IFAC World Congress 2017

Open Invited Track:

Embedded Predictive Control and Optimization

Abstract: Embedded predictive control and optimization cover the design methodologies and technologies for solving optimal control or estimation problems by considering the limited resources imposed by real-time constraints or by the dedicated hardware of a specific industrial application.

There are multiple aspects driving the research on this topic and which have witnessed significant advances: control problem formulations that lead to efficient embedded optimization algorithms; developments on the numerical methods; computer aided embedded optimization tools; embedded optimization software and hardware implementation technologies.

This open invited track session will welcome contributions on these topics and offer a forum for discussions between the participants from industry and academia.

IFAC technical committee for evaluation:
        TC 2.3 Non-linear control systems

Detailed description of the topic:

Model Predictive Control (MPC) is a successful modern control design paradigm that formulates the control engineering objectives in terms of mathematical optimization problems with dynamic constraints.

Since 2000, important advances have been made in the theory and numerical methods for solving optimization problems in real-time. In parallel, the developments on embedded (hardware) controllers and their certification followed a positive trend. As a result, the field of embedded MPC and optimization is emerging nowadays as the technology of choice in advanced embedded control systems in industry.

Traditionally, the optimal solution for an MPC problem is obtained either by an iterative numerical procedure (referred to as implicit MPC), or by evaluating the explicit representation of the MPC feedback law, which is computed off-line using parametric programming (referred to as explicit MPC) and implemented on-line as a lookup table. The limited computational resources in low power industrial embedded devices, in combination with increased demands for computational speed and system reliability, motivate theoretical research on fundamental limitations, the development of new methodologies and the establishment of software tools.

In the last few years significant contributions have been made to enabling technology for innovative and challenging industrial applications in different sectors where MPC was not in use a decade ago:

- order-of-magnitude increased reliability and scalability of optimization-based and explicit MPC, targeting fast embedded control systems with enhanced functionality and performance, as well as reduced cost;
- order-of-magnitude reductions in computation times, enabling optimization with microsecond update rates with strict real-time requirements in new application areas;
- order-of magnitude reductions in the software and hardware footprint for low cost industrial embedded controllers, such as micro-controllers PLCs and FPGAs;
- theories and tools for theoretically verifiable performance in terms of real-time requirements and sub-optimality;
- technology platforms available through robust plug-and-play software tools to support automated design, implementation and validation.

Within the present invited track session, the following technical and scientific contributions are expected:

- Numerical solvers for embedded optimization
- Hardware and software for real-time embedded predictive control and optimization
- Parametric programming and explicit MPC
- Embedded MPC and moving horizon estimation
- Complexity reduction, approximation and sub-optimal methods
- Verification and validation
- Modelling, simulation and robustness in embedded MPC
- Applications in mechatronics, automotive, power systems, robotics, autonomous vehicles, medical devices, etc.

Internet link to some additional material:

http://www.itk.ntnu.no/tempo/start