Segments Identification in Water Distribution Systems by Using Network Topological Matrices

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ABSTRACT

The partitioning of water distribution systems (WDS) into segments and district metered areas (DMAs) provides various management benefits for system operators [1,2]. These benefits include, for instance, improved pressure management, more efficient leakage control and effective isolation of network parts in cases of pipe breakages or equipment failures. All this, in turn, increases system reliability and resilience [3]. Identification of network segments depends mainly on the distribution and location of valves in a given WDS. In general, valves are used for controlling flow conditions (i.e., pressure and flow) and for isolating a failure area due to pipe breakage/equipment failure or contamination events.

In this paper, a methodology is proposed to identify network segments (i.e., sets of pipes and nodes) that belong to an individual valve or a set of valves. The methodology is developed based on the basic network topological matrices (i.e., node-link connectivity matrix, valves topological matrix) [2]. In comparison to other existing methods, the proposed methodology has able to produce all segments for a given WDS in single network run without introducing pseudo valves, pipes and auxiliary valve matrix [2,3,4] or performing hydraulic analysis. Additionally, it is very simple for computer coding and does not require the user to have extensive programming knowledge. Figure 1 shows the steps for the methodology and segmentation results obtained on a simple network under a hypothetical pipe failure scenario (i.e., burst pipe p2).

The methodology has been further validated and demonstrated on the well-known C-Town network [5]. The results show that the approach is capable of identifying both regular segment valves association and unintentionally isolated segments [4] in an accurate and efficient way. A regular segment is a part of the network (i.e., nodes and pipes) that contains the failure element to be isolated from the rest of the network (e.g., pipe failure), which needs to be repaired or fully replaced. While an unintentionally isolated segment is the portion of the network that is separated from water source(s) as a consequence of isolating a regular segment (as shown in Figure 1). Due to its generic nature and relative simplicity, the proposed methodology has the ability to create network segments in an automated way from network input data, e.g., by reading and automatically processing the relevant data from the EPANET2.0 input file. The methodology proposed, therefore, lends itself naturally to tackling practical problems, such as determining strategic and optimal location for isolation and PRV valves, WDS reliability, and response approaches to network failure events.

Keywords: network segmentation, isolation, valve, segments, unintentional segments

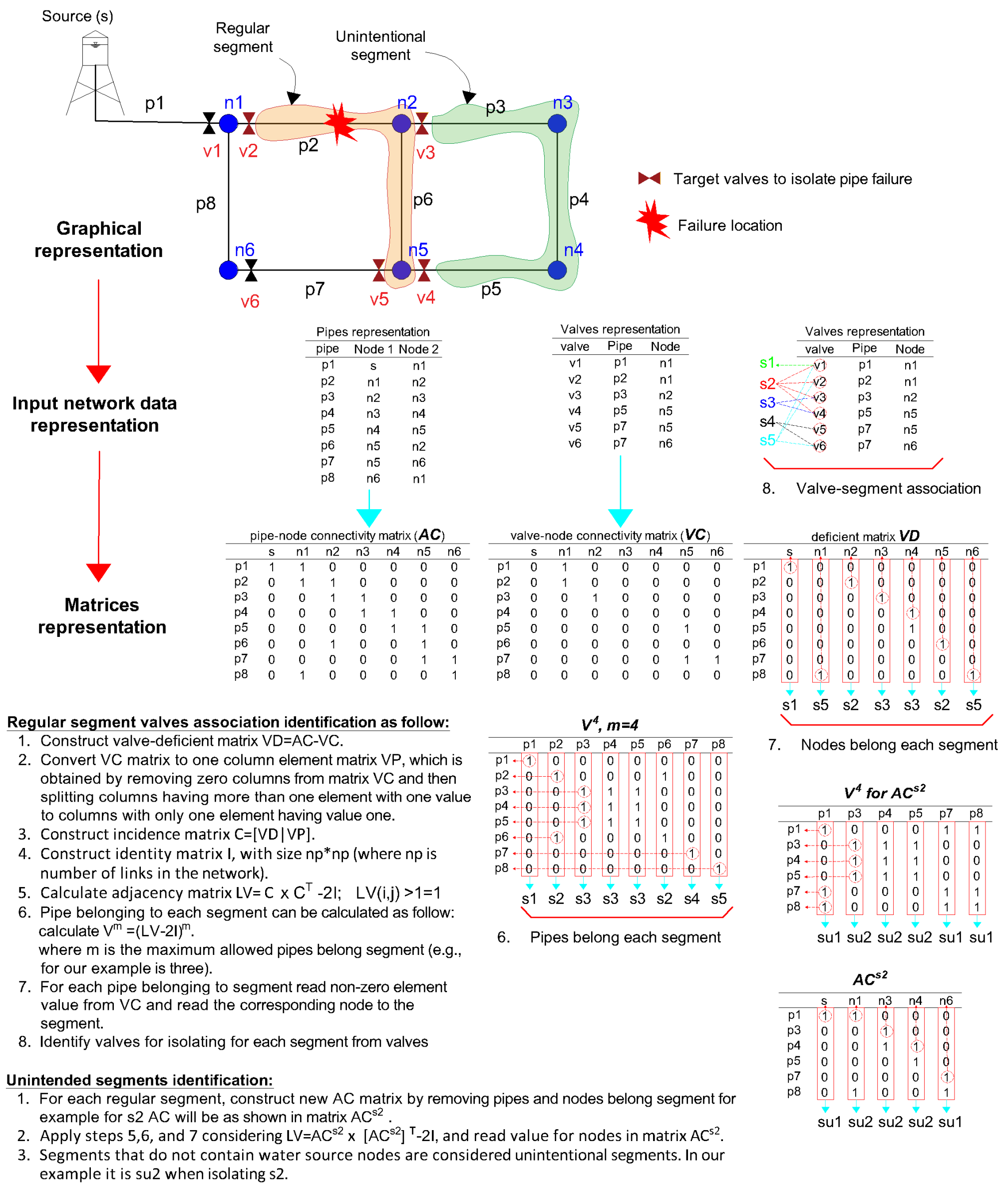

Figure 1. General framework for segmentation methodology

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