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Comparison of Machine Learning Algorithms for Multivariate Timeseries Reconstructing on Example of BDS Sensors Data

THESIS PROPOSAL

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Hydropower plants play a significant role in the world's general electrical production and there are more than 20000 hydroelectric power plants in Europe and even more around the world [1]. Despite being a very effective source of energy, hydropower plant also provides a danger to downstream migrating fish causing severe damage and mortality [1, 2, 3]. As part of the FIThydro project Barotrauma Detection System (BDS) sensors, live fish sensors (so-called "backpacks"), and Computational fluid dynamics (CFD) simulations are used to assess the impact of different hydropower plant structures and operation modes on fish mortality. However, each of these approaches has its drawbacks.

BDS sensors that are designed to pass through hydropower turbines and extreme underwater, provide numerous physical parameters like pressure, acceleration magnitude, magnetometer, and gyroscope readings, that are directly related to causes of fish mortality [4], but it is time- and money-consuming to apply these sensors to each power plant and they still do not have all the characteristics of a living fish (for example size variance and movement ability). CFD simulation, on the other hand, can be executed from anywhere and various parameters can be adjusted for various scenarios, but a simulation of the physical environment does not provide a very accurate representation and is computationally expensive [5, 6]. Solving this problem requires a solution that would be able to combine the physical characteristics of empirical measurements and highly configurable simulation.

The first objective of this thesis is to make regression models capable of recreating BDS sensor data to find out which parameters of hydropower plant configuration have a direct impact on obtained sensor data and how they affect data creation. The initial plan is to convert BDS sensor data into *pressure gradient*, *change in linear kinetic energy,* and *change in rotational kinetic energy* (suggested by J. A. Tuhtan), then find an appropriate regression algorithm capable of reconstructing this data. The second objective is to compare different models in terms of computational complexity, performance (RMSE, MAE) as well as generalizability, and interpretability. The last two are especially important as it is necessary to understand how parameters affect obtained data, which is typically not possible in the case of neural networks as they are typical "black-box"-models having thousands of weights that humans just cannot interpret and obtained models must have the same performance in different scenarios, which CFD simulations typically does.

Produced models can be used in comparison to fish studies under the same hydropower plant conditions as part of general studies of hydropower plant impact on various species' mortality. Obtained model parameters will contribute to improving computational fluid dynamics (CFD) simulations so that in the future the usage of BSD sensors and live fish studies will not be necessary to assess hydropower plant configuration and operation modes, as obtained parameters will allow the creation of more physical-accurate CFD environments.

References

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