Identification of Contaminant Injection in Water Distribution Network

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Abstract

Water contamination in a water distribution network (WDN) is harmful since it directly induces the consumer's health problem and suspends water service in a wide area. Actions need to be taken rapidly to countermeasure a contamination event. A contaminant source ident ification (CSI) is an important initial step to mitigate the harmful event. Here, a CSI approach focused on determining the contaminant intrusion possible location and time (PLoT) is introduced. One of the methods to discover the PLoT is an inverse calculation to connect all the paths leading to the report specification of a sensor. A filtering procedure is then applied to narrow down the PLoT using the results from individual sensors. First, we spatially reduce the suspect intrusion points by locating the highly suspicious nodes that have similar intrusion time. Then, we narrow the possible intrusion time by matching the suspicious intrusion time to the reported information. Finally, a likelihood-score is estimated for each suspect. Another important aspect that needs to be considered in CSI is that there are inherent uncertainties, such as the variations in user demand and inaccuracy of sensor data. The uncertainties can lead to overlooking the real intrusion point and time. To reflect the uncertainties in the CSI process, the Monte-Carlo Simulation (MCS) is conducted to explore the ranges of PLoT. By analyzing all the accumulated scores through the random sets, a spread of contaminant intrusion PLoT can then be identified in the network.

Keywords : Back-tracking simulation, Contaminant injection, Uncertainty, Water distribution network

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