Applications of Hybrid Predictive Control

Many existing research and development efforts have focused on the constructive and theoretical aspects of hybrid predictive control systems that take into account the dynamic interactions of continuous dynamics and discrete time events within the model predictive control framework. The dynamics of the continuous states are governed by differential or difference equations, while the discrete states can be described by logic rules, finite state machines, if-then-else conditions and other representations.

During the last years, it has been illustrated through many publications that the principles of model predictive control can be extended to hybrid dynamical systems, including efficient algorithms to solve the associated optimization problems, stability analysis, robustness and other aspects.

This special issue, however, is focused on new industrial applications of the hybrid predictive control techniques. It contains six papers that provide a wide variety of practical applications of hybrid predictive control theory, such as the control for a sugar factory, optimization of thermal power plants, routing control of vehicles and others. The main contents of the papers are briefed as follows.

Cortés *et al.* [1] propose an adaptive hybrid predictive control strategy for a dynamic pick-up and delivery problem incorporating both future unknown demand and expected traffic conditions. Moreover, fault detection and isolation and fuzzy fault-tolerant control approaches are proposed to capture unpredictable congestion events.

de Prada *et al.* [2] describe an adaptive hybrid predictive control strategy for the crystallization section of a sugar factory where continuous and batch units operate jointly. A more efficient NLP optimization technique is proposed, instead of MINLP, and is applied to an industrial sugar factory simulator.

Fiacchini *et al.* [3] discuss the application of the reachability analysis and safety verification to a fuel cell system. The authors exploit the concepts of the set invariance theory in order to improve controller synthesis and guarantee that the proposed controller will ensure safe operation of the plant provided the initial condition of the plant is within an invariant set. The underlying process, modelling issues and controller design are explained and simulation results are reported.

Mhaskar *et al.* [4] consider robust predictive control of switched uncertain nonlinear systems required to satisfy a prescribed switching sequence with uncertainty in the switching times subject to state and input constraints. The results are generalized under parametric uncertainty and exogenous time-varying disturbances in the dynamics of the constituent modes. The proposed control method is applied to a scheduled chemical process example.

Rodríguez *et al.* [5] presents a two-layer hierarchical control architecture in which the lower layer is based on both adaptive and predictive controllers for the greenhouse crop growth. The system dynamics at this level are described with hybrid models that arise due to the different modes of operating/controlling the greenhouse climate (heating and ventilation). Experimental results of the implementation of the hierarchical control structure in an industrial greenhouse are presented and discussed.

Sáez *et al.* [6] propose an adaptive hybrid predictive controller for the optimization of a real combined cycle power plant. Start modes, minimum up/down times and other logical features are represented using mixed integer equations, and dynamic behaviour of the ambient temperature is represented using adaptive fuzzy models.

REFERENCES

1. Cortés CE, Núñez A, Sáez D. Hybrid adaptive predictive control for a dynamic pickup and delivery problem including traffic congestion. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.1005.
2. de Prada C, Sarabia D, Cristea S, Mazaeda R. Plant-wide control of a hybrid process. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.983.
3. Fiacchini M, Alamo T, Alvarado I, Camacho EF. Safety verification and adaptive model predictive control of the hybrid dynamics of a fuel cell system. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.987.
4. Mhaskar P, El-Farra NH, Christofides PD. Robust predictive control of switched systems: satisfying uncertain schedules subject to state and control. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.975.
5. Rodríguez F, Guzmán JL, Berenguel M, Arahal MR. Adaptive hierarchical control of greenhouse crop production. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.974.
6. Sáez D, Zúñiga R, Cipriano A. Adaptive hybrid predictive control for a combined cycle power plant optimization. *International Journal of Adaptive Control and Signal Processing* 2007; DOI: 10.1002/acs.988.

DORIS SÁEZ
Electrical Engineering Department
Facultad de Ciencias Físicas y Matemáticas
Universidad de Chile
Av. Tupper 2007, Santiago 837-0451, Chile

MANUEL BERENGUEL
Departamento de Lenguajes y Computación
Universidad de Almería
Ctra. Sacramento s/n, 04120, Almería, Spain