TU Delft

Master Project

Leakage Detection in Water Distribution Networks: An Active Diagnosis Framework

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Context

One of the main challenges for water utilities is the detection and control of leakage from an aging water distribution network (WDN) infrastructure. The early detection and management of leaks, in addition to reducing financial cost in non-revenue water, is critical to mitigate deterioration of pipes and surrounding infrastructure. The aim to reduce leakage is further motivated by stringent regulations and financial incentives. Conventional techniques for detecting leakage include random and regular sounding surveys using listening sticks and acoustic loggers, and step-testing of subsystems through gradual valve closures. More advanced methods like leak noise correlators, pig-mounted acoustic sensing and gas-injection techniques are the most precise at locating leaks. However, all these techniques come with expensive equipment cost and are man-hour intensive, and so are not scalable.

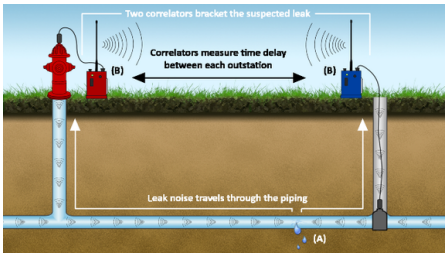

Figure 1: A schematic representation of the leak noise correlator method

Recent approaches use model-based analysis of near real-time telemetry data from pressure sensors and flow metres distributed over the network. The leak detection methods rely on a calibrated hydraulic model to predict pressures at nodes, which are then compared with actual measured pressure values to analyse and localise potential leaks. Let r represent the residual vector obtained by comparing the pressure measurements p from the sensors installed in the network and the model-based prediction $\hat{p}$, i.e. $r_i = p_i - \hat{p}_i$. By calculating the normalised projections of the residual matrix

on the sensitivity vectors s_j (i.e. a sort of correlation), it is possible to calculate the most likely leak location. However, these projections can be very close to each other and may not allow leakage identification uniquely or reliably under data uncertainty.

Project tasks

This master thesis project is aimed at researching the enhancement of the observability of leaks in a WDN using active pressure control inputs. Varying the pressure over time affects the observability of the leaks within the system. Using an example network and given sensor locations, it needs to be shown that observability does not only depend on the topology of the network (passive) but also on the hydraulics (active). Then the gained knowledge can be exploited by improving the identification and localisation of the leaks by using already installed equipment as pumps and valves.

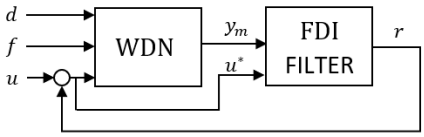

Figure 2: Active fault detection scheme using FDI method.