Editorial: Towards improved real-time management of urban water systems

This special issue contains a number of selected papers from the 11th International Conference on Computing and Control for the Water Industry (CCWI), organised by the Centre for Water Systems and held at the University of Exeter in September 2011. The conference aims were as follows: (1) to facilitate the continued co-operation of academic institutions and industry; (2) to examine the current state-of-the-art in computing and control techniques applicable to the water industry; and (3) to provide a forum for discussions and the dissemination of ideas on applied computing and control for the water industry, with particular emphasis on: (a) providers' perspectives – recent developments in research; (b) users' perspectives – users' experience of the latest techniques; and (c) future needs – current and future planning and operational requirements.

More than 160 papers were presented at the conference by leading academics and industry practitioners with cutting edge modern technology applied to the design, planning and operation of all aspects of urban water systems. This special issue represents the selection of the aforementioned papers with the focus on real-time management of urban water systems and related topics, especially the use of advanced hydroinformatics techniques to solve real world problems in this context. All the papers shown in this special issue are fully rewritten, extended versions of respective conference papers with substantial additional material provided. Also, all the papers shown here have been fully peer reviewed.

The paper by Fiorelli *et al*. (2013) presents a new optimal predictive controller for real-time control of a real-life water distribution network in Luxembourg under normal operating conditions. The methodology presented explores different control strategies and concludes that global predictive control leads to improved management in comparison to PID and mechanical control. Real-time control of urban water systems is a rapidly growing area of research in the water engineering community which is not a surprise given the increased number of new, improved, lower cost sensors being installed together with associated advanced, mobile phone technology-based data loggers transmitting sensor data into a control room in near real-time.

The paper by Romano *et al*. (2013) presents a new methodology for locating pipe bursts and other events in a pipe network following successful detection of these events in real time. The paper explores a series of geostatistical techniques that can be used for this by processing the information coming from a number of pressure and flow sensors installed in the field. The key feature of the methodology presented is that it does not make use of any physically based models, i.e. both the detection and location of pipe bursts and other events is done entirely by processing the sensor data only. The methodology presented is successfully verified on a real-life network with engineered burst events used in blind type tests.

A topic closely related to real-time management of water distribution systems is the topic of simulation model simplification. This topic is addressed in the Paluszczyszyn *et al*. (2013) paper in which the authors present an extended version of their earlier simplification algorithm for the purpose of inclusion into the real-time optimisation strategy for the energy and leakage management in water distribution systems. The modified approach is based on the energy audit of the water network and the calculation of new minimum service pressure constraints for the simplified model. This way both hydraulic and energy characteristics of the original water network are preserved but with substantially increased computational speed. Optimising the leakage management also requires a good knowledge of the pressure–leakage flow relationship. This issue was addressed in the paper by Ferrante *et al*. (2013) by conducting first a relevant theoretical work followed by a series of laboratory experiments that were used to estimate a range of related leakage model parameter values.

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Increasing the computational efficiency of a simulation model whilst preserving the prediction accuracy is equally important for real-time management of wastewater systems, especially in the context of flooding. The Ghimire *et al.* (2013) paper presents a new methodology that makes use of Cellular Automata as an alternative to a physically based 2D pluvial flood prediction model. The paper clearly demonstrates that using Cellular Automata can lead to a substantial reduction in computational time whilst preserving the flood prediction accuracy.

The paper by Fu & Kapelan (2013) explores a different avenue but with a similar goal of increasing the computational efficiency of a flood prediction model, this time in the context of uncertain rainfall and wastewater system parameters. The new methodology proposed makes use of copulas to represent the probabilistic dependence structure between rainfall depth and duration which are then combined with fuzzy representation of sewer model parameters in a unified framework based on Dempster-Shafer Theory of Evidence. The study shows that the framework proposed can accurately and efficiently predict the exceedance probabilities of flood depth and volume at any location in the sewer network.

Finally, the paper by McClymont *et al.* (2013) focuses on the problem of optimal discolouration risk reduction in the context of water distribution network design. The networks designs are optimised using the Markov-chain Hyper-heuristic (MCHH), a new multi-objective online selective hyper-heuristic. The MCHH is incorporated in to the well-known NSGA-II and SPEA2 and supplied with a range of heuristics tailored for use on the WDN design problem. The results demonstrate an improvement in performance obtained over the original algorithms.

Enjoy reading the papers!

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