PROGRAM of the study day of the CT Identif (SAGIP)

THURSDAY 19 JANUARY 2023 from 14:00 till 17:30 (Paris time)

VIRTUAL MEETING

ZOOM LINK

This meeting of the CT Identif will be virtual. You can obtain the Zoom link to attend the meeting by contacting Xavier Bombois, Rachid Malti or Mathieu Pouliquen.

TIME SCHEDULE

- 14:00-15:00 Simone Formentin (Politecnico di Milano, Italy)
  Data-driven predictive control of stochastic systems

- 15:00-15:45 Charles Poussot-Vassal (Onera)
  Loewner: a framework for realisation, approximation and identification

- 15:45-16:00 Virtual coffee break

- 16:00-16:45 Xavier Bombois (CNRS)
  Control Design via Bayesian Optimization with Safety Constraints

- 16:45-17:30 Mohamed El Sherbiny (Université de Poitiers, Michelin)
  Estimation of physical parameters and signals for automated driving vehicles

ABSTRACTS

Data-driven predictive control of stochastic systems

Authors: **S. Formentin,** V. Breschi and A. Chiuso

Abstract: Model predictive control (MPC) is among the most popular strategies to deal with feedback control of multivariable constrained systems. The key idea behind MPC is to obtain the control signal at each sampling time by solving an open-loop finite-horizon optimal control problem based on a given prediction model of the plant. Indeed, modeling errors lead to prediction inaccuracies, which in turn may jeopardize the closed-loop performance. For this reason, data-driven predictive control (DDPC) methods, which compute the input sequence directly from data without requiring any preliminary identification step, have recently captured considerable attention within the control community. However, existing works look at DDPC problems under a deterministic lens, thus coping with stochastic noises only through a set of posterior augmentations of the predictive control problem, e.g., ad-hoc regularization terms. Although these countermeasures have proven their effectiveness in practice, they

require expensive safety-critical closed-loop tuning and may potentially shift the focus away from the original problem. In this talk, we redefine DDPC from scratch within a stochastic setting and we show that the proposed reformulation provides new insights into when and how regularization should be applied. The resulting tuning rationale will allow us to select the regularization hyperparameters before closing the loop and with no additional experiments.

Loewner: a framework for realisation, approximation and identification

Authors: **C. Poussot-Vassal**

Abstract: In this seminar, the Loewner framework is presented as a central element bridging the realization theory with data, rational function-based approximation and identification. The presentation is divided in three parts:
(1) we start with elements on linear dynamical systems and data representations, then
(2) the linear Loewner realization landmark, minimality and properties are stated and, finally,
(3) its extensions to parametric, passive and nonlinear modeling is given.
Each part is illustrated with didactic dynamical system examples, ranging from applied mathematics to classical engineering.

Control Design via Bayesian Optimization with Safety Constraints

Authors: **X. Bombois** and M. Forgione

Abstract: Bayesian Optimization is a powerful machine-learning tool enabling automated design of fixed-structure controllers. A sequence of closed-loop calibration experiments is performed, and the next configuration to be tested is selected by the optimization algorithm in order to minimize an objective function measured directly on the real system. While the approach has been shown to be effective, its applicability is limited in certain domains by safety considerations, as the algorithm may suggest controller configurations which lead to dangerous behaviours in some of the calibration experiments. In this paper, we modify the standard Bayesian Optimization algorithm by introducing explicit constraints for safe exploration of the controller configuration space. The constraints are derived based on a preliminary model of the process dynamics, which is assumed to be available. Aspects for efficient implementation of the proposed methodology are discussed. Simulation examples highlight the advantage of the proposed methodology for controller calibration over the plain Bayesian Optimization algorithm. For more details, please see https://hal.archives-ouvertes.fr/hal-03559979

Estimation of physical parameters and signals for automated driving vehicles

Authors: **M. El Sherbiny**, G. Mercère, R. Tomasso, V. Arvis and F. Biesse

Abstract: Tire slip ratio is one of the important quantities and extremely valuable for the automotive manufacturers in order to ensure the passenger's safety and design of advanced vehicle controllers, including the anti-lock braking system and improving the Advanced Driver Assistance Systems, which will reduce the traffic accidents. On the one hand, empirical equation for the tire physics can be obtained under laboratory conditions or with dedicated equipment, and therefore not applicable to the normal use of a vehicle by a standard driver. On the other hand, there are interesting contributions in the literature that use model based approaches. However, little has been done on studying the equations in order to find the best

model for tire slip estimation. This paper proposes a new approach for tire slip ratio estimation that excludes adding sensors at the tire level, to reduce the cost and the industrial complexity, and uses the measurements available on the vehicle’s on-board network (CAN-bus). The proposed algorithm is first evaluated in simulation and then validated experimentally on Tesla model S which show the effectiveness of the proposed approach for tire slip ratio estimation.