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Cyber-Physical Systems control: Algebraic and Optimization techniques

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Abstract

Modern control systems are more and more complex. Not only are they impacted by increasingly involved and multiple constraints (sustainability, privacy, security, resilence, etc.), they are also subject to the increasingly complex nature of computation technology (embedded, decentralized, hybrid, crowdsourced,…). Such systems are often coined under the name of Cyber-Physical Systems.

Often, these nonidealities make the classical control techniques fail, either because they become poorly efficient, or because they simply do not work in these new environments. The course will survey several advanced techniques to tackle these new challenges. These techniques rely on deep theoretical bases from Mathematics or Computer Science.

We will survey both models and optimization/computation methods, which are well fit to cope with these nonidealities; finally we will see several important applications which exemplify well the introduced methods. An emphasis will be put on open problems and promising challenges for young researchers.

Outline

Models
- Switching systems
- Hybrid automata
- Graphs and Networks in control

Techniques
- LMI's, Sum-of-Squares,
- Tarski's procedure, s-procedure,
- Subgradient methods, Chance-constrained optimization
- Automata theoretic techniques for hybrid systems

Applications
- Analysis of black-box systems
- Wireless Control Networks