March 2016

Invitation
to the IEA Wind Task 32 Workshop #2 on

Optimizing Lidars for Wind Turbine Control Applications

Date: July 5th 2016
Venue: Boston Marriott Copley Place, Boston, MA, USA
Immediately preceding the 2016 American Control Conference
Workshop leader: Eric Simley, Envision Energy

Introduction to IEA Wind Task 32

The main objective of the Task 32 is to identify and mitigate barriers to the use of lidar technology in wind energy applications such as site assessment, power performance, loads & control, and complex flow. One yearly workshop is organized for each of the four applications focusing on one specific problem, and with a well-defined program and tangible outcome.
More details can be found on the task website.

Objective

Lidar-assisted control using preview wind information has become an important research topic in the wind turbine control community, and several lidar manufacturers offer forward-staring nacelle lidars that can be used for control purposes. The use of lidar-assisted control is currently limited to a few research turbines, but results are promising; during initial field testing collective pitch feedforward controllers have been able to successfully reduce rotor speed error. Additionally, control studies relying on simulation suggest that reductions in fatigue loads and blade pitch actuator effort as well as slight increases in power production can be achieved with lidar preview measurements.

One obstacle to the widespread adoption of lidar-assisted control is its multi- and interdisciplinary character. A thorough understanding of lidar measurement principles and limitations (e.g., reliability, accuracy, scan pattern capabilities, etc.) is mandatory for designing a control system. Also, detailed knowledge about wind turbine dynamics and controls is necessary to determine what types of lidar signals are useful for control. Since lidar and turbine manufacturers typically only know about their own part of the puzzle, current lidar systems are not necessarily optimized for wind turbine control applications.

The purpose of this workshop is to bridge the gap between lidar manufacturers and wind turbine control engineers by identifying lidar system properties that are well-suited for control applications while taking into account the capabilities of current lidar technology. Both the theoretical aspects of lidar system optimization (e.g., from the perspective of academia) as well as the practical aspects (with input from wind turbine manufacturers and the lidar industry) will be addressed. The overall objective is to produce a document based on the discussions at the workshop which will serve as a tutorial for optimizing lidar systems for control purposes.

Concept

In this workshop, the optimization of lidar systems for control applications will be addressed using input from wind turbine manufacturers, the lidar industry, and the academic community. The requirements or "objectives" of lidars for control purposes will be defined, particularly with suggestions from participants from wind turbine manufacturers. Lidar design considerations or "constraints" will be incorporated based especially on guidance from participants in the lidar industry. Lastly, models for calculating lidar measurement accuracy, based on contributions from the research community, will be used to determine the effectiveness of different lidar measurement strategies and help solve the lidar optimization problem. Specifically, a frequency-domain wind field model including a simple model of wind evolution will be used to determine measurement error. Transfer functions derived from linear dynamic wind turbine models will be used to analyze the impact of different scan patterns on important turbine variables. Additionally, time-domain control simulations will be used to investigate how practical issues such as measurement filtering and time-of-arrival uncertainty impact control performance.

The workshop will begin with invited presentations from participants from wind turbine manufacturers and lidar suppliers. Workshop attendees will then participate in collaborative exercises examining how different lidar parameters and scan patterns affect measurement quality. The program will also include roundtable discussions, allowing all participants to share their perspectives on optimizing lidar systems for control applications and help shape the outcome of the workshop.

Expected Outcome

A report describing requirements and recommendations for lidar systems for wind turbine control applications will be compiled based on the results of the workshop and any follow-up exercises. The report will contain both results from theoretical investigations and practical considerations. All interested participants are invited to contribute to the preparation of the report, which will be coordinated by the workshop leader. Follow-up meetings will be held remotely so that workshop attendees can collaborate on the document, with a target completion date of December 2016. Once finalized, the report is to be published as a tutorial paper in an appropriate journal, to be defined at the workshop, and made available to stakeholders in the lidar and wind energy communities.

Practical Arrangements

Registration

For participation in the workshop, please register by sending an email to the Operating Agent Representative David Schlipf (Email). Please state in your registration email:

- Name and institution, member country
- Please describe your stakeholder role (e.g., wind turbine manufacturer, lidar supplier, academic, ...)
- Will you have access to a laptop with MATLAB during the workshop?
- Following the workshop, will you be attending the American Control Conference?
- What specific topics would you like to see discussed at the workshop?

Please register before June 3rd 2016. Prior to the workshop, registered participants will receive additional workshop details and exercise materials as well as a pre-workshop survey.

Registration for the workshop is free of charge. Note that it is not necessary to register for the American Control Conference if you will only be attending this 1-day workshop.

Venue Information

The meeting will be held at the Boston Marriott Copley Place in downtown Boston, MA, USA. Note that the meeting immediately precedes the 2016 American Control Conference (ACC) to be held July 6th-8th, also at the Boston Marriott Copley Place.

The 2016 ACC will contain several invited sessions on wind energy, with topics including lidar-enhanced control and wind plant control. Therefore, workshop attendees may be interested in combining the workshop with the American Control Conference.

Additional information about the workshop venue, including transportation and lodging information can be found via the ACC website here. The ACC technical program is available here.

Detailed information about the meeting room and workshop logistics will be made available on the workshop website (www.ieawindtask32.ifb.uni-stuttgart.de/workshop-2) and sent to registered participants once finalized.

Contact Information

Please contact Eric Simley, workshop leader at or David Schlipf, IEA Wind Task 32 Operating Agent with any questions you may have about the workshop.

Program Draft

8:30	Welcome and introductions
9:00	Introduction to lidar-assisted control (invited presentation)
9:45	Requirements and objectives of lidar systems for control purposes from the wind turbine manufacturers' perspective (invited presentations)
10:30	Coffee break
10:45	Design considerations and constraints for lidar systems for control purposes from the lidar industry's perspective (invited presentations)
11:30	Roundtable discussion on current barriers for lidar for wind turbine control and how they can be mitigated (group discussion)
12:30	Lunch
1:30	Sources of lidar wind speed measurement error for control applications and numerical estimation of measurement error (presentation by workshop leader)
2:15	Exercise 1: Investigating how lidar parameter and scan pattern choices impact measurement quality (group exercise)
3:15	Coffee break
3:30	Exercise 2: Investigating how practical issues, including measurement filtering and wind speed time-of-arrival uncertainty, impact controller performance (group exercise)
4:30	Roundtable discussion on lidar system optimization for control applications (group discussion)
5:30	Workshop wrap-up and formulation of next steps, including continuing exercises and preparation of the final report (group discussion)
6:00	End of workshop
7:30	Dinner

Expected Participants

Engineers from wind turbine manufacturers with control experience, engineers and scientists from nacelle-lidar manufacturers, researchers, and academics.