IDENTIF

SAGIP
Société d'Automatique, de Génie Industriel & de Productique

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

THURSDAY 28 November 2024 from 10:00 till 16:15 (Paris time)

CNAM (292 rue St Martin, 75003 Paris): Salle 11A3.33, access 11A

VENUE - REGISTRATION – ZOOM LINK

The 28nd November meeting of the CT Identif will be organized in Salle 11A3.33 (access 11A, 292 rue St Martin, 75003 Paris).

Participants can register to the different parts of this study day via the following doodle:

https://evento.renater.fr/survey/reunion-du-ct-identif-a-paris-jeudi-28-novembre-2024-f10gxavg

For the colleagues that cannot join us in Paris, we will retransmit the presentations via Zoom. The Zoom link can be obtained by writing an email to the animators of the CT Identif.

TIME SCHEDULE

- 10:00-10:45 Zaman Yazbeck (Laboratoire Ampère, INSA Lyon, CEA)
  Sensitivity function-based identification of solid oxide electrolyzer parameters

- *10:45-11:30* Charles Poussot-Vassal (ONERA, Toulouse)
  The Loewner framework for parametric systems: Taming the curse of dimensionality

- 11:30-14:00 Lunch

- 14:00-14:30 Régis Ouvrard (Université de Poitiers)
  Partial moments in System Identification (book presentation)

- 14:30-15:30 Marco Forgione (IDSIA, Lugano, Switzerland)
  Model order reduction of deep structured state-space models: A system-theoretic approach

- 15:30-16:15 Jamy Vignaud (Université de Bordeaux, VLM Robotics)
  Closed-Loop System Identification Using Parallel PI Controller and Reference Prefiltering: White Noise Case

- 16:15- …. Visit of the Musée des Arts et Métiers

ABSTRACTS

Sensitivity function-based identification of solid oxide electrolyzer parameters

Authors: **Zaman Yazbeck**, Federico Bribiesca-Argomedo, Minh Tu Pham, Bertrand Morel, Ronit Kumar Panda, Vincent Dimitriou

Abstract: A novel approach is introduced for parameter estimation of a Solid Oxide Electrolyzer Stack (SOES) model. The complexity of multi-physics in SOES models poses a unique challenge for parameter identification due to the presence of nonlinearities, the large number of parameters, and few available measurements. Consequently, this study presents an enhanced method of parameter estimation, based on the Gauss-Newton optimization algorithm, incorporating a truncated Singular Value Decompostion (SVD) of a normalized sensitivity matrix. This modification prioritizes the update of parameters in the directions of high sensitivity while limiting the condition number of the matrix inverted to choose the step size, thus attenuating the adverse effects of noise and model errors unavoidable in the estimation process. This departure from the conventional approaches allows a more nuanced and effective identification strategy tailored to the intricacies of SOESs. The proposed method is validated using data from an experimental test bench and compared to other identification methods.

The Loewner framework for parametric systems: Taming the curse of dimensionality

Authors: **C. Poussot-Vassal**, A. C. Antoulas and I. V. Gosea

Abstract: The Loewner framework is an interpolatory framework for the approximation of linear and nonlinear systems. The purpose here is to extend this framework to linear parametric systems with an arbitrary number n of parameters. One main innovation established here is the construction of data-based realizations for any number of parameters. Equally importantly, we show how to alleviate the computational burden, by avoiding the explicit construction of large-scale n-dimensional Loewner matrices of size NxN. This reduces the complexity from O(N3) to about O(N1.4), thus taming the curse of dimensionality and making the solution scalable to very large data sets. To achieve this, a new generalized multivariate rational function realization is defined. Then, we introduce the n-dimensional multivariate Loewner matrices and show that they can be computed by solving a coupled set of Sylvester equations. The null space of these Loewner matrices then allows the construction of the multivariate barycentric transfer function. The principal result of this work is to show how the null space of the n-dimensional Loewner matrix can be computed using a sequence of 1-dimensional Loewner matrices, leading to a drastic computational burden reduction. Finally, we suggest two algorithms (one direct and one iterative) to construct, directly from data, multivariate (or parametric) realizations ensuring (approximate) interpolation. Numerical examples highlight the effectiveness and scalability of the method.

Links: https://arxiv.org/abs/2405.00495 and https://sites.google.com/site/charlespoussotvassal/nd_loew_tcod

Partial Moments in System Identification

Authors: **Régis Ouvrard**, Thierry Poinot, Jean-Claude Trigeassou

Abstract: The partial moments approach to system identification is a tool introduced in the 80s at Poitiers. A book has just been published to provide a complete round-up of developments concerned with the application of partial moments in system identification and data-driven modelling; it captures the essence of work carried out at the *Laboratoire d'Informatique et d'Automatique pour les Systèmes* for more than 40 years. The aim of this talk is to recall the principle of the approach and to describe the contents of this book.

Model order reduction of deep structured state-space models: A system-theoretic approach

Author: **Marco Forgione**, Manas Mejari, Dario Piga

Abstract: With a specific emphasis on control design objectives, achieving accurate system modeling with limited complexity is crucial in parametric system identification. The recently introduced deep structured state-space models (SSM), which feature linear dynamical blocks as key constituent components, offer high predictive performance. However, the learned representations often suffer from excessively large model orders, which render them unsuitable for control design purposes. This work addresses this challenge by means of system theoretic model order reduction techniques that target the linear dynamical blocks of SSMs. We introduce two regularization terms which can be incorporated into the training loss for improved model order reduction. In particular, we consider modal L1 and Hankel nuclear norm regularization to promote sparsity, allowing one to retain only the relevant states without sacrificing accuracy. The presented regularizers lead to advantages in terms of parsimonious representations and faster inference resulting from the reduced order models. The effectiveness of the proposed methodology is demonstrated using real-world ground vibration data from an aircraft.

Closed-Loop System Identification Using Parallel PI Controller and Reference Prefiltering: White Noise Case

Authors: **Jamy Vignaud**, Stéphane Victor, Jean-Yves K'Nevez, Olivier Cahuc, Philippe Verlet

Abstract: Some industrial processes cannot be opened for system identification, therefore closed-loop system identification is required, thus leading to issues with cross-correlated signals. Instrumental variables can be used to estimate noise-free control and output signals. Typically, a filter is designed to limit high-frequency noise during the identification process. However, an optimal filter can minimize noise without reducing valuable information from the input and output signals. When the output is tainted with white noise, the simple refined instrumental variable method for closed-loop systems (CLSRIV) can be used. However, in the context of machining with CNC (Computer Numerical Control) machine tools, the closed-loop of the spindle rotational speed is more complex. Indeed, this loop includes a parallel proportional-integral (PI) controller, where a prefiltered reference is applied only to the integral component. The aim of this talk is to explore various identification methods for such a closed-loop system in a white noise context.