CONCLUSIONS

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Linear model predictive control (MPC)

Linear time-varying and nonlinear MPC

MPC computations: quadratic programming (QP), explicit MPC

Hybrid MPC

Stochastic MPC

Data-driven MPC

MATLAB Toolboxes:
- MPC Toolbox (linear/explicit/parameter-varying MPC)
- Hybrid Toolbox (explicit MPC, hybrid systems)

Course page:
http://cse.lab.imtlucca.it/~bemporad/mpc_course.html
Choice of prediction model

SYSTEM IDENTIFICATION

LTI model

switched LTI MPC

LTV model

Nonlinear MPC

LPV model

Hybrid MPC

stochastic model

Hybrid MPC

LTI MPC

LPV MPC

Stochastic MPC

LTV MPC

NL model
RESULTING OPTIMIZATION PROBLEM

- Offline QP construction
  - Online QP solver

- Mixed-integer QP (or MILP)

- Online model/QP construction + Sequential QP

- Online QP construction and solver

- LTI model
  - LPV model
  - LTV model
  - NL model

- Explicit MPC

- Hybrid model

- Stochastic model

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CONCLUSIONS

• MPC is a **universal control methodology**: 
  – different **models** (linear, nonlinear, hybrid, stochastic, ...) 
  – **optimize performance** index subject to **constraints** 
  – **widely applicable** to many domains (process industries, automotive, aerospace, smart grids, ...)

• **MPC research**: 
  1. Linear, uncertain, explicit, hybrid, nonlinear MPC: **mature theory** 
  2. Stochastic MPC, economic MPC, data-driven MPC: **many open issues** 
  3. Embedded optimization methods for MPC: **many open issues** 
  4. Systems identification for MPC: **a lot to “learn”** from machine learning 

• **MPC technology**: already mature for industry
General references on MPC


A. Bemporad, “Model-based predictive control design: New trends and tools,” in Proc. 45th IEEE Conf. on Decision and Control, San Diego, CA, 2006
Hybrid systems


Explicit MPC


F. Borrelli, M. Baotic, A. Bemporad, and M. Morari, "Dynamic programming for constrained optimal control of discrete-time linear hybrid systems," Automatica, 41(10), 2005
The End

Linear MPC controller of a DC-Servomotor (Hybrid Toolbox)