CT CPNL (Commande Prédictive Non Linéaire)

French Research Group on Nonlinear Model Predictive Control

GDR Groupement de recherche
MACS Modélisation, analyse et conduite des systèmes dynamiques

Scientific Day

LCIS
Laboratoire de Conception et d'Intégration des Systèmes

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

Thursday, 16 November 2023

Location: Room: D030, Esisar-Grenoble INP, Time: 10:00-17:30

50, rue Barthélémy de Laffemas - 26000 Valence

Organizers: Ionela Prodan (LCIS, Grenoble INP, Valence)
Sylvain Bertrand (ONERA, Palaiseau)

ct-cpnl.fr

Recent technological advances have enabled the development and design of Model Predictive Control (MPC) for complex systems with hard constraints, fast nonlinear dynamics, large uncertainties and perturbations, networked components, dynamic models learned from data, etc. These systems are naturally requiring hierarchical/distributed control architectures. A wide spectrum of applications has emerged from these developments, with model predictive controllers being nowadays applied to autonomous and robotic systems (aquatic/terrestrial/aerial/space), large-scale and multi-agent systems, power and energy systems, health, biology and neuroscience, etc.
This day is intended to bring together researchers from France (and outside France) and to shed light on efficient implementations and control architectures for NMPC. Two widely recognized researchers in the domain will give extended talks of 50 minutes (see Abstracts below). We warmly invite other PhDs, postdocs and researchers to join with short talks of 30 minutes.

Mazen Alamir
CNRS, GIPSAlab,
Grenoble INP, France

Title: A (small) step towards a systematic design of NMPC effective and implementable setting

Abstract: It is needless to say that Nonlinear Model Predictive Control is currently the most effective and widely used feedback design methodology in academic works that address the control of constrained nonlinear systems. The theoretical foundations of NMPC are now quite established. Moreover free and easy-to-use programming frameworks that embed multiple efficient and trustworthy dedicated solvers for the NMPC-underlying optimization problems are now available. Nevertheless, practitioners still lack a systematic design procedure for the NMPC components (such as the control updating period, down-sampling period for prediction, control parameterization, prediction horizon's length as well as the penalties on the terminal cost and the soft constraints) that enables the last step to be achieved, namely the real-time implementation on a specific computation target device. In this talk, the real-time implementation-related issues are first recalled. Then a framework that enables a systematic and rational design of NMPC design components is sketched. The rationale that underlines the design choices expresses real-time implementability, convergence and constraints satisfaction for a given computational device and a specific optimization algorithm. Finally, a freely available associated Python-based implementation is also proposed with a fully developed illustrative example before an overview of remaining-to-achieve tasks is proposed.

Alexandra Grancharova
UCTM, Bulgaria

Title: Distributed predictive control based on Gaussian process models

Abstract: A suboptimal approach to distributed NMPC is proposed based on Gaussian process models of the interconnected systems dynamics and taking into account the imposed constraints. The suggested method is based on a sequential linearization of the nonlinear system dynamics and finding a suboptimal solution of the resulting Quadratic Programming (QP) problem by using distributed iterations of the dual accelerated gradient method. The main advantages of the distributed approach are that it allows the computation of the suboptimal control inputs to be done autonomously by the subsystems without the need for centralized optimization and it has a simple software implementation. The proposed method is illustrated with simulations on the simplified model of a sewer system.

For more information about the organization and presentation proposals you can contact Sylvain Bertrand (sylvain.bertrand@onera.fr) and Ionela Prodan (ionela.prodan@lcis.grenoble-inp.fr). The registration is mandatory at the following link. The final program will be available at ct-cpnl.fr.