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Inline electric leak detection in the water distriubtion network

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Motivation

In urban areas, the majority of the potable water is delivered through a Water Distribution Network (WDN)[1]. Deteriorating components in the WDN may cause leakage. In some cases, leakage comprises 20 to 30% of the total water production [2]. This is not only a waste of natural resources but also causes financial losses, damage to surrounding structures, potential leakage of contaminants into the water network and increased carbon footprints. Therefore, accurate and cost-effective methods to detect leakage have both financial and environmental benefits.
While many accurate inspection methods already exist, most of them are best suited for metallic pipes[2] which only comprise a small portion of the total network in the Netherlands. So, new research is required to develop highly accurate methods to inspect non-metallic hydraulic components in the WDN.

Technological challenge

Two methods have been proposed for leakage detection: capacitive imaging and voltage differential. As shown in Fig. 1 a, capacitive imaging utilises the fringing electric fields generated by a pair of coplanar capacitor. The fringing field penetrates non-conductive sample and create an “image” of the interior of the WDN. The required resolution, sensitivity and image processing capabilities to make meaningful detection is unclear and maybe challenging to execute

Unlike CI, the voltage potential method doesn’t require a full mapping of the interior. As shown in Fig 1 b, leakages in the pipe creates a “short circuit” and causes a spike in voltage in the detector. However, conductors the WDN will create a similar effect. Elimination of false positive detections will be challenging using this method.

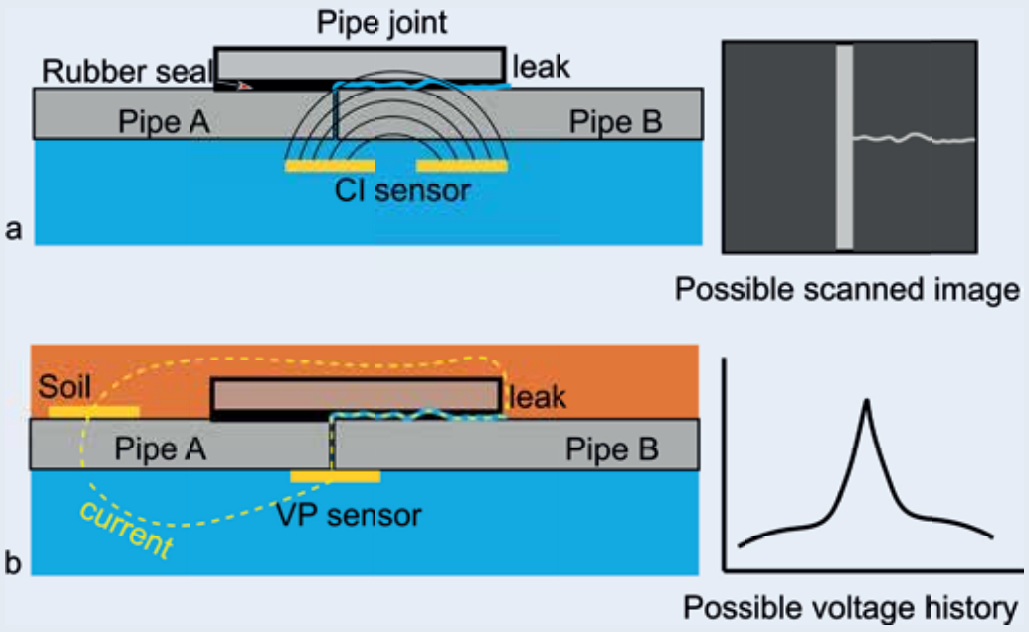

Figure 1: schematic showing the principles behind the: a) capacitive image, b) voltage potential techniques

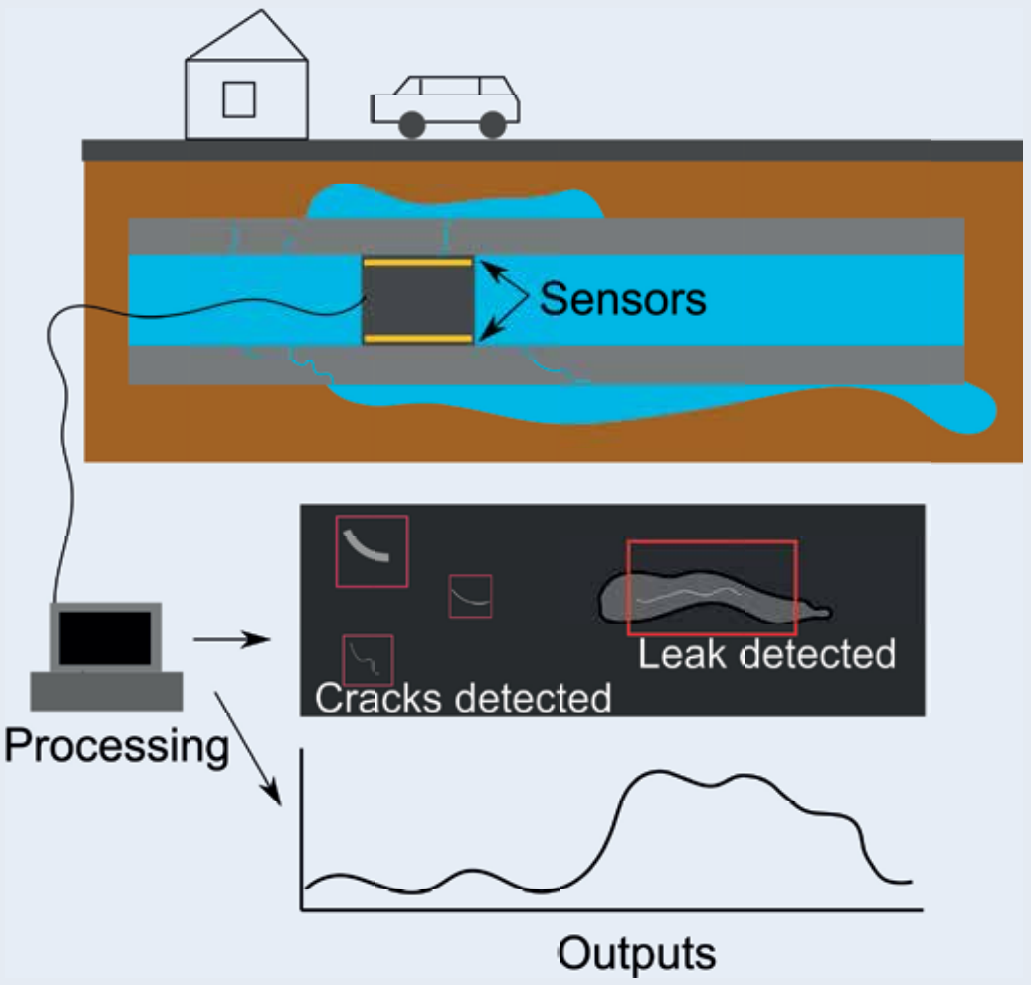

Figure 2: graphical abstract showing the desired outcome of the project

Research goals

This project aims to develop a new inline leak detection method to use in the water distribution network with a particular focus on non-metallic materials. Some of the research questions that need to be answered in this project include:
Where and how do leakages occur in the non-metallic components of the WDN?
Can the proposed methods detect leakage in a controlled lab environment?
Can the proposed methods detect microcracks, is that useful?
How can the sensors be optimised to deliver the best performance?
Can the proposed methods work in the field?
A desirable outcome of the project is demonstrated visually in the graphical abstract shown in Figure 2.

[1] A. Ostfeld,. “Water Distribution Networks” in Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems, pp.101-124. 2014
[2] C. Teck Kai, C. S. Chin, en X. Zhong, “Review of Current Technologies and Proposed Intelligent Methodologies for Water Distributed Network Leakage Detection”, IEEE Access, vol PP, bll 1–1, 12 2018.

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