CHALLENGES OF DATA CLASSIFICATION FOR MACHINE LEARNING ALGORITHMS: CASE STUDIES IN DRINKING WATER DISTRIBUTION SYSTEMS

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ABSTRACT

Online monitoring of water quality in drinking water distribution systems (DWDS) is critical to ensure public health and regulatory compliance [1]. It is expected that full scale machine learning (ML) in drinking water quality applications will be applied in the future [2]. Online sensor systems can provide real-time insights into water quality variations and enable prompt detection of anomalies [3]. This paper presents two case studies demonstrating a multi-sensor monitoring approach for detecting and diagnosing water quality issues in DWDS and evaluates challenges of water quality classification tasks for ML applications.

In the first case study, an online sensor system with pH, turbidity, total organic carbon, electrical conductivity, and oxidation-reduction potential (ORP) sensors was deployed in the middle of a distribution network. A consistent drop in ORP values was observed in this area compared to other locations (Figure 1). Further investigation revealed the presence of a partially closed valve, which increased water age. Residents in the affected area reporting complaints of elevated turbidity and smell were also noticed. This case highlights the role of sensor networks in identifying hydraulic anomalies and their impact on water quality.

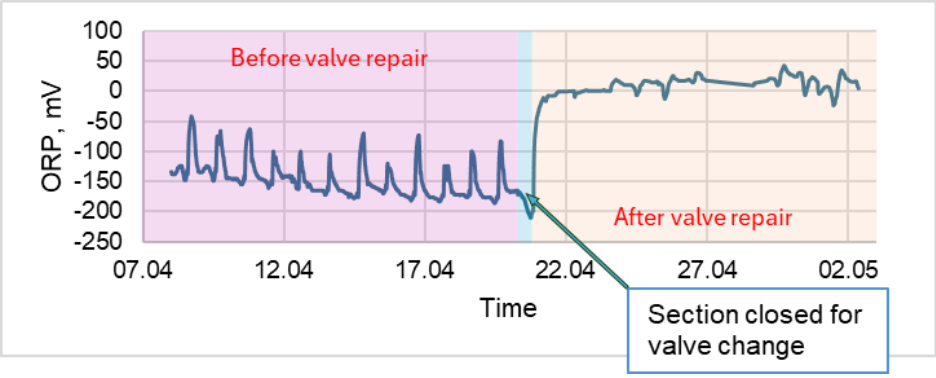

Figure 1. Measured ORP [mV] values before, after valve repair and in the supply point to the DWDS in 1st case study.

The second case study involved monitoring water quality at iron removal water treatment plant. The sensor system detected recurring increases in turbidity, reaching 10-20 NTU every 2–3 days (Figure 2). Detailed analysis traced the issue to an eroded butterfly valve within the de-ironing plant, which failed to properly separate flushing water from treated water. This case demonstrates the utility of online sensors in detecting and diagnosing equipment failures affecting drinking water quality.

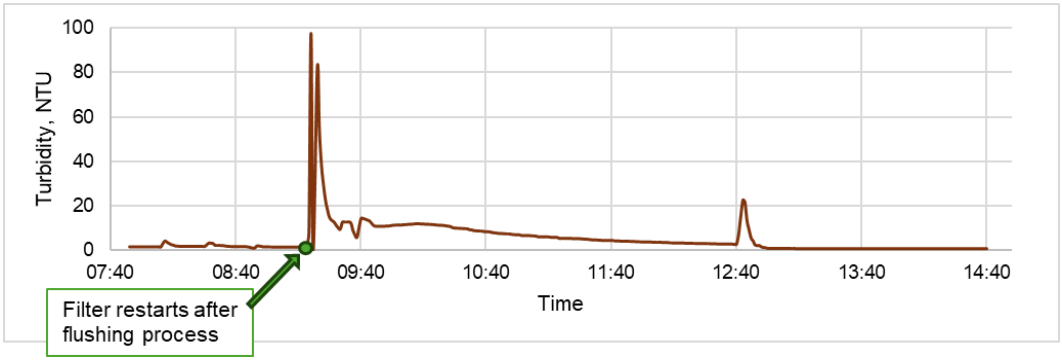

Figure 2. Measured turbidity [NTU] values before valve repair leading to backwash water mixing.

Utilizing sensor data for classification in machine learning algorithms remains challenging due to the vast number of possible scenarios and the difficulty in acquiring sufficient data to accurately represent different problems. Data interpretation of DWDS processes require site-specific information and data is often highly variable. The findings highlight the necessity of integrating multi-sensor platforms with hydraulic and operational assessments to enhance the reliability and safety of DWDS.

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