Título:

Hybrid modeling and control of water network canal systems

Orientadores

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Enquadramento (Indicar adicionalmente Ramo/Área de Especialidade caso aplicável):

The scarcity of fresh water is becoming one of the most important environment constraints with a major impact on economic development and the quality of life in the South of Europe, including Portugal. The present dissertation work is proposed in the context of the AQUANET FCT project and aims at contributing to mitigate these problems by the development of advanced modeling and control methodologies for optimizing the management of water conveyance and delivery in multipurpose open-channel systems, with the goal of minimizing the use of energy and water spills. Water delivery channel networks are complex systems that require special modeling and control techniques. In this thesis it is proposed to use subspace methods to obtain hybrid black box models, either PieceWise Linear (PWL) or PieceWise Affine (PWA) state space models, that can accurately describe the system dynamics while complying with the intrinsic channel reconfigurability. These hybrid models can be used in Model Predictive Control (MPC) schemes to achieve desired control specifications while complying with eventual requirements imposed, e.g., on the control action.

Objectivos:

The objectives of this dissertation are:

- To develop Hybrid Subspace black-box models, either PWL or PWA, to accurately describe the system dynamics while complying with the intrinsic channel reconfigurability.
- To apply MPC schemes to achieve desired control specifications while complying with specific requirements imposed, e.g., on the control action.

Descrição:

The modeling and control of water canal networks are engineering areas that have been attracting increasing attention since recent years [1,2]. This type of systems present several challenges and require advance modeling and control techniques: water canals are complex multivariable systems that consist of large number of interconnected elements, such as gates, level and gate sensors, transmitters, etc.

A subspace identification approach is proposed in [3] to estimate state space models for hybrid systems. These models can be either PWL or PWA and result from a composition of multiple local state space models. It is proposed in this work to derive such type of hybrid models directly from the system input/output data and using a special purpose identification toolbox [3]. The system data will be generated from a theoretical model, which was developed in the context of the AQUANET project, implemented using Simulink.

The resulting hybrid models will be used in a MPC scheme to provide optimal control actions that will be applied to the theoretical model in order to achieve desired performance. The optimal control actions will result using a Branch and Bound (BB) approach to solve the non-convex optimization along MPC.

[1] Su Ki Ooi, M.P.M. Krutzen, and E. Weyer (2005) On physical and data driven modelling of irrigation channels. Control Engineering Practice (13) pages 461–471

[2] J. M. Igreja and J. M. Lemos (2009) Nonlinear Model Predictive Control of a Water Distribution Canal Pool. Nonlinear Model Predictive Control, Lecture Notes in Control and Information Sciences. Springer. Pages 521-529

[3] José Borges (2007). State-Space System Identification: New Developments and Applications. Ph. D. thesis, Instituto Superior Técnico/UTL.

Requisitos (e.g. média,disciplinas concluídas):

Controlo de Sistemas, Sistemas Inteligentes.

Resultado esperado:

- Derivation of hybrid models from the canal input/output data.
- Implementation of MPC scheme using BB discrete optimization.
- Development of a software tool for hybrid modeling and control of reconfigurable water canal networks.
- Interpretation and evaluation of both the hybrid models and MPC scheme.

URL da descrição detalhada da dissertação:

Observações:

Este trabalho está inserido no projecto da Fundação para a Ciência e para a Tecnologia "AQUANET – Decentralised and Reconfigurable Control for Water delivery Multipurpose Canal Systems", PTDC/EEA-CRO/102102/2008.

Localização da realização da dissertação:

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