**PhD position in Fast and Robust Estimation of Dynamical Systems: a Hybrid Approach, Université de Lorraine, Nancy, France.**

Dates:

2020/10/01 - 2023/09/30

Supervisor(s):

Romain POSTOYAN

Other supervisor(s):

Prof. Nesic Dragan

Description:

Estimation is a central theme of control systems engineering. It consists in estimating variables, which we do not measure with sensors by exploiting other available measurements and a mathematical model of the system under consideration. When the mathematical model of the plant is given by a linear finite-dimensional ordinary differential equation, solutions are available since the 60's [K60, L66]. When the model is non-linear, solutions exist only for specific classes of systems, or exhibit major issues. Indeed, generic solutions for nonlinear systems like high-gain observers [KP14] are very sensitive to noise, which can be redhibitory in practice. In general, observers almost always exhibit a trade-off between the speed of convergence, which is essential to quickly know the desired unmeasured variables, and the accuracy in presence of measurement noises, which are inevitable in practice.

The purpose of this PhD topic is to overcome this paradox by exploiting hybrid techniques, that is, observers, which exhibit continuous-time dynamics and jumps. Recent results along those lines have recently appeared in the literature [PTZ12, APTZ16, AZ18]. The approach we envisioned is different and should be applicable to much broader classes of systems. Our idea is the following. Given a system, linear or nonlinear, we assume that we know how to design an observer and we have several choices for its parameters. Some values lead to fast convergence but high sensitivity to noises, and others are more robust but generate a slow convergence. We propose to switch among different values of these parameters to make the best out of them using hybrid techniques [GST09]. This approach is sometimes used in an ad-hoc way in applications. The objective here is to provide rigorous, robust analytical tools to do it.

Hybrid techniques have been proved to overcome fundamental limitations in the context of control e.g. [ZNTH19], but, as far as we know, no such results exist for estimation. This PhD topic will give us the opportunity to demonstrate the power of hybrid tools for estimation. We will rely for this purpose on our expertise on (nonlinear) estimation, hybrid dynamical systems and, in particular, on our recent results in [APN20] where we already demonstrated the benefits of hybrid techniques for estimation in a different context and for a different objective. The challenge here will be to carefully mathematically define performances and how to switch between the observers to make the best use out of them. We will also give us the flexibility to pursue an alternative hybrid route for the same goal and with the same philosophy, namely, the design of supervisory observers, which we initially proposed in [CNPK15, CPKN17] for adaptive estimation problems, to improve performance.

References

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Keywords:

estimation, hybrid systems, Lyapunov stability, nonlinear systems, robustness

Conditions:

Duration: 3 years

We are looking for a strongly motivated candidate with a Master degree in control engineering or applied mathematics.

Department(s):

Control Identification Diagnosis

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