Introduction to Course

Prof. Dr.-Ing. David Schlipf

02.09.2024

Lecture #0
Controller Design for Wind Turbines and Wind Farms

Hochschule Flensburg
University of Applied Sciences

SWE Stuttgart Wind Energy @ Institute of Aircraft Design

Wind Energy Technology Institute

History

Course at the SWE - University of Stuttgart

- block seminar since summer semester 2017, 3 ECTS
- course for control engineers who want to learn more about wind
- organized by David Schlipf with the help of Holger Fürst, Florian Haizmann, Frank Lemmer, Viola Yu, and Steffen Raach

SWE Stuttgart Wind Energy @ Institute of Aircraft Design

Course at the WETI - Flensburg University of Applied Sciences

- lecture since winter semester 2018/2019, 5 ECTS
- course for wind engineers who want to learn more about control
- extended SWE course in agreement with SWE

Wind Energy Technology Institute

Skills

Acquired skills

The students are able to ...

- describe the basic dynamics of wind turbines
- design a baseline controller, basic filters and additional control loops for onshore and floating wind turbines and test and evaluate them in Matlab/Simulink
- generate wind fields for simulation, process lidar data and use them for feedforward control
- reproduce the challenges in wind farm control, explain basic wind farm control approaches, optimize wind farm operation with python

Required skills

- Tutorial for Matlab Onramp and Simulink Onramp
- Tutorial for python, e.g. from python.org
- Optional: Tutorial for LaTeX e.g. from overleaf

Organization

Lectures and exercises

The course is organized in

- lectures in the first block
- start of group exercises in the second block
- rest of group exercises in the afternoon

Examination and grading

Final report based on IEA Wind Task 52 Summer Games 24.

Schedule

02.09.	1	Controller Design Objectives and Modeling
03.09.	2	Baseline Generator Torque Controller
04.09.	3	Collective Pitch Controller
05.09.	4	Filter Design
06.09.	5	Tower Damper
09.09.	6	Advanced Torque Controller
10.09.	7	Wind Field Generation
11.09.	8	Steady State Calculations
12.09.	9	Individual Pitch Control
13.09.	10	Lidar-Assisted Control I
16.09.	11	Lidar-Assisted Control II
17.09.	12	Wind Farm Effects
18.09.	13	Wind Farm Control
19.09.	14	Floating Wind Control I
20.09.	15	Floating Wind Control II

About the lecturers - Prof. Dr.-Ing. David Schlipf

- Diploma Engineering Cybernetics in Stuttgart
- Dr.-Ing. about Lidar-Assisted Control [1] at SWE
- EAWE Excellent Young Wind Doctor Award 2016
- Postdoc at NREL about floating wind turbine control
- Founder of start-up sowento in 2016

- Operating Agent of IEA Wind Task Lidar 2016-2023
- Treasurer and Board Member of EAWE since 2017
- Research professor at WETI since September 2018
- Editor at Wind Energy Journal for controls since 2020
- Publications at Google Scholar, Scopus, University site

Some videos for basic control

- MATLAB - Everything You Need to Know About Control Theory
- Barry Van Veen - Power Spectrum Estimation Examples: Welch's Method
- MATLAB - Control Systems in Practice, Part 1-11
- Brian Douglas - PID Control - A brief introduction
- MATLAB - Understanding PID Control Part 1-7
- Brian Douglas - Bode Plots
- MATLAB - Introduction to State-Space Equations
- Brian Douglas - Transfer Functions
- DTU - Control of wind turbines and wind power plants

References

[1] D. Schlipf. “Lidar-Assisted Control Concepts for Wind Turbines”. PhD thesis. University of Stuttgart, 2015. DOI: 10.18419/opus-8796.

[2] S. Raach. “Lidar-assisted wake redirection control”. PhD thesis. University of Stuttgart, 2019. ISBN: 978-3-8439-4155-6. DOI: 10.18419/opus-11177.

[3] F. Lemmer. “Low-Order Modeling, Controller Design and Optimization of Floating Offshore Wind Turbines”. PhD thesis. University of Stuttgart, 2018. ISBN: 978-3-8439-3863-1. DOI: 10.18419/opus-10526.

[4] W. Yu. “Modelling, Testing and Application of Tuned Liquid Multi-Column Dampers for Floating Offshore Wind Turbines”. PhD thesis. University of Stuttgart, 2023.

Please let me know if you have further questions!

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