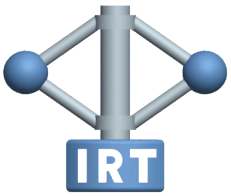

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Water Distribution Networks

Modeling, Observation, Roughness Identification and its Application

Abstract

With a rather off-mainstream view on the modeling and parameter-identification, a completely new set of tools is presented which, ultimately, aim to identify losses in water distribution networks. Allowing flow dynamics to be part of the mathematical network description, the traditional steady-state modeling approach is put into question as it has actually not been improved upon in the last 40 years. Apart from the additional dynamic information, this methodology allows a more physically suitable consideration of the water consumption in simulation which enables it to be decreased inherently if not enough pressure is available. Benchmarked on a real experimental network at Graz University of Technology, strengths and weaknesses of these developed models are discussed when compared to measurements. Influenced by a control-theoretical background, this additional dynamic model information is then utilized to deduce more general statements about the observability of the model's states of the hydraulic network. Unsurprisingly and completely analogous to the steady state, unknown friction parameters yield to be the major unknowns. Motivated by the observability analysis, the identification of individual friction parameters per pipe in the network turns out to be particularly challenging. The proper problem formulation basically relies on the steady-state model inversion and requires a whole set of assumptions to be uniquely solvable. The solving, in general, proves to be specifically challenging. The developed methods, however, enable the solving to be robust to an extent which not only allows to find individual friction parameters, but also to identify faults in the network itself. A claim which is supported by the results when applying the developed friction parameter identification scheme on a real-world drinking water network.

Stefan Kaltenbacher received his B.S. and M.S. degrees from Graz University of Technology, Austria, in 2013 and 2016, respectively, in electrical engineering. From the same university he just received his doctoral degree in technical sciences, where he is working as research assistant for the Institute of Automation and Control. His research interests include the observation and control of water distribution networks and, generally, lie in the field of control engineering with particular focus on nonlinear modeling and control.