PhD Proposal 2017

School: Ecole Centrale Nantes	
Laboratory: IRCCyN	**Web site: http://www.irccyn.ec-nantes.fr/fr/**
Team: Control	**Head of the team: F. Plestan et Ph. Chevrel**
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Collaboration with other partner during this PhD: **In France: RTE R&D**	**In China:**

Title: Optimal Control of Power Electronic Elements Inserted into Modern Power Transmission Grids
Scientific field: Electrical engineering, Automation and Robotics, System Engineering, Industrial Engineering
Key words: power converters, HVDC, renewable energy sources, interaction and coordination, inter-area oscillations, small-signal stability, transmission delays, robust/predictive control

Details for the subject:

(Maximal length of 2 pages, including images, list of reference, …The pdf file should not exceed 1Mo)

Background, Context:

Power electronics is more and more used on the power transmission grids. Indeed, all wind and photovoltaic generation is connected to the grid by converters. Also, the reinforcement of the grid is frequently done with High-Voltage Direct Current (HVDC) lines which consist of 2 power converters into a back-to-back connection and a DC cable. This tendency will be extended in future in order to ensure the transition towards decarbonized energy systems as formulated, for example, in Europe.

This new technology based on power electronics is active in the sense that it provides several degrees of freedom for the power and voltage control. Thus, it has an impact on the dynamics of the neighbour AC power system. In particular, the small-signal and the transient stability depend on the way in which the regulators of the converters are synthesized. Previous work [1], [2] showed that the control of these devices can be done in order to improve grid stability of the neighbour zone (and thus not only to ensure local – i.e., on converters - control objectives). The framework of optimal robust control – particularly H∞ control (see, e.g., [3]) was used for this.

Research subject, work plan:

This methodology can now be further exploited to treat 2 new points necessary for the implementation of such controls in practice:

- Take into account the limitations of the actuators (the currents of the converters should not overpass maximum values for obvious material protection reasons)
- Co-ordinate the control of 2 or several close HVDC in order to avoid/diminish bad/underoptimal interactions of their controls.

The classic convex optimization (based on Linear Matrix Inequalities-LMI or other) [4] or new non-smooth stabilisation techniques for parametric structured systems [5] should be investigated to treat the 2 points mentioned above.

This work is proposed in a general framework of collaboration with RTE – the French Transmission System Operator – and it is thus connected to real needs of the interconnected power systems. Realistic tests and validations of the theoretic developments mentioned above are possible on grid models and scenarios provided by RTE.

References:

[1] L. Arioua, Commande des liaisons à courant continu HVDC dans un contexte réseau, PhD thesis Ecole Normale Supérieure de Cachan, 2015.

[2] L. Arioua, B. Marinescu, Robust grid-oriented control of high voltage DC links embedded in an AC transmission system, *Int. J. Robust Nonlinear Control* 2015.

[3] S. Skogestad, I. Postlethwaite, *Multivariable Feedback Control*. John Wiley: Chichester, 1996.

[4] S. Tarbouriech, G. Garcia, J.M. Gomes da Silva Jr., I. Queinnec, Stability and Stabilization of Linear Systems with Saturating Actuators, Springer-Verlag, 2011.

[5] Pierre Apkarian, Minh Ngoc Dao, and Dominikus Noll , Parametric robust structured control design, *IEEE Trans. on Automatic Control*, 2015.

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