Imperial College London

Department of Civil and Environmental Engineering

EPSRC CDT in Sustainable Civil Engineering

PhD Studentship:

Near Real-Time Modelling and Failure Diagnosis of Water Distribution Networks

Supervisor: Dr Ivan Stoianov

Industry Partner: Cla-Val (with Bristol Water)

This project will focus upon the near real-time modelling and failure diagnosis of water distribution networks. The work is motivated by the increasing need for water companies to optimize performance by gaining understanding of the behaviour of their complex large scale networks.

Water supply systems include (i) ageing pipeline infrastructure, (ii) control assets such as pumps and valves whose performance might frequently deviate from design values; and, (iii) an increasing number of customers and associated water demand. These operational challenges are further complicated by regulatory changes and financial constraints. Consequently, water utilities are beginning to recognise the need for near real-time knowledge (monitoring and modelling) and efficient control of their networks. These capabilities are currently constrained by the lack of data with sufficient temporal and spatial resolution, and computationally efficient and robust near real-time hydraulic models which can utilise data with increased resolution in order to support advanced applications for leak and bursts diagnosis and incident management.

The work in this project will aim to develop and validate computationally efficient and robust near real-time hydraulic solvers and control methods to enable reliable failure diagnosis, which includes the detection, localisation and identification of leaks and bursts. Leaks and bursts have a major impact not only in terms of resource losses and increased carbon footprint but also on the deterioration and cascading failure of neighbouring infrastructure. Urban roads are conduits for water, gas, electricity, communication and other infrastructure and water pipe bursts may cause major traffic disruptions and tunnels deterioration for Transport for London.

The research will analyse and validate mathematical methods and factors affecting the accuracy and applicability of near-real time hydraulic models to support the implementation of failure diagnosis.

The work will include the use of model-based optimization and estimation tools for fault diagnosis. The impact of different modelling techniques and the impact of their accuracy on uncertainties will be analysed. The candidate will study and further develop tailored optimization tools necessary for the estimation problems arising here so that near real-time decision making capabilities can be created. The design and execution of an experimental programme in collaboration with Bristol Water will allow validation of developed tools to quantify the effect of uncertainties in demand data,

sensor measurements, and the level of leakage on the accuracy of the different approaches to estimate the location level of leakage.

The successful candidate will join a multidisciplinary team of researchers in the InfraSense Labs (www.infrasense.net) led by Dr Ivan Stoianov (Department of Civil and Environmental Engineering). The immediate research group is currently composed of 2 post-doctoral research associates and 9 PhD students working on various aspects of smart water systems modelling, optimization and control.

The successful candidate will develop their understanding of water distribution networks and appropriate numerical tools for large scale water distribution systems. There will also be an opportunity to develop relevant algorithms in Matlab, and other software. You will learn from the technical expertise of our dynamic, multidisciplinary team of researchers and collaborators.

Eligibility and Funding

Funding is available for applicants with settled UK status (see https://www.epsrc.ac.uk/skills/students/help/eligibility/ for eligibility). The studentship offers a stipend of approximately £16,000 per annum (tax free) and covers fees at the UK/EU student rate for a period of four years.

Applicants for the studentship should have or expect to obtain a first or upper second class honours degree or equivalent, in a relevant aspect of Mathematics, Engineering, Computing, or other strongly quantitative discipline. Good computing skills are required. An MSc (or proven research experience/equivalent) in Applied Mathematics, Electronic Engineering, Control Engineering, Process Systems Engineering, Optimization or a related discipline would be advantageous but is not mandatory. It would also help if you have a background in the following areas, or have backgrounds indicating you can acquire skills in these areas would be a bonus:

- Optimal Estimation
- Numerical Optimization
- Linear Algebra, Numerical methods for solving linear and nonlinear equations
- Matlab, and possibly Python, C++ etc

Contact

For informal enquires and to request more information, contact Dr Ivan Stoianov (http://www3.imperial.ac.uk/people/ivan.stoianov)

This PhD studentship is co-funded by the EPSRC CDT in Sustainable Civil Engineering at Imperial College London:

(http://www3.imperial.ac.uk/sustainablecivilengineering)

Deadline

Review of application is now in progress and will continue until suitable candidate is identified. The starting date for this PhD Studentship is 1st of October, 2018.