State Estimation of a Wind Turbine Model using Recurrent Neural Networks in a Cascade Observer Design

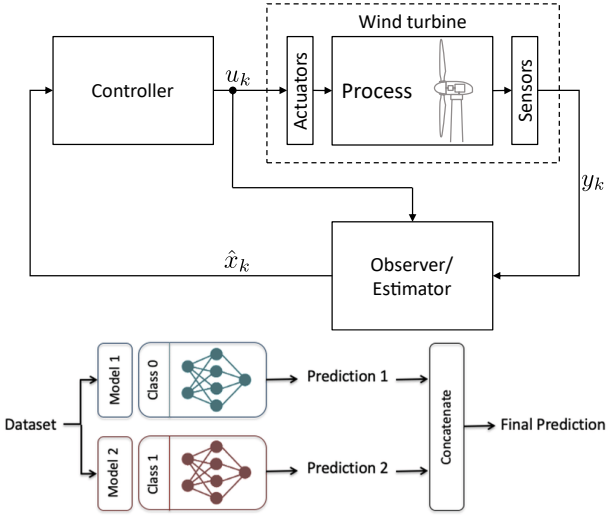
TECHNISCHE UNIVERSITÄT DARMSTADT

Project Seminar (3-4 People)

Wind turbines are highly nonlinear, dynamical systems with complex disturbances, such as varying wind speeds. In order to efficiently control such systems, modern wind turbine controllers (e.g. Model Predictive Controllers) need precise knowledge of the wind turbine system states. Since not all states can be measured directly, the use of state estimation techniques becomes necessary [1].

Over the course of this project, you will investigate the idea of using recurrent neural networks (e.g. LSTMs) to repeatedly estimate the system states of a wind turbine model [2] from the stream of measurement data. As the system dynamics of the wind turbine are of high order, it is necessary to estimate not only the positions of wind turbine components, but also their derivatives. While initial state estimation results already show promising estimation accuracy, we want to investigate possible approaches to further increase the observer performance, e.g., by leveraging the knowledge about the physical properties of the wind turbine model. Possible approaches include but are not limited to ensemble observer designs, e.g., using parallel network structures, and cascade observer designs, e.g., by chaining multiple neural networks. Additionally, this work requires some amount of hyperparameter optimization to maximize the observer performance.

For this project, background knowledge about neural networks is required, preferably including recurrent network approaches such as LSTMs. Experience in programming in Python/Pytorch is beneficial. The report will be written in English. If you have any questions, feel free to contact us.



[1] F. Häusser. Real-time capable State Estimation for a Wind Turbine Model. Master thesis, Institute for Automation Engineering, University of Magdeburg. 2020.

[2] https://github.com/jgeisler0303/CADynTurb

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