CERIS : Civil Engineering Research and Innovation for Sustainability

AI-Anomaly – Condition Assessment of Urban Water Assets through the Detection and Classification of Anomalies based on Artificial Intelligence

AI-Anomaly CONDITION ASSESSMENT

Summary

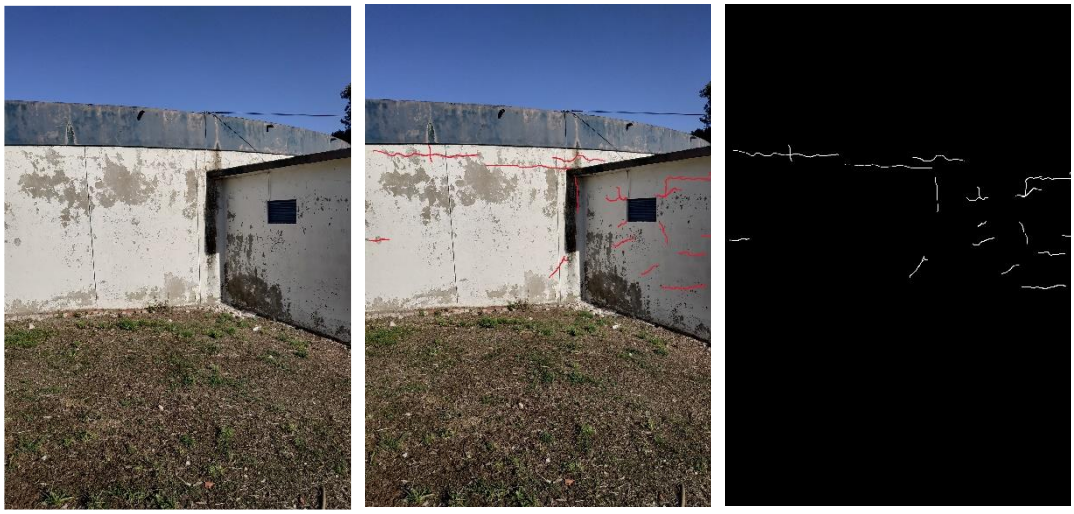
Urban water assets are continuously deteriorating and more investments are necessary to maintain adequate levels of service despite investment budgets are often limited. In the context of the urban water rehabilitation process, the asset condition assessment plays a key role in the investment planning and the establishment of operation & maintenance (O&M) programmes, being the basis and the first step towards the development of infrastructure asset management plans.

The project AI-Anomaly aims at innovating, extending and automating the existing methodology for assessing the physical condition of vertical water assets, which is developed by a multidisciplinary team, including specialists in computer science and civil engineering, such as hydraulics, hydrology, construction and structures. Specifically, the aim is to apply and compare artificial intelligence (AI) methods, combining deep learning and computer vision methods to detect and classify structural anomalies in water reservoirs and pumping stations.

The proposed methodology includes the following steps: 1. Review and improve the current methodology for assessing the physical condition of vertical water assets, taking into account the procedures used in other areas of civil engineering, namely construction and structures. 2. Automate the inspection process of these assets using ground and aerial robotic platforms to augment the current database made up of images from previous inspections. 3. Apply and compare AI methods, combining deep learning and computer vision methods, to enable the digitization and monitoring of the deterioration of inspectable components. 4. Apply and compare methods of explaining the AI solutions used, to ensure the transparency of the methods and highlight possible biases in the results. 5. Prepare three articles to be published in indexed international scientific journals.

In situ inspections of vertical urban water assets are carried out, including a complete photographic record of identified anomalies in different inspected components, as well as the technical characterization of the assets and the identification of operation and maintenance practices. A dataset of photographic recordings collected from low-resolution cameras is obtained not taking into consideration the camera positions and environment conditions to represent real-world situations. Figure 1 depicts the steps of image processing that include drawing and labeling of cracks (Figure 1b) and image binarisation (Figure 1c). Additionally, drawn and binary images are divided into patches with a 127 px × 127 px resolution, leading to more than 4000 images.

An existing convolutional neural network (CNN) pre-trained with images of concrete surfaces in buildings with and without cracking will be applied to processed images of urban water assets and results will be discussed. Additionally, different explicability artificial intelligence methods will be applied to guarantee the transparency of the methods and highlight possible biases in the results, enhancing the interpretability of the results for users to make models more transparent and less similar to a "black box".



(a) *(b)* *(c)*

Figure 1. Image processing: (a) original image; (b) image with drawn cracks; and (c) binarized image.

Project Reference

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Leading Institution

CERIS – Civil Engineering Research and Innovation for Sustainability (Portugal)

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TU/e – Eindhoven University of Technology (Netherlands), AGS – Administração e Gestão de Sistemas de salubridade, S.A. (Portugal)

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Funding

CERIS – Civil Engineering Research and Innovation for Sustainability

Period

2023-2024

Total

7 500.00€

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Project Website

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