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Pr.-Per-Olof-Gutman.jpg

The Mechatronics, Computer Science and Applied Mathematics Division at IFPEN hosted Per-Olof Gutman, **Professor of Automation and Optimization at Technion – Israel Institute of Technology** (Haifa, Israel) as a scientific visitor from September 2016 to February 2017.

During his time at IFPEN, **Per-Olof Gutman worked on two separate projects**:

- **in the field of processes**: temperature control in the catalytic zone of a continuous reactor,
- **in the field of mobility**: dynamic control of vehicle speed between intersections with traffic signals, in order to minimize energy consumption.

For the first project, Professor Gutman worked with researchers from three research divisions* on a **design methodology for a multi-input multi-output controller intended to control the temperature of a reactor**.

The research was supported by a discretized model based on a partial derivatives model of the reactor, which itself evolved as the project advanced. The reactional system considered, which was highly non-linear, presents non-minimum phase behavior, due to cross-coupling. Hard constraints need to be considered vis-à-vis the control variables and the temperatures. The process is therefore very difficult to control, particularly when it comes to obtaining a uniform temperature in the catalytic zone. A methodology for the design of a multi-input multi-output controller was therefore developed.

A decentralized controller was designed by LMI ("Linear Matrix Inequalities") optimization. The stability of the closed-loop system has been verified and the controller successfully tested on the complete model. This methodology could be implemented for other reactors.

The second project, relating to road traffic control, was carried out in collaboration with **Giovanni de Nunzio** (***Science@ifpen issue 27***), drawing on the latter's doctoral thesis results.

In this research, speed limitation was considered to be a variable capable of controlling vehicle flows on a road section equipped with traffic lights for incoming and outgoing traffic. The purpose of such control was to minimize total vehicle energy consumption. Traffic was represented by a variable-length model (VLM)[1] consisting of two cells: the first corresponds to an area of traffic congestion (close to the traffic lights for outgoing traffic) and the second an area of free-flowing traffic upstream of the former.

This model, based on a system of differential equations, was fine-tuned at IFPEN to create a new VLM. Analysis of the simulation results of different models revealed that the solution of this new VLM could be simply approximated, significantly improving the efficiency of optimum speed limit calculation.

* Mechatronics, Computer Science and Applied Mathematics Division,
Process Design and Modeling Division,
Process Experiments Division.

Publication

[1] Carlos Canudas-de-Wit, Antonella Ferrara (2016), *A Variable-Length cell road traffic model: Application to ring road speed limit optimization*, Proc. 2016 IEEE 55th Conference on Decision and Control (CDC), 12-14 Dec. 2016, Las Vegas, USA.
>> DOI:10.1109/CDC.2016.7799308

Scientific visit to IFPEN by Per-Olof Gutman, Professor at Technion – Israel Institute of Technology (Haifa)
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