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AI assisted design of hydraulic turbine components and plausibility check of experimental data based on anomaly detection techniques

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Abstract

This paper presents our research in hydraulic turbine component design assisted by plausibility checks based on laboratory model test data. Advanced learning models can be applied to assist the hydraulic design process and reduce errors observed on the measured data. Being able to predict the hydraulic behavior of the turbine components by using domain knowledge of components allows employment of a surrogate model-based reinforcement learning approach [1]. The strategy learned by this method is the optimal mixture of the physical surrogate information and solutions of CFD computations as well as data provided by an existing component database. Once learned, it will be applied to future hydraulic component design for speeding up the optimization process. In this work, this method will be applied on draft tube component design based on a database of existing draft tubes, which comprises the draft tube geometrical parameters along with their hydraulic behavior.

On the laboratory model testing side, being able to identify errors or behaviors that deviate from the usual on the large number of measured data that are being produced is very important, because it will speed up the testing phase and increase our knowledge on the critical parameters. In this work, anomaly detection techniques are applied on a database of pressure pulsation measurements, between the guide vane and runner domain, on different specific speed Francis turbines measured on different test rigs. Our study focuses not only on detecting the errors but also identifying the influencing factors responsible for these anomalies. We do so by employing a change point detection scheme [2] which is able to work on non-stationary data and which is based on the principal ability of advanced ML models to distinguish between fluctuations, non-trivial trends, and true anomalies.

Keywords: Hydraulic Design Optimization, Reinforcement Learning, Time Series Anomaly Detection

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