Real-time control of hydrodynamic models on networks

Johannes Hild[1]

We present the development and implementation of a software framework, which is suited to compute the optimal weir control for an urban drainage system in real-time. The framework aims to generate an infinite sequence of optimal control parameters in a moving horizon setting in real-time. The objective of the real-time control is as follows: Moveable weir structures are driven to channel flows with major and minor pollution distributions through the network into their corresponding destination.

This problem is not only of practical relevance for hydraulic engineering but also related to continuous matching and transport problems, like traffic problems on networks. To solve the problem, the urban drainage system is represented by an hydrodynamic model based on the nonlinear shallow water equations and other hydrological conservation laws.

This model is best suited for a finite volume discretization on networks, therefore the state variables - water level, flow rate and pollution density - are computed by an explicit Godunov scheme to guarantee fast and robust evaluations.

The optimization process is executed by the external optimization tool IPOPT, which is based on a set of quasi-Newton methods. It is therefore necessary to provide not only objective information of the network flow but also gradient information. The successful interfacing of the automatic differentiation tool ADOL-C with a C++-template technique fulfills this task and provides fast and robust gradient information.

[1] Friedrich-Alexander-Universität Erlangen-Nürnberg, Lehrstuhl fuer Angewandte Mathematik II, AMII, Martensstraße 3, 91058 Erlangen, Germany,
hild@am.uni-erlangen.de