Multi-resolution Networks Decomposition, Optimisation and Control for Dynamically Adaptive Water Supply Networks

Current URL:

https://www.findaphd.com/phds/project/towards-dynamically-adaptive-water-supply-networks-design-for-control-of-sectorised-water-supply-networks-with-evolving-topologies-for-improving-resilience-and-pressure-management/?p118147

Project Description

Supervisor Imperial College London: Dr Ivan Stoianov

Supervisor Severn Trent Water: David Morrell

One PhD scholarship funded by Severn Trent Water and Imperial College London to investigate, formalise and validate an analytical and computational framework for the multi-resolution decomposition, optimisation and control of District Meter Areas (DMAs) in water supply networks (WSNs). This will enable the optimal evolution of existing network topologies (e.g. sectors with single water inlets) into networks, which dynamically adapt their connectivity and operational conditions in order to improve both the redundancy in connectivity and the pressure control; and therefore, improve their resilience (the ability of networks to tolerate and recover from failures and/or respond to extreme demand). The PhD will be based in the Dept. of Civil and Environmental Engineering, in the InfraSense Labs research group working with Severn Trent Water, offering a wide range of training and development opportunities in a highly stimulating environment, as well as access to world-leading academics and water utility experts, facilities and networks.

Project details:

The overall research goal for this PhD project is to investigate, formalise and validate an analytical and computational framework for the multi-resolution decomposition, optimisation and control of District Meter Areas (DMAs) in water supply networks (WSNs). This will enable the optimal evolution of existing network topologies (e.g. sectors with single water inlets) into networks, which dynamically adapt their connectivity and operational conditions in order to improve both the redundancy in connectivity and the pressure control; and therefore, improve their resilience (the ability of networks to tolerate and recover from failures and/or respond to extreme demand).

We refer to this framework as Design-for-Control of Adaptive Networks (DCAN). The DCAN framework simultaneously optimises the design (e.g. opening kept shut valves, valve placements and network connectivity modifications) and the operational control (e.g. control functions and settings for valves and pumps for a given configuration). This co-design approach for large-scale WSNs takes into account the hydraulic dynamics and associated uncertainties, and the development of robust mathematical optimisation and control methods that enable multiple operational objectives.

The research builds upon previous work done by Dr Stoianov and his research team. Some examples include:

1. Ulusoy, J., Pecci, F. and Stoianov, I. (2020). An MINLP-Based Approach for the Design-for-Control of Resilient Water Supply Systems. IEEE Systems Journal, DOI: 10.1109/JSYST.2019.2961104.
2. Herrera, M., Abraham, E. and Stoianov, I (2016). A Graph-Theoretic Framework for Assessing the Resilience of Sectorised Water Distribution Networks. Water Resources Management. Water Resources Management, DOI: 10.1007/s11269-016-1245-6.

The project is part of a broader research programme on Dynamically Adaptive Networks led by Dr Ivan Stoianov. The PhD student will join the InfraSense Labs research group, which currently has 4 PhD students and 3 PDRA (Post-Doctoral Research Associates).

Academic requirements and experience:

- A good First Class Degree (or International equivalent) Applied Mathematics, Chemical Process Engineering, Civil Engineering or a course with strong emphasis on mathematical optimisation, control and systems engineering.
- A Masters level degree qualification in any of these subjects/courses (Applied Mathematics, Chemical Process Engineering, Civil Engineering or a course with strong emphasis on mathematical optimisation, control and systems engineering) will be highly beneficial.
- Solid background in applied mathematics (linear algebra), mathematical optimisation or control engineering.
- Good knowledge of Matlab and/or Python.
- Ideally, some experience in systems engineering/civil engineering.

A lack of experience in the above experience and skills could be compensated by evidence of research potential. Appropriate training will be provided.

How to apply:

Applicants wishing to be considered for these opportunities should send the following application documents to Ivan Stoianov (ivan.stoianov@imperial.ac.uk)

1. Current CV including details of their academic record
2. Covering letter making explaining their motivation and suitability
3. Contact details of two academic referees

Application via the Imperial College Registry is not necessary at this stage.

The closing date for applications is the 30th June 2020. However, applications will continue to be accepted until the position is filled.

Funding Notes

The studentship will provide funding for 3 years including tuition fees and a tax-free stipend at the standard UKRI London rate, ~ £17,000 for the 2019/20 academic year. In addition, allowance is provided for research consumables and conference attendance.

Full funding is available to Home and EU students. The funding can also be used to partly support an international student.