Developing an Enhanced Soft Sensor for Wastewater Treatment Plants: A Comparative Study of Multiple Machine Learning Approaches

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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DECLARATION

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Sri Lanka Institute of Information Technology or to any other institution for assessment for any other purpose.

Sign: …… ....

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Date: ………27/10/2025…………

ABSTRACT

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Wastewater treatment plants (WWTPs) require continuous monitoring of critical water quality parameters to ensure operational efficiency and regulatory compliance. Traditional physical sensors are accurate but expensive and maintenance-intensive, creating a need for cost-effective alternatives. This research investigates the development of enhanced soft sensors using advanced machine learning techniques to estimate key wastewater parameters including Chemical Oxygen Demand (COD) and Total Phosphorus (TP) concentrations at both influent and effluent points. The study addresses fundamental limitations of existing soft sensor implementations particularly their inability to capture complex non-linear relationships which is suspected to have sensor drift and degradation due to seasonal variations and equipment aging. Through comprehensive evaluation of multiple machine learning approaches including Neural Networks and Decision Tree-based methods with the aim to develop robust, adaptable soft sensor models that maintain accuracy over extended periods with reduced recalibration requirements. The methodology involves systematic data collection from a Norwegian WWTP, comprehensive preprocessing to handle data quality issues, feature engineering and rigorous comparative evaluation based on prediction accuracy, computational efficiency and adaptability. Expected outcomes include deployable soft sensor models offering reliable real-time monitoring capabilities, significant cost savings, and improved operational efficiency for WWTPs. The research contributes both theoretical insights into soft sensor design and practical solutions for the wastewater treatment industry.

soft sensors, wastewater treatment, machine learning, neural networks, decision trees, sensor drift, water quality monitoring

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