CRC for Water Sensitive Cities

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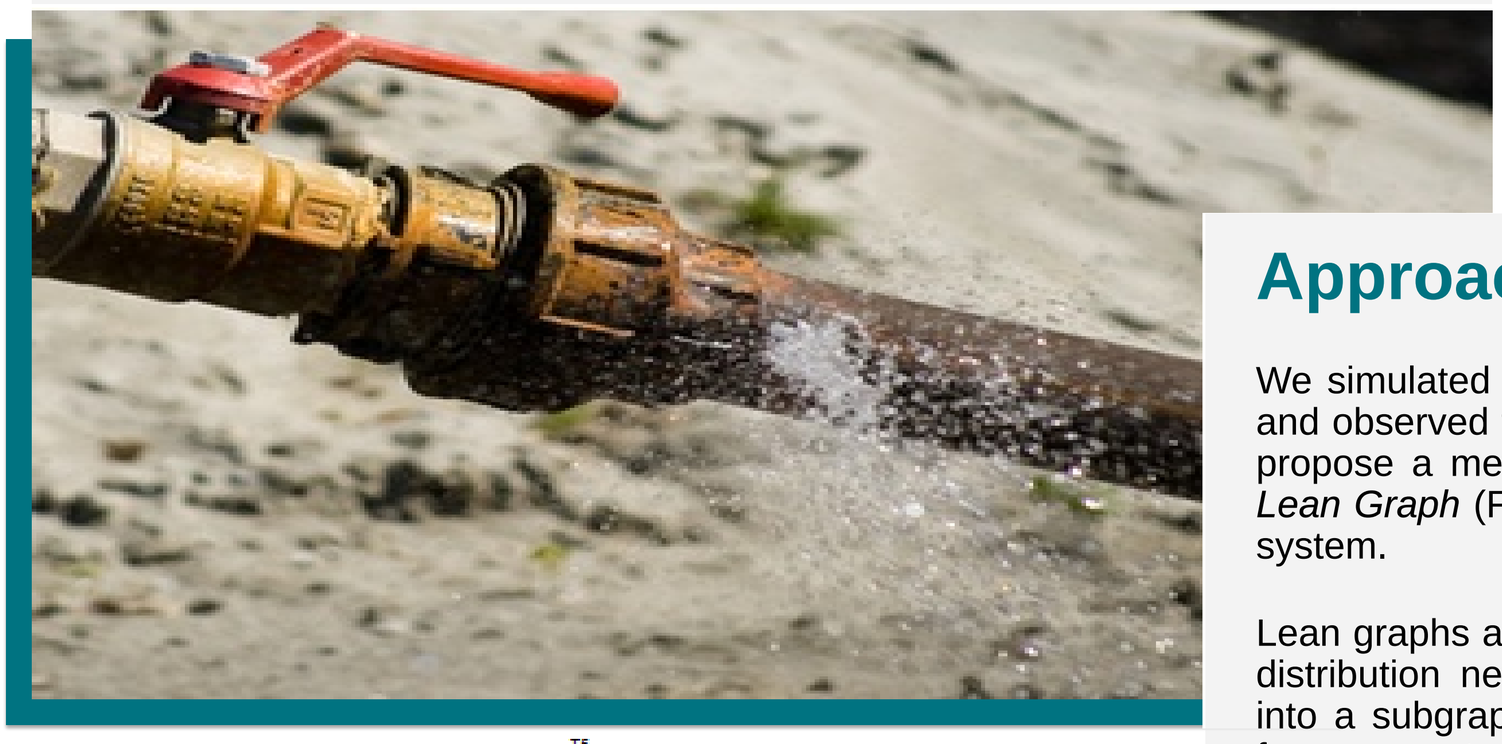
C 5.1 Intelligent Urban Water Systems

Sensor Placement Strategy for Locating Leaks using Lean Graphs

Introduction

Undetected leaks in water distribution networks cause significant economic and environmental problems worldwide. Small leaks are hard to detect yet their contribution to water losses is substantial.

Finding leaks through full observation of all pipes will give the best result. However, it is not feasible to install flow sensors on every pipe. One solution is to develop a sensor placement strategy that maximizes leak quantification accuracy given a fixed number of sensors (*k*).



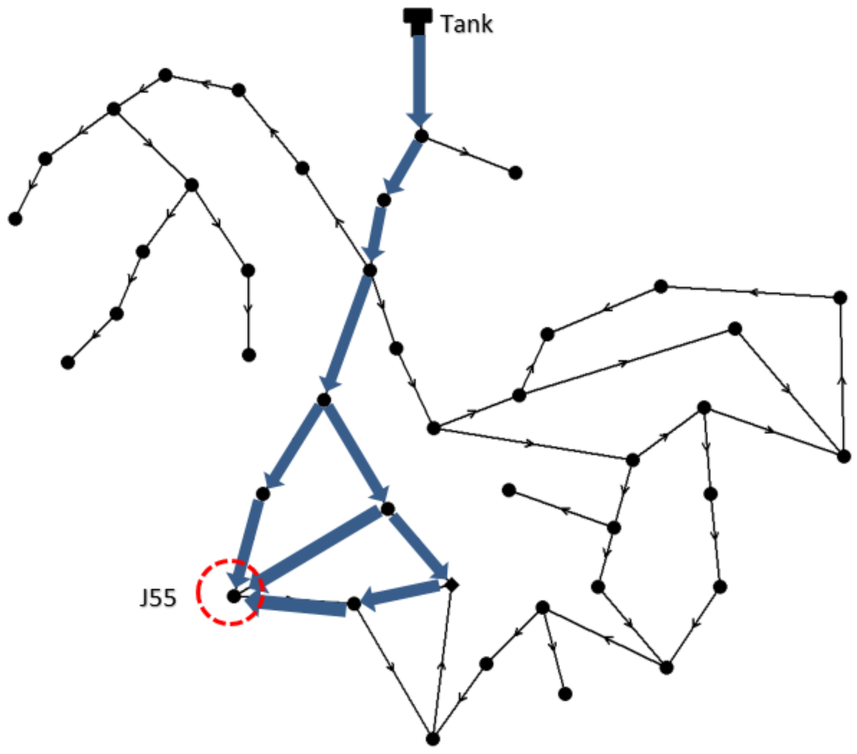


Figure 1: Leak Signature

Approach

We simulated small leaks in a real world water distribution system and observed flow changes in pipes to capture leak signatures. We propose a method to characterize small leak signatures, called a *Lean Graph* (Figure 1), which is a sub-graph of a water distribution system.

Lean graphs are generated for all possible leak positions in a water distribution network. Leaks with similar lean graphs are grouped into a subgraph (Figure 2). An inlet to each subgraph is selected from a set of candidates with the highest leak signature distinguishing ability. Then, *k* sensors are placed at the subgraph inlets to narrow down a leak position to one of the *k* subgraphs.

We evaluated the performance of our proposed leak quantification system by employing sensor reading distinctiveness and partition balance measurements.

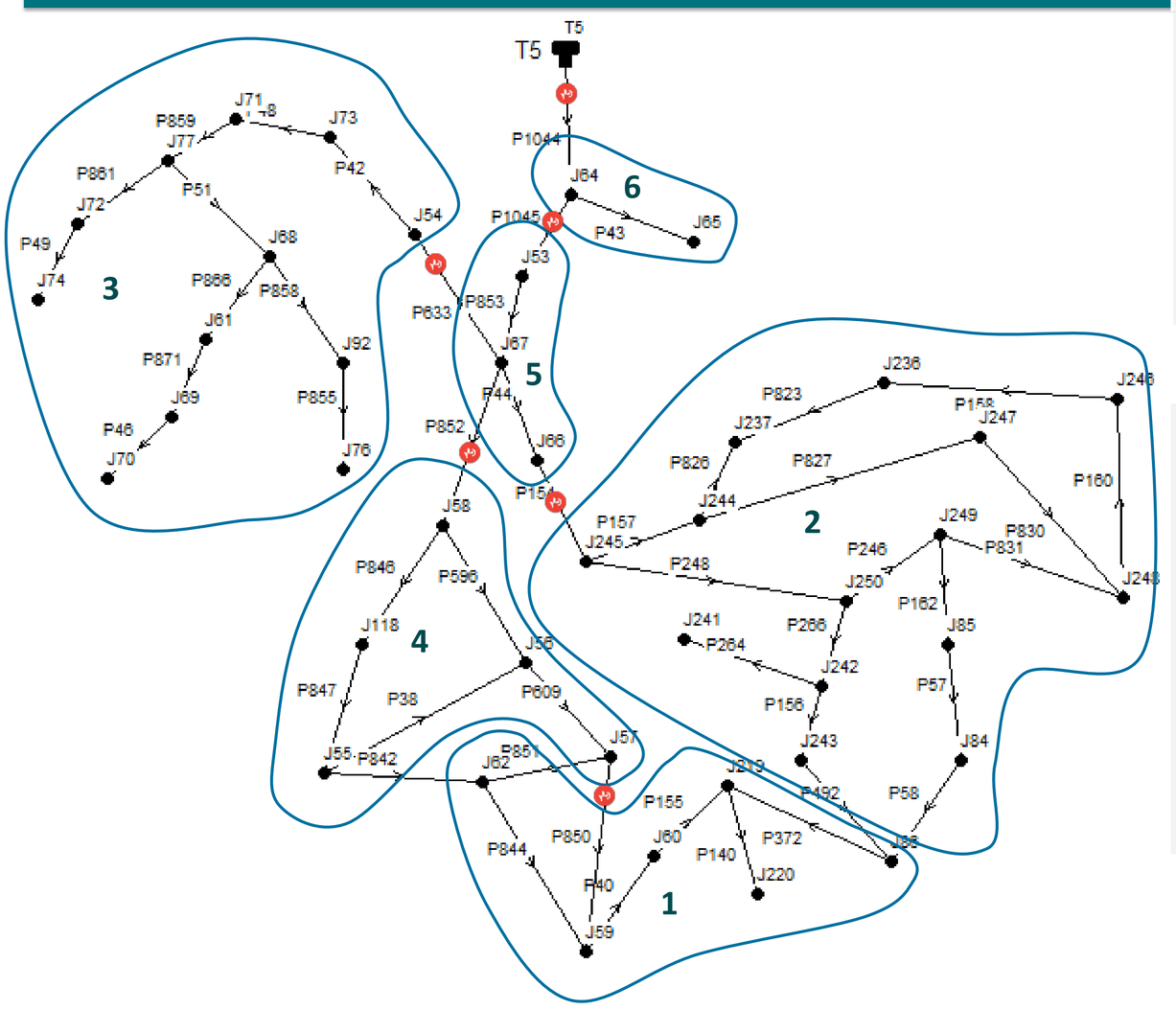


Figure 2: Locating leak regions with 6 sensors

Results

- We have introduced a novel approach for effectively quantifying small leaks in a water distribution system
- We demonstrated that our sensor placement strategy maximizes leak quantification accuracy for a given *k* sensors
- Our approach is important for water utilities management to minimize the cost of water loss caused by small leaks.

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