M2 internship: polynomial optimization for time-delayed power systems

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Context: There is an increasing need for efficient methods to approximate values of secure operating conditions for electrical systems. Indeed, recent and ongoing changes in the European power network, such as the increase in renewable energy sources, are bringing up new challenges in terms of power grid security and large-scale stability assessment. The optimal power flow (OPF) problem aims at determining an optimal steady-state operating point for an alternative-current (AC) electric power system in terms of a given objective function, usually the power generation costs or power losses per time unit, subject to both electrotechnic equality constraints and engineering limits. AC-OPF problems can be modeled as nonlinear optimization ones, involving polynomials in complex variables, and can be approximated by the famous hierarchy of convex relaxations developed in [1]. For large-scale power systems, sparsity-adapted relaxations allow one to either approximate optimal values of AC-OPF instances [2] or to assess stability [3]. However these frameworks do not take into account the presence of time-delays and their potential impact on electrical systems.

Objectives of the internship: This research internship proposes to tackle the important problem of control and analysis of time-delayed power systems, by means of polynomial optimization. The goal is to familiarize the candidate with this research area, through literature study, and investigating some first research questions: in particular analyzing the behavior of power systems subject to both polynomial dynamics and linear time-delays, and exploiting sparsity.

Application requirements: A successful candidate will have a strong background in applied mathematics and/or computer science, a working knowledge of convex optimization as well as strong programming skills. The candidates are kindly asked to send an email with "M2 candidate" in the title, a CV, detailed course records, as well as a motivation letter to henrion@laas.fr, vmagron@laas.fr and patrick.panciatici@ieee.org. Knowledge of French does not constitute a pre-requisite, but an excellent command of English is demanded.

Working place and salary: The M2 internship is expected to start during first-half of 2025. According to their preference, the M2 intern will be hosted either at LAAS CNRS Toulouse or at RTE in Paris La Défense, and jointly supervised by Didier Henrion, Victor Magron from LAAS, as well as by Patrick Panciatici from the RTE company. The monthly stipend for M2 internships in France is around 600 euros, please visit this link for more details.

PhD opportunity: Upon successful completion of the M2 internship, a Cifre PhD position may be a possibility in the context of the industrial chair "Combining Polynomial Optimization and Machine Learning (POPML4PS)", part of the ANITI 2 AI cluster, funded for the period 2025-2028. This PhD position would be located at LAAS CNRS, and jointly supervised with RTE.

References

[1] J. B. Lasserre. Global optimization with polynomials and the problem of moments. SIAM Journal on optimization, 11(3), 796-817, 2001.

[2] J. Wang, V. Magron, and J.-B. Lasserre. Certifying Global Optimality of AC-OPF Solutions via sparse polynomial optimization. Electrical Power Systems Research, 213:108683, 2022.

[3] M. Tacchi. Moment-SOS hierarchy for large scale set approximation. Application to power systems transient stability analysis, Doctoral dissertation, INSA de Toulouse, 2021.