
**Co-organised by:**
**IEEE EMBS (Singapore Chapter) | NUS Advanced Robotics Centre**

**Topic:** **Modern Robust Control Methods for Artificial Pancreas**

**Speaker:** **Dr. Levente Kovács**
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Óbuda University, Budapest, Hungary

**Date:** **2 June 2014, Monday**

**Time:** **10.00am to 11.00am**

**Venue:** **EA-06-02** *(map of NUS can be found at http://map.nus.edu.sg/)*

## Abstract

Due to the continuous development in computer science, control engineering and measurement theory, the possibilities of biomedical engineering are extending. The aim of physiological control—a subdiscipline of biomedical engineering—is to study, model and apply identification and control strategies in order to understand and help the automated treatment of various diseases and injuries of the human body.

In many biomedical systems external controllers provide biosignal input or inject given specific dosage substituting the internal, physiological procedure because patient's body cannot ensure it or produce it. The outer control might be partially or fully automated. The regulation has several strict requirements, but once adequately established, it permits not only to facilitate the patient's life, but also to optimize (if necessary) the amount of the used dosage.

Recent technological advances in diabetes treatment like Continuous Glucose Monitors (CGMs) for the subcutaneous measurement of glucose concentration and insulin pumps for the subcutaneous delivery of insulin allowed investigating the applicability of an external controller. In type 1 diabetes, where the disease can be characterized as a general clinical picture (e.g. complete pancreatic β-cell insufficiency) different individualized model-based (mostly model predictive control (MPC) based) solutions have been already formulated and even first clinical trials appeared demonstrating that nocturnal hypoglycaemia can be efficiently avoided. However, during the daytime, due to several uncontrolled and not modeled events (like stress, physical activity, etc.) a robust solution is still missing.

As already mentioned, individualized model-based control gains more and more importance in pathophysiological control. The investigated models are nonlinear and rather complex by nature. Furthermore, the parameters of the patients slowly change over time. However, despite the difficulties, the controllers have to ensure safety and stability under all circumstances. Hence, not only classical nominal control requirements, i.e. disturbance rejection, good command following and stability are required, but robust

performance as well. Modern robust control methods (in terms of linear $H_\infty$, and μ control syntheses) endeavor to provide this safety, and guarantee to handle even the worst case scenario by taking neglected dynamics into account. This is done by exact mathematical formulations, but also by empiricism gained from the medical expertise of the corresponding control process. Although modern robust control theory represent linear control methods, their extension into nonlinear cases is an actively researched case as well. A promising candidate is the Linear Parameter Varying (LPV) methodology, where the nonlinearity can be hidden by adequately choosing variables; hence, being a practical alternative to differential geometric approach-based classical nonlinear control theory.

The topic of the presentation will focus on this methodology, i.e. modern robust control methods. Linear and nonlinear control case will be presented focusing on artificial pancreas. The survey will present the possibilities from theory to application.

## About the Speaker

Levente Kovács received his electrical engineering degree as best graduate in Automation from the "Politehnica" University of Timisoara, Romania, in 2000, and his Ph.D. from the Budapest University of Technology and Economics (BME), Hungary in 2008. In 2011, Dr. Kovács completed his M.Sc. in Biomedical Engineering from BME as well.

He is currently Associate Professor at the Obuda University where he has defend his habilitation in 2013. In 2012, Dr. Kovács established the Physiological Controls Group at the Obuda University where he is currently supervising 4 PhD students. From 2013, he serves as Vice-Dean for Education at the John von Neumann Faculty of Informatics of the Obuda University. Under his guidance, the Computer Engineering MSc has been restructured and will start from September 2014 with applied informatics topics in Robotics and Biomedical engineering. Dr. Kovacs's research topic is in physiological control, control theory with more focus on modern robust control theory, biomedical engineering and bioinformatics, with special interest in diabetic modeling and control.

He is an IEEE member from 2009 and Membership Development Officer of the IEEE Hungary Section from 2010. From 2013 his is Vice Chair of the IEEE Hungary Section. From 2010 Dr. Kovács is member of the International Federation of Automatic Control Technical Committee on Biological and Medical Systems (IFAC Tc 8.2). From 2010 he is member of the Hungarian Diabetes Association (HDA) where he has established with the president of the HDA the Hungarian Artificial Pancreas Working Group working presently with 11 insulin pump center units throughout all Hungary. Dr. Kovács is author of more than 200 scientific papers (conference and journal). His cumulative impact factor is 14,676. He is Janos Bolyai fellow of the Hungarian Academy of Sciences. He serves as reviewer at several Elsevier and IEEE journals in biomedical and control field.

**Admission is free. All are welcome to attend.**