Chair of Urban Water Systems Engineering
Department of Civil and Environmental Engineering
TUM School of Engineering and Design
Technical University of Munich

Opportunities for Talents

Master Thesis

"Machine Learning supported Prediction of Fouling Intensity in High-pressure Water Filtration Membranes based on Camera Images"

About us

The Chair of Urban Water Systems Engineering is involved in the education of students (Bachelor and Master) in environmental and civil engineering. Our research covers all aspects of the urban water cycle: urban water supply, wastewater treatment and energy recovery, water recycling, drainage systems, industrial wastewater treatment, membrane systems, and the urban water-food-energy nexus.

Topic

Reverse Osmosis (RO) and Nanofiltration (NF) membranes are widely used in seawater and brackish water desalination, treatment of industrial and municipal wastewater as well as water reuse and water supply. Biofouling is a major limitation to the performance of these membranes, affecting product water quality, flux, and increasing the feed channel pressure drop (and hence power consumption and operational cost). As biofouling assessment is needed during operation of full-scale commercial membrane systems, but also when investigating biofouling remediation approaches in lab-scale membrane cells, numerous monitoring techniques have been studied. At our institute, we developed a low-cost and easy-to-use optical system for biofouling monitoring based on a consumer-grade digital single lens reflex (DSLR) camera equipped with a macro lens and post-processed the images using Python and ImageJ.

From experiments conducted, we have a database of approximately 1,500 images of the surface of high-pressure membranes at different fouling states. The scope of the proposed Master Thesis is to apply Machine Learning (ML) tools in order to: a) detect biofilm-covered areas of the membrane surface, and subsequently b) predict the biofouling intensity on the membrane surface, associating the image data with available data on the well-established fouling indicator "feed channel pressure drop" (FCPD). Similar approaches have been developed in previous work based on optical coherence tomography scans [1, 2].

Tasks

- Screen the literature for publications on ML approaches to process membrane system data, in particular image data
- Use common Python ML libraries (e.g., scikit-learn, PyTorch) to build and train an ML model for a) detection of biofilm-covered membrane areas and b) prediction of biofouling intensity

Requirements:

- Good programming skills in Python
- Basic knowledge and experience in Machine Learning and/or Image Processing
- Interest in water treatment/reuse and membrane systems (no prior knowledge required)

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Time Range

Starting mid-January 2026, there will be time to screen the literature and get to know the topic. Building and training the model should be performed during 3-4 months. With analyzing the result and writing the report, the Master Thesis can be completed by summer 2026.

Contact

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References

[1] H.J. Tanudjaja, N.A. Amin, A. Qamar, S. Kerdi, H. Basamh, T. Altmann, R. Das, N. Ghaffour, Precise biofilm thickness prediction in SWRO desalination from planar camera images by DNN models, npj Clean Water 8(1) (2025) 22.
[2] A. Qamar, S. Kerdi, N. Amin, X. Zhang, J. Vrouwenvelder, N. Ghaffour, A deep neural networks framework for in-situ biofilm thickness detection and hydrodynamics tracing for filtration systems, Separation and Purification Technology 301 (2022) 121959.