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

THURSDAY 27 MAY from 13:30 till 17:45 (Paris time)

TIME SCHEDULE

- 13:30-14:30 Cristian Rojas (KTH Stockholm)
  Inverse filtering and other problems on Markov decision processes

- 14:30-15:15 Sébastien Fueyo (INRIA, Sophia-Antipolis)
  Stability of high frequency amplifiers via singularities of the Harmonic Transfer Function

- 15:15-16:00 Bassem Boukhebouz (Université de Strasbourg, CEA LIST)
  Shaping multisine excitation for closed-loop identification of a ball-screw cable actuator

- 16:00-16:15 Virtual coffee break

- 16:15-17:00 Louis Massucci (Université de Lorraine)
  Regularized switched system identification: a statistical learning perspective

- 17:00-17:45 Vincent Mussot (Université de Poitiers, Michelin)
  Grip potential estimation with Monte-Carlo Markov Chain Method

ABSTRACTS

Inverse filtering and other problems on Markov decision processes

Authors: C. Rojas, R. Mattila, B. Wahlberg and V. Krishnamurthy

Abstract: Markov decision processes and related processes are used in a large number of applications in diverse fields, ranging from signal processing to control and machine learning, due to their simple structure as models of dynamical systems. In this talk, we will discuss some inverse problems related to these models, such as inverse filtering and counter-adversarial learning, where the goal is to reconstruct the sensor or the models used by an agent, based on its private belief or its actions. Solving these tasks is expected to lead to large improvements in data-driven reinforcement learning and control design, by relying on existing prior knowledge existing in the form of agent acting on a prescribed environment.

Stability of high frequency amplifiers via singularities of the Harmonic Transfer Function

Authors: Sébastien Fueyo, Laurent Baratchart and Jean-Baptiste Pomet

Abstract: Amplifiers contain linear, passive components as well as nonlinear, active ones, all of which can be described by finitely many state variables; but they also contain transmission

lines, typically modelled by simple hyperbolic Partial Differential Equations (PDE) like lossless telegrapher equations, that make the global state space of the circuit infinite-dimensional. Considering then a sinusoidal input to be amplified, the (steady state) output simulated by harmonic balance techniques will typically be periodic trajectory and one needs to characterize its stability. Using first order approximation, this reduces to exponential stability of the time-periodic linear system obtained by linearizing around the periodic solution. To study the stability properties of the previously-described linearized system, one constructs a family of input-output systems, obtained by perturbing the linearized system by a small current at some node of the circuit and observing the resulting perturbation of the voltage between two nodes. The use of Fourier development and Laplace transform leads to the concept of the harmonic transfer function (HTF), which is an infinite matrix considered as an operator-valued analytic map. Under controllability and observability assumptions, the HTF carries the stability information *via* its singularities. It is proven that the HTF can possess essential singularities in the whole complex plane when lossless transmission lines are considered in the amplifier. However, under the rather natural assumption that the amplifier dissipates energy, we are able to prove that the HTF has just possibly unstable poles, *i.e.* a countable number of isolated poles in the complex right half plane. This result legitimates the search of unstable poles *via* meromorphic approximation in the complex right half plane.

Shaping multisine excitation for closed-loop identification of a ball-screw cable actuator.

Authors: Bassem Boukhebouz, Guillaume Mercère, Mathieu Grossard and Edouard Laroche

Abstract: In robotic systems, saturations on current and voltage are active in inner control loops. Consequently, on the one hand, high amplitudes of the excitation should be avoided when we aim at finding the underlying linear system in some frequency spectrum, because they can lead to saturation and introduce distortions in the estimated FRF. On the other hand, the need to properly excite all the robot dynamics requires large amplitude within the frequency band of interest. In this work, we present a multisine excitation design method to improve the quality of the estimated FRF in presence of saturation on the control signal and in a closed-loop setup. The method is based on the shaping of the multisine excitation that allows improving the Crest Factor of the control signal from 7.29 to 1.51. The perspective is to synthesize non-conservative model-based controller for a ball-screw cable actuator.

Regularized switched system identification: a statistical learning perspective

Authors: Louis Massucci, Fabien Lauer and Marion Gilson

Abstract: This talk deals with the identification of hybrid dynamical systems that switch arbitrarily between modes. Switched system identification is a challenging problem, for which many methods were proposed over the last twenty years. Despite this effort, estimating the number of modes of switched systems from input–output data remains a nontrivial and critical issue for most of these methods. A novel method from statistical learning including regularized models, and more precisely based on structural risk minimization, is presented. It relies on minimizing an upper bound on the expected prediction error of the model.

Grip potential estimation with Monte-Carlo Markov Chain Method

Authors: Vincent Mussot, Guillaume Mercère, Thibault Dairay, Vincent Arvis and Jérémy Vayssettes

Abstract: During the next half century, the development of new information and communication technologies tools should enable cars to be operated in a fully autonomous mode as well as in a combined human-machine
mode (better than the one we currently know). In this context, future cars will be more and more based on innovative control algorithms to ensure autonomous functions, to improve car performance, to optimize occupant comfort and, more importantly, to increase passenger as well as pedestrian safety. In order to guarantee such performance constraints, one of the paths considered by many companies working in vehicle related field goes through an accurate estimation of factors influencing the vehicle behaviour. One of these factors is the grip potential, also called tire-friction potential or tire-road friction coefficient [1]. The tire-road friction coefficient represents the maximum effort that the tire can transmit to the ground. Thus, precise estimation of this quantity is particularly useful to anticipate the right trajectory during emergency manoeuvres. Several studies were carried out to estimate the grip potential [2, 3, 4]. They can be separated in two categories. In the first one, the tire-road friction coefficient is estimated directly by using dedicated (thus costly) sensors. Convincing results were obtained with this approach [5]. However, driver assistance systems are intended to be used on production vehicle where the use of costly sensors is an obstacle. Thus, economical methods should be considered. These methods are mainly part of the second category, the model-based methods. As the name suggests, model-based methods use models combined with measurements to make predictions on the tire-road friction coefficient. Among the model-based methods, we distinguish the non-parametric methods, which used essentially mathematical models, from the parametric methods which included a physical model representing the tire behaviour. In the case treated here, the measurements used to perform the tire-friction road estimation are real, thus noisy, measurements of the friction. Besides, in normal driving conditions, friction measurements are only available for low friction values far from the tire-friction potential. Those constraints on the measurements complicate the use of non-parametric methods which are particularly efficient to estimate points between the measurements but not for points far from the measurement area. Hence, a parametric model-based approach is privileged here to estimate the tire-road friction coefficient. In summary, the method considered should (i) work in real time, (ii) be feasible with noisy low friction measurements (iii) guarantee a user defined level of precision. Considering these constraints the method suggested here is an adaptive Monte-Carlo Markov Chain (MCMC) method [6] including a Pacejka Magic Formula tire model [7]. The MCMC methods have the advantage to work with few points and the Pacejka tire model is a parsimonious model which represents accurately the tire behaviour in various situations. Several tests are made on this approach with in a first part simulation data and in a second part, real data coming from a flat-track tire testing machine.

References

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