

## Preface

This special issue has two parts:

- A) TP Model Transformation-based Control Theories and Applications
- B) Cognitive Infocommunications: Virtual Reality in Education

### Part A)

The topic of Part A) belongs to multi-objective control design based on quasi Linear Parameter Varying (qLPV) models and Linear Matrix Inequality (LMI) based optimization. The special issue focuses on advanced theories and design solutions based on Tensor Product (TP) model transformation. The TP model transformation is capable of constructing and manipulating polytopic representations of given qLPV models, and can be applied generally without analytical intervention, regardless of whether the model is in the form of dynamics equations derived from basic principles, or the outcome of soft computing based identification techniques such as neural networks or fuzzy logic, or the combination of these. The LMI design is very sensitive for the features of the polytopic model, therefore the TP model based manipulation of the polytopic models play a crucial role in control performance optimization. This Part A) includes six papers such as:

- 1) Tensor Product Model Transformation Simplification of Takagi-Sugeno Control and Estimation Laws – An Application to a Thermoelectric Controlled Chamber

This paper presents a novel application of the Tensor Product Model Transformation: the approximation of fuzzy control and estimation laws. A thermoelectric controlled chamber is built using peltier coolers and an H Bridge. A Takagi-Sugeno discrete time fuzzy model and LMI-based design is used to derive a controller.

- 2) A Tensor Product Model Transformation Approach to the Discretization of Uncertain Linear Systems

This work proposes a novel approach based on a grid of the possible values for the matrix exponential function and an application of the tensor product model transformation technique to find a suitable polytopic model. Numerical examples are presented to illustrate the advantages and the applicability of the proposed technique.

3) Tensor Product Model-based Control Design with Relaxed Stability Conditions for Perching Maneuvers

This paper proposed a control design approach based on tensor product models for perching maneuvers of fixed-wing aircraft. The highly nonlinear longitudinal dynamics of perching maneuvers is transformed into a tensor product model. The properties of the time derivatives of premise membership functions are utilized in the control design process to further reduce the control conservatism.

4) Tensor Product Model-based Control for Space-Craft with Fuel Slosh Dynamics

TP model transformation based solution is developed in this paper to the problem of Large spacecrafts undertaking long-life mission. Such missions greatly suffer from the nonlinear fuel slosh when altering the orbit or maneuvering, which leads to the downgrade on the performance and even stability of the body attitude control by unintentionally generating the huge disturbance thrust.

5) A State and Input Constrained Control Method for Air-Breathing Hypersonic Vehicles

This paper presents a systematic constrained control framework for the longitudinal motion of an air-breathing hypersonic vehicle via a combination of tensor product (TP) transformation and command governor approach. The significance of this proposed method mainly lies in its capability to avoid the flight exceeding constraints with varying flight conditions.

6) Tensor Product Model Transformation-based Parallel Distributed Control of Tumor Growth

The current work investigates tumor growth control under antiangiogenic targeted molecular therapy by use of TP model transformation. During the dynamics of the tumor growth we have considered that the tumor volume is measurable, while due to the lack of information about the inhibitor level in the serum an appropriate Extended Kalman Filter is applied as an observer. The paper also deals with the sensor noise of the system. The paper show that using the proposed solution: (i) the tumor volume was lower than  $1 \text{ mm}^3$  at the end of the therapy; (ii) the developed models have approached each other with good accuracy; (iii) the totally injected inhibitor level was physiologically acceptable.

## Part B)

Cognitive infocommunications (CogInfoCom, CogInfoCom.hu) investigates the link between the research areas of infocommunications and cognitive sciences, as well as the various engineering applications which have emerged as the synergic combination of these sciences. The primary goal of CogInfoCom is to provide a systematic view of how cognitive processes can co-evolve with infocommunications devices so that the capabilities of the human brain may not only be extended through these devices, irrespective of geographical distance but may also be blended with the capabilities of any artificially cognitive system. This merging and extension of cognitive capabilities are targeted towards engineering applications in which artificial and/or natural cognitive systems are enabled to work together more effectively. This Part B) of the special issue is focusing on Virtual Reality (VR) based solution in education. It includes the following papers:

### 1) MaxWhere VR-Learning Improves Effectiveness over classical Tools of e-learning

The paper focus primarily on the content and digital tools of e-learning and VR learning in general. It compares the effectiveness of three techniques, ranging from well-known to radically new: classical e-mail / attachment based sharing, sharing through web interfaces (through a Moodle frontend), and sharing through a VR interface provided by a recently developed VR engine called MaxWhere. The paper shows that the users were able to complete the required workflow at least 50% faster in the MaxWhere 3D environment than in all other competing cases.

### 2) Factors Contributing to the Enhanced Performance of the MaxWhere 3D VR Platform in the Distribution of Digital Information

This paper presents an experiment contrasting traditional 2D interfaces and the MaxWhere 3D VR educational platform in order to shed light on how the effectiveness of various operations and workflows constituting the core of digital literacy has evolved in recent times. In order to draw specific conclusions, a new framework of concepts, qualitative and quantitative metrics and experimental procedures is proposed in the paper. The paper concludes that MaxWhere VR platform offers users a number of ways to accomplish tasks that would otherwise require extremely complicated digital workflows in more traditional 2D environments.

### 3) 2D Advertising in 3D Virtual Spaces

In this paper, a comparison of the classic banner ads, and 2D ads placed in a 3D virtual world is discussed. The effectiveness of the VR advertisement is higher than the classic web-based ads. As virtual space, we used the MaxWhere virtual platform. The paper concludes that the memory recall of users was considerably more effective in 3D VR environment.

### 4) Towards a Modern, Integrated Virtual Laboratory System

The aim of this paper is to give an overview on virtual and remote laboratory systems and to evaluate current solutions focusing on feasibility and applicability in higher education. The paper proposes new set of requirements against a modern virtual laboratory system. Finally, an overview of state of the art cognitive infocommunication technologies are presented, which can help to create high user experience in the new virtual laboratory environment.

### 5) Cooperative Learning in VR Environment

The paper aims to introduce how a lesson built on the improvement of different intelligence levels through cooperative techniques can be implemented with the help of virtual space, what opportunities are provided by the MaxWhere program for planning and organizing teamwork and for supporting learning.

### 6) The Evaluation of BCI and PEBL-based Attention Tests

In this paper, an EEG-based engineering research work is demonstrated, which supports the acquisition of practical knowledge and can measure cognitive ability with a device capable of brain activity observation. In the engineering research task, a brain-computer interface (BCI) had to be developed for the measurement of the average level of attention. The results of the BCI have been compared and contrasted to the results of two tests applied in cognitive psychology, the PEBL Continuous Performance Test (pCPT) and the PEBL Test of Attentional Vigilance (pTOAV).

### 7) Examining the Learning Efficiency by a Brain-Computer Interface System

The main goal of this paper is to develop a Brain-Computer Interface (BCI) system to observe the level of vigilance calculated by Think Gear-ASIC Module (TGAM1) technology and to evaluate the output with learning efficiency tests applied in cognitive neuroscience. The developed BCI system has a significant correlation with P CORSI and P EBBINGHAUS cognitive neuroscience tests. The BCI system is capable of observing attentional vigilance continuously.

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