CERIS Civil Engineering Research and Innovation for Sustainability

Real-time pipe burst location using artificial intelligence techniques

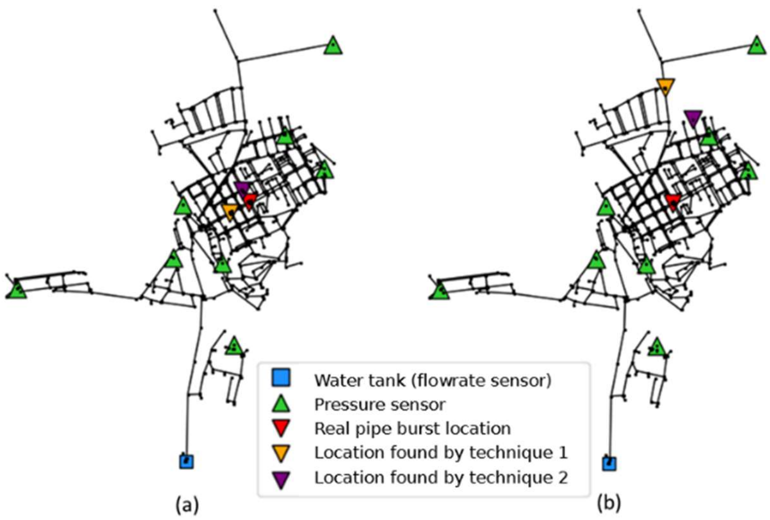
Summary

The current research aims at the development, implementation and testing of a robust methodology for real-time pipe burst location combining different artificial intelligence techniques at different levels of application. The proposed methodology is composed of four distinct stages, namely: 1) data collection; 2) time series processing; 3) burst detection; and 4) burst location. The first stage includes network sensorization and data collection. It includes the installation of flow meters at the inlet and the outlets of network sectors (e.g., district meting areas, DMA) as well as water consumption meters at the endusers. It also includes the definition of the number and location of pressure sensors and their respective installation. The second stage corresponds to time series processing which aims at identifying, removing and replacing anomalous values, so that these do not affect the performance of burst detection and location techniques. The third stage is pipe burst detection. In this stage, it is determined if the stream of flow rate data indicates that a pipe burst has occurred in the network. When a burst is detected, the location can be assessed in a fourth stage by using hydraulic simulation models with either steady-state or transient-state techniques.

This research work encompasses contributions in different subjects, such as the optimal location of pressure sensors, time series processing, and leak detection and location methods. The main outcomes of this research are (i) the development of a multi-objective optimization method for pressure sensor location; (ii) the development of a sensitivity analysis for the parameterization of NSGA-II algorithm for the optimal location of pressure sensors; (iii) the development of a method to determine the optimal number of pressure sensors; (iv) the development of a methodology for processing unevenly (and evenly) spaced flow rate time series; (v) the assessment of the ideal parameters of a statistical approach for pipe burst detection; (vi) the development of a model-based method using inverse analysis for real-time pipe burst location; and (vii) the development of guidelines for the implementation of the real-time pipe burst detection and location, demonstrated with practical applications using both artificial and real data.

Keywords

Burst detection, burst location, hydraulic simulation, optimal number and location of pressure sensors, time series processing.



Pipe burst location found by two distinct methods for (a) pipe burst of medium size (6Ls) and low noise level (1%); (b) pipe burst.

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