot of interesting scientific discussions among the junior researchers and graduate students, and the representatives of the Faculty of Electrical Engineering and Informatics. This Scientific Network included various research problems and education, communication between young scientists and students, between students and professors. Conference was also a platform for student exchange and a potential starting point for scientific cooperation. The results presented in papers demonstrated that the investigations being conducted by young scientists are making a valuable contribution to the fulfillment of the tasks set for science and technology at the Faculty of Electrical Engineering and Informatics at the Technical University of Košice.

We want to thank all participants for contributing to these proceedings with their high quality manuscripts. We hope that conference constitutes a platform for a continual dialogue among young scientists.

It is our pleasure and honor to express our gratitude to our sponsors and to all friends, colleagues and committee members who contributed with their ideas, discussions, and sedulous hard work to the success of this event. We also want to thank our session chairs for their co-operation and dedication throughout the whole conference.

Finally, we want to thank all the attendees of the conference for fruitful discussions and a pleasant stay in our event.

Liberios VOKOROKOS
Dean of FEI TUKE

May 14th 2018, Herľany

Patrik Jacko
Fast signal sampling by interleaved mode of STM32 AD converters 109

Martin Pečovský
Front-End Circuits for Electrically Short UWB Antennas 111

Pavol Šatala
Gathering and usage of accelerometer data in the medical domain 113

Zuzana Dankovičová
Handwriting pre-processing for clinical decision support systems 117

Matúš Uchnár
Hybrid system for malware detection 120

Marián Hudák
Immersion enhancing virtual reality interfaces 122

Dominik Vošček
Implementation Enhancement of Hybrid Systems Modelling within Distributed Control System . 126

Zuzana Bilanová
Increasing the Expressive Power of the Intensional Logic Used for Logical Analysis of the Natural Language Sentences 128

Michal Špes
Influence of average climatic parameters on the maximum permissible current value of the conductor 130

Michal Kosterec
Influence of electromagnetic field on ticks 132

Peter Pastornický
Interaction possibilities in virtual reality systems with regard to disabilities 134

Norbert Ferenčík
Interactions in Intelligent Rehabilitation Space 136

Lukáš Kruželák
Investigation of Electro-physical Processes in Electrical Power Systems 138

Juraj Mihaľov
Low Cost Motion Sensors and Resolution Expansion of Thermal Data Based Images for Smart House Solution 140

Branislav Kunca
Magnetization reversal processes and interphase interactions in rapidly quenched soft/semi-hard magnetic bilayer ribbon 143

Ján Romaňák
Maintenance management of MV and LV distribution grid devices 146

Aleš Deák
Mechanisms for predicting the behavior of electrical appliances – effective data storing 150

Ján Juhár
Metadata Supporting Layer for Development Environments 153

Implementation Enhancement of Hybrid Systems Modelling within Distributed Control System

[1]*Dominik VOŠČEK (3rd year),*
Supervisor: [2]*Anna JADLOVSKÁ*

[1,2]Department of Cybernetics and Artificial Intelligence, FEEI TU of Košice, Slovak Republic

[1]dominik.voscek@tuke.sk, [2]anna.jadlovska@tuke.sk

***Abstract*—This paper presents achieved results during the last year in the field of modelling, simulation and control of the cyber-physical systems in the form of hybrid systems. Within modelling of the hybrid systems various enhancements were implemented in the set of the simulation models which were derived/inspired by laboratory models, namely hydraulic hybrid systems with logical states/inputs as well as the lift model based on finite state machines enhanced with linear temporal logic. The big attention was dedicated to the tasks within the international project "*Experiment ALICE on LHC in CERN : Study of strongly interacting matter at extreme energy densities* which were focused on broadening already existing communication and control architecture.**

***Keywords*—cyber-physical system, detector control system, hybrid system, linear temporal logic**

I. Introduction

Cyber-physical systems are defined as a profound part of Industry 4.0 and are defined as a synergy of computation platforms with physical processes. CPS posse many challenges, thoroughly described in [1] and [2], one of which the author focuses on is to model such a CPS within hybrid systems framework.

The natural way to model hybrid systems is by using hybrid automata (HA) framework [3]. Utilizing this framework, it is possible to define system's dynamics based on the physical laws (continuous part) and logic (discrete part). Some of such systems are located at Department of *Cybernetics and Artificial Intelligence, FEEI, TUKE*, specifically hydraulic system, lift system and single inverted pendulum with linear synchronous motor within *Multipurpose Workplace of Non-destructive Diagnosis* solved within a project *USP TECHNICOM, Centre for Nondestructive Diagnostic of Technological Processes with Standard Software Package for Control and Communication* at *Center of Modern Control Techniques & Industrial Informatics* (CMCT&II).

The main purpose of this paper is to give an overview of the implementation enhancements of hybrid system framework, either in cooperation with the linear temporal logic (LTL) or using logical states and/or logical inputs.

Possible further enhancements are proposed at the end of the paper.

II. Previous Analysis and Achieved Results in Research Field

CPS are commonly described in the form of hybrid systems (HS) framework. This framework is based on finite state machines (FSM) framework augmented by continuous dynamics for some or each of the FSM discrete state and therefore defining hybrid system framework as is.

One of the most common used representation of HS is discrete hybrid automata (DHA) framework. DHA is represented by an interconnection of the switched affine dynamical systems (SAS) and FSM via mode selector (MS) and event generator (EG) as seen in Fig. 1, [3] and [4].

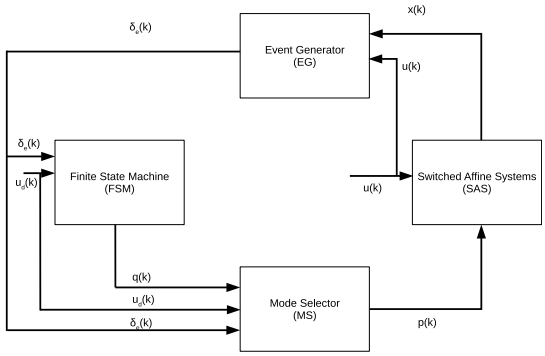

Fig. 1. Discrete hybrid automata framework

III. Solved Tasks and Results

Following achieved results from the last year [5], described hybrid hydraulic system was enhanced with logical states and inputs meaning that it can be in one of eight possible hybrid modes. As it can be seen in Fig. 2, the bottom valve can be closed as well as the system can exists as hydraulics system with or without interaction. For aforementioned system optimal control was designed for suitable hybrid mods since optimal control cannot be designed for *Mode C* and *Mode G*. The whole control system was then implemented in *MPT* toolbox within *MATLAB/Simulink* using *HYSDEL* language.

Another implementation enhancement of HS was made on the *Lift System* which was inspired by the real laboratory

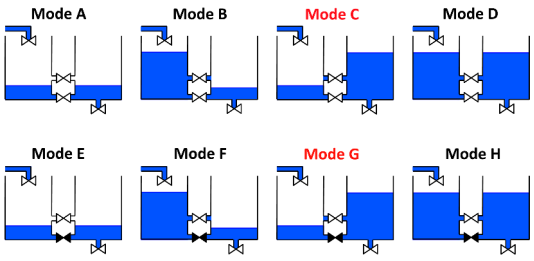

Fig. 2. Visual comparison of the hydraulic system individual discrete modes

model of the lift [4]. At first, propositions based on the (LTL) were stated and then the whole logic alongside with FSM of the lift were implemented in *Stateflow toolbox* within *MATLAB/Simulink* environment.

One explanatory FSM subsystem, for the *Door mechanism*, is depicted in Fig. 3 and for the the completeness a LTL notation is introduced.

Based on the LTL nomenclature and its operators $\mathcal{G}$ for *globally*, $\mathcal{F}$ for *finally*, $\mathcal{X}$ for *next*, $\mathcal{U}$ for *until* it is possible to introduce the following atomic propositions within LTL framework [6]:

- h_i the lift stays on the *i*-th floor,
- d_i the door on the *i*-th floor is open,
- d_{so} door space occupied.

Then for the Lift System inspired by the real lift behaviour following LTL formula Φ can be defined.

If the door space is occupied, do not close the door, neither change the height of the lift until the door space is not occupied:

$$\Phi = \mathcal{G}(\bigwedge_{i=1,2,3,4} h_i \wedge d_{so} \rightarrow \rightarrow \mathcal{X}((\bigwedge_{i=1,2,3,4} h_i \wedge d_i)\mathcal{U}(\neg d_{so}))). \quad (1)$$

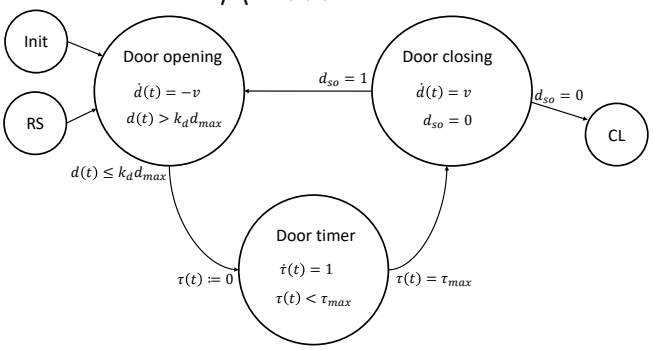

Fig. 3. One of the discrete modes of the Lift System - *Door mechanism* mode

As far as the project "*Experiment ALICE on LHC in CERN : Study of strongly interacting matter at extreme energy densities*", in cooperation with *European Nuclear Research Center* in Geneva is concerned (http://alice-cern.fei.tuke.sk/), author focused on replacing placeholder electronics in the testing workplace, i.e. Arduino and Raspberry, with custom electronics from CERN as well as on writing modular software for this electronics which will be mounted within the final communication and control DCS architecture [7], [8] and [9]. This whole communication and control architecture represents complex distributed CPS. Furthermore, the author's main focus was dedicated on simulation of the final *Detector Control System* throughput as seen in Fig. 4. For this purpose, the simulator for data generation, which is considered as CPS, was implemented within SCADA software *WinCC OA*. The simulator is going to be mounted on the computational farm made of servers and the throughput of the final data load is to be measured.

IV. FUTURE RESEARCH STEPS

The purpose of this paper was to summarize the author's research activities during the last year. Within future research steps author will be mainly focused on further enhancing of various hybrid control techniques, using these techniques for modelling hybrid systems as well as on their algorithmization.

Tested modelling, identification and control algorithms within simulation models will then be verified on the real

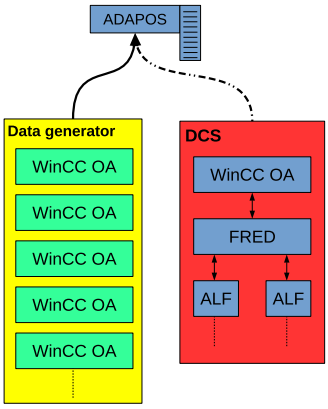

Fig. 4. Position of the Data Generator within Detector Control System at CERN

applications at *Center of Modern Control Techniques & Industrial Informatics* (CMCT&II) at *DCAI*.

Another substantial research activities will be focused on the finalizing project tasks concentrated on enhancing of existing communication and control infrastructure within project "*Experiment ALICE on LHC in CERN : Study of strongly interacting matter at extreme energy densities*".

ACKNOWLEDGMENT

This publication is the result of the Project implementation: University Science Park TECHNICOM for Innovation Applications Supported by Knowledge Technology - II. phase, ITMS: 313011D232 (60%), supported by the Operational Programme Research & Development funded by the ERDF and grant KEGA Implementation of research results in the area of modeling and simulation of cyberphysical systems into the teaching process - development of modern university textbooks 072TUKE-4/2018 (40%).

REFERENCES

[1] D. Vošček, "Contribution to hybrid models of cyber-physical systems and their implementation into distributed control system," in *Dissertation prospectus*. TU, 2017.

[2] E. A. Lee and S. A. Seshia, "Introduction to embedded systems," *A cyber physical approach*, 2014.

[3] Q. Wang, G. Yang, X. Zhou, and Y. Yang, "Behavior modeling of cyber-physical system based on discrete hybrid automata," in *Computational Science and Engineering (CSE), 2013 IEEE 16th International Conference on*. IEEE, 2013, pp. 680–684.

[4] D. Vošček, A. Jadlovská, and D. Grigľák, "Modelling and analysis of the lift system as a hybrid system," *Acta Electrotechnica et Informatica*, vol. 17, no. 4, pp. 28–34, 2017, "ISSN:1335-8243".

[5] D. Vošček and A. Jadlovská, "Modelling and control of a cyber-physical system represented by hydraulic coupled tanks," in *15th International Symposium on Applied Machine Intelligence and Informatics (SAMI), IEEE*. IEEE, 2017.

[6] M. Y. Vardi, "An automata-theoretic approach to linear temporal logic," in *Logics for concurrency*. Springer, 1996, pp. 238–266.

[7] J. Jadlovský, A. Jadlovská, S. Jadlovská, M. Oravec, D. Vošček, M. Kopčík, J. Čabala, M. Tkáčik, P. Chochula, and O. Pinazza, "A novel general purpose data acquisition board with a DIM interface," in *Proceedings, 16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS 2017): Barcelona, Spain, October 8-13, 2017*, 2018, p. THPHA076.

[8] J. Jadlovský, A. Jadlovská, S. Jadlovská, M. Oravec, D. Vošček, J. Čabala, M. Kopčík, M. Tkáčik, P. Chochula, and O. Pinazza, "Communication architecture of the Detector Control System for the Inner Tracking System," in *Proceedings, 16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS 2017): Barcelona, Spain, October 8-13, 2017*, 2018, p. THPHA208.

[9] J. Jadlovský, O. Pinazza, M. Tkáčik, J. Čabala, A. Jadlovská, M. Kopčik, P. Chochula, S. Jadlovská, M. Oravec, and D. Vošček, "Information system for ALICE experiment data access," in *Proceedings, 16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS 2017): Barcelona, Spain, October 8-13, 2017*, 2018, p. THPHA041.