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PROFESSUR FÜR COMPUTERGRAPHIK UND VISUALISIERUNG
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Großer Beleg

Reinforcement-Learning Windturbine Controller

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Dresden, 17. Oktober 2019

Aufgabenstellung

0.1 Background:

Here at the HFI Experimental fluid mechanics group, we have developed an open source project called QBlade. QBlade is a simulation tool used for testing wind turbines in the hostile environment that they normally operate. We normally tackle problems of aerodynamic or structural optimization but we have also a research focus on the development of the control systems of the wind turbines. We currently have a research effort looking at developing cluster-based controllers building on the work of Professor Bernd Noack who is a guest professor at our group. In the last year or so (Nair, A. G., Yeh, C.- A., Kaiser, E., Noack, B. R., Brunton, S. L., & Taira, K. (2018). Cluster-based feedback control of turbulent post-stall separated flows. Journal of Physics Fluid Dynamics, (M), 1-32. Retrieved from http://arxiv.org/abs/1809.07220). AI projects such as openAI have enabled he rapid development of neural network in the field of control using reinforcement learning. The goal of this project is to use QBlade as a wind turbine simulator and attempt to control the pitch and rotor speed in a way that doesn't cause the wind turbine to shatter but instead to yield energy, i.e. reward and death condition. This first stage of work should be considered as exploratory but will hopefully open up avenues of controlling active flow control elements such as flaps.

0.2 Tasks

The major tasks of the project are as follows:

- Build up and interface between QBlade and python the model code so that an external code can run as a controller within a QBlade simulation.
- Gain a rough understanding of the mechanics of wind turbines and their controllers.
- Research reinforcement learning methods suitable for use as a windturbine controller and perform a literature review on these approaches.
- Create a reinforcement learning agent which uses the Qblade interface for controllers to control a windturbine.
  - Inputs to the agent could be defined by the standartized controller input format to Nordex turbines, which consists of 39 real-valued sensor-inputs. However, initial tests can be conducted with whichever inputs are easiest to tackle. If required, further hidden state from the simulation can be exported to enrich data quality. If aiming for industrial quality, more inputs

and also sensor faults could be optionally incorporated.

  - Outputs are in a minimum version pitch angles for the 3 blades and turbine torque. Optionally the agent should be able to control active element such as flaps on the blades.

- Optimize the agent to deliver maximum energy yield.
- Optimize under respect of certain boundary conditions (maximum pitch acceleration, maximum power, maximum blade load, blade touching the tower) and optionally other boundary conditions like long term turbine wear.
- If necessary for the training process, scale the simulation to run at a larger scale.
- Implement and attempt to get the agent to perform something close to sensible control of the wind turbine. Optionally evaluate the results against existing controllers and try to outperform them.
- Optionally, create a conference paper, poster or blog post etc.. on the results.

Selbstständigkeitserklärung

Hiermit erkläre ich, dass ich die von mir am heutigen Tag dem Prüfungsausschuss der Fakultät Informatik eingereichte Arbeit zum Thema:

Reinforcement-Learning Windturbine Controller

vollkommen selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt sowie Zitate kenntlich gemacht habe.

Dresden, den 17. Oktober 2019

Nico Westerbeck

Inhaltsverzeichnis

1 ein kapitel

1.1 eine Grafik

Abbildung 1.1: beschriftung

1.1.1 Etwas Mathe

$$\sum_{i=1}^{100} x_i$$

noch mehr text

1.1.1.1 Verweise auf Literatur

So kann ich Literatur aus literatur.bib zitieren: [**?**].

```
//comment
for(int i = 0; i < 100;i++)
{
test(i);
}
```

etwas quelltext text

[]

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