Master Internship

Event and Self Triggered Stabilizing Controllers for Linear Switched Systems

Scientific advisers:
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Key words: ODEs, Finite-state machines, Dynamical systems, Switched systems, Stability Analysis, Event- and self-triggered controllers.

Objectives: This internship is proposed conjointly by **Gipsa-lab** and **LJK** laboratories. Its main goal is the co-design of event-triggered stabilizing controllers and their event-triggered mechanisms for switched linear systems. Moreover, the self-triggered control synthesis problem will be tackled in the framework of this internship.

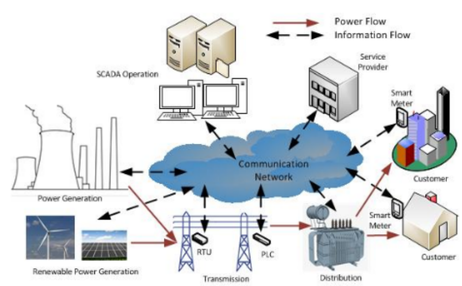

Figure 1: Networked systems

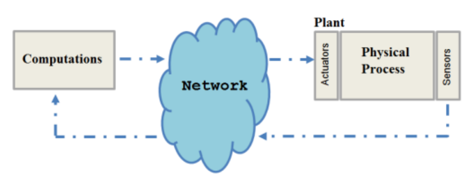

Figure 2: Communication via networks

Context: Event-triggered control offers a promising alternative to the classical, resource-consuming, periodic control. This advantage appears clearly in the case of networked systems, where physical systems are governed by computing stations via communication networks (Figure 1). The concept of networked systems is expected to play a major role in the design and development of future smart systems. In other works, networked systems or Cyber-physical systems are those systems that link the physical world through sensors or actuators with the virtual world of information processing. They are composed from diverse constituent parts that collaborate together to create some global desired behavior. These components will include software systems, communications network technology, and sensors/actuators that interact with the real world (Figure 2). From the mathematical point of view, these class of dynamical systems can be presented as switched or hybrid systems, where continuous-time dynamics are coupled with discrete-time dynamics [1]. More precisely, these systems can be modeled as sets of differential equations supervised by finite-state machines.

However, in practice, communication networks have limited bandwidth. Thus, it is of great interest to be able to develop new control strategies that require fewer interactions with the physical systems. It suggests to replace the periodic, high frequency sampling used in the continuous-to-discrete transformations of control signals with aperiodic sampling. A new value of the event-triggered control law is computed only when the system's behavior is unsatisfactory. The control value is kept constant otherwise. In this master internship, on the one hand we attempt to improve the aperiodic control methods proposed in [2], by developing co-design approaches where the stabilizing controllers and its event-triggered mechanism are designed at the same time. On the other hand, we attempt to extend the self-triggered approach introduced in [3] to the case of switched systems.

Expected candidate skills/background:

- good mathematical background (differential equations, dynamical systems, stability analysis, LMIs, Lyapunov analysis);
- good knowledge in control system theory (hybrid systems, switched systems, networked systems);
- good programming skills in Matlab/Simulink or Java/python or C/C++.

Application: The candidates should send the following material by email to both advisers:

- cover letter describing background and motivation,
- curriculum vitae,
- last three transcripts.

References

[1] R. Goebel, R. G. Sanfelice, and A. R. Teel. Hybrid Dynamical Systems: modeling, stability and robustness In *Princeton University*, 2012.

[2] F. Zobizi, N. Meslem and B. Bidegaray-Fesquet. Event-Triggered Stabilizing Controllers for Switched Linear Systems. In *Nonlinear Analysis: Hybrid Systems*, Volume 36, May 2020.

[3] F. Zobizi, N. Meslem and B. Bidegaray-Fesquet. Self-triggered stabilizing controllers for linear continuous-time systems. `https://arxiv.org/abs/1907.01861`, July 2019.