RESEARCH BRIEF
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NAWI
National Alliance
for Water Innovation

Advanced Process Controls: Autonomous Control and Optimization

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Challenge

Today's operations in water treatment and production facilities are highly focused on continuously meeting the facility's performance standards regardless of disturbances caused by (a) variability in water source, demand, and quality and (b) degradation of critical components, such as process equipment and sensors. The need for reliability has been addressed through redundant infrastructure, but this approach is capital-intensive and an inefficient use of resources. Today, generic models rooted in machine learning and adaptive control strategies offer a novel promise: the same reliability at unit- and plant-wide scale without redundancy, while spending minimal energy and resources.

Research Approach

This research project will evaluate this promise by developing and testing broadly applicable control methods for adaptive optimization. The unique challenge is to design a single control framework that is applicable across a variety of water treatment systems, thus making efficient, low-cost operation available in multiple settings. The research tasks are grouped into 6 activities:

1. Upgrading and maintaining a pilot system for direct to potable reuse (DPR) to benchmark state-of-the-art solutions for water quality monitoring, process optimization, and automation.
2. Develop and study tools for automatic detection, identification, and forecasting of faulty process components and sensors, the most sensitive component to any automation strategy in aquatic systems.
3. Develop the tools for online model identification and updating so that the model predictive control methods can rely on an accurate and up-to-date model at all times.
4. Ensure that the data collected online are informative about any changes in the process state or its dynamic behavior.
5. Implement state-of-the-art methods for model predictive control (MPC) to achieve optimal operation.
6. Integrate quantitative techno-economic models into the MPC framework to ensure the optimization goals reflect the economic reality accurately.

Impact

Each water treatment plant in operation today is the result of a response to a unique local and regional context, including economic and socio-political history. Naturally, the automation industry has responded by providing solutions on a case-by-case basis; however, this is not affordable for small-scale systems. Successful completion of this project will lead to generic, transferable, and scalable methods for autonomous operation for systems of all scales and will enable affordable water production.

Figure 1. Outside and inside views of the DPR mobile demonstration lab. The six unit-processes installed in the trailer include: ozonation, biologically active filtration (BAF), ultra-filtration (UF), granulated activated carbon adsorption (GAC), ultraviolet irradiation with advanced oxidation (UV-AOP), and chlorination.

RESEARCH PARTNERS

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