Universidad Tecnológica de Pereira

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Alejandro Garcés received his Ph.D. degree in electrical engineering from the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway, where he developed a new control for HVDC integration of offshore wind farms.

He is currently an associate professor at the Department of Electric Power Engineering, Universidad Tecnológica de Pereira, Colombia.

Dr. Garcés has been a consultant for different national and international organizations. He is a senior member of IEEE and Senior research of the National Research System in Colombia.

Stability Analysis for Continuous Control-Set Model Predictive Control for AC and DC Converters

Model-predictive control (MPC) has become popular in industrial electronic applications due to its advantages in terms of performance and its capability to introduce constraints effortlessly [1]. Two main approaches exist for MPC in power electronic applications, namely: finite-control-set MPC (FCS-MPC) and continuous-control-set MPC (CCS-MPC) [2]. In the former, the control signals act directly on the switching states, while in the latter, the control signals are sent to a pulse-width modulator [3]. CCS-MPC is becoming more relevant in applications due to advantages such as constant switching frequency and simple implementation. However, the stability analysis is still an open research question.

Stability can be ensured in MPC by imposing long horizons, terminal constraints, or penalization in the final step. This approach is helpful in applications where the dynamic is slow, e.g., chemical applications. However, power electronics applications use an ad-hoc MPC with short horizons and simplified optimization models that can be implemented in real-time. Therefore, the stability analysis requires being carefully studied.

This seminar presents recent results related to stability analysis of CCS-MPC for power electronic applications. In particular, we discuss analytical and experimental results for DC/DC converters presented in [4] and its extension to AC converters.

[1] S. Vazquez, J. I. Leon, L. G. Franquelo, J. Rodriguez, H. A. Young, A. Marquez, and P. Zanchetta, “Model predictive control: A review of its applications in power electronics,” IEEE Industrial Electronics Magazine, vol. 8, no. 1, pp. 16–31, 2014.

[2] P. Cortes, M. P. Kazmierkowski, R. M. Kennel, D. E. Quevedo, and J. Rodriguez, “Predictive control in power electronics and drives,” IEEE Transactions on Industrial Electronics, vol. 55, no. 12, pp. 4312–4324, 2008.

[3] C. Bordons and C. Montero, “Basic principles of mpc for power converters: Bridging the gap between theory and practice,” IEEE Ind. Electronics Magazine, vol. 9, no. 3, pp. 31–43, 2015.

[4] A. Garcés-Ruiz, S. Riffo, C. Gonzalez-Castano, and C. Restrepo, “Model predictive control with stability guarantee for second-order dc/dc converters,” IEEE Transactions on Industrial Electronics, pp. 1–9, 2023.

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