Wind turbine and wind farm control: Control challenges and solutions (session code: 1w49h)

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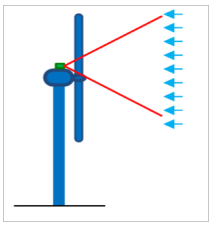
Abstract: Controls research plays an important role in wind energy. Advances in controls are making wind turbines more efficient, more reliable, and more cost-effective. Wind turbines have evolved from passively controlled machines to actively controlled machines, and more recently, to distributed machines controlled collectively (wind farms). With this open session, we invite researchers to present their latest results in wind energy control. The attendees of these sessions will learn how controls research can make substantial contributions to wind energy, and they will also get an overview of the latest developments and open issues. Example contributions include: 'smart' rotor control, lidar-based control, control of floating turbines, and wind farm control.

1. Smart rotor control (novel actuators)

There are a number of concepts for the next generation of wind turbines. For many concepts, loads (both extreme and fatigue) represent critical design drivers. In current wind turbine designs, this is solved by the mechanical design and collective pitch control. In the previous IFAC World Congress, we discussed that the current set of actuators is not a feasible solution for larger and more flexible machines, consequently more advanced concepts are required.

One advanced operational concept is to use a number of actuators that locally change the force profile on the wind turbine blade to cope with the spatial distributed nature of turbulence. This, in combination with sensors that measure the loads and a controller that manipulates the measured signals and generates an appropriate actuation signal, is defined as the 'smart' rotor concept. We invite researchers with novel control concepts to submit their paper(s) to this open invited track.

2. Lidar-based control



Lidar technology allows direct measurement of the wind approaching the turbine. Because the wind is both the source of energy and the primary disturbance, this information is potentially useful for improving any control loop within the turbine. Pitch and torque control can be improved by applying a feed-forward action in response to incoming changes in the wind, such as gusts. The availability of a predictive measurement of the main disturbances also enables the use of Model Predictive Control algorithms. The direct measurement of the incoming wind also gives an estimate of available power for improving grid-support services. Finally, rear-facing lidars can also improve wake control. Papers covering lidar-based control are invited for this open invited track. Lidar-assisted control is also very promising for large floating offshore wind turbines.

3. Control of floating wind turbines

By placing a wind turbine on a floating platform, large areas of high-wind resource become possible sites for large wind power plants. Additionally, such offshore turbines can be assembled at a port and towed to their locations. One of the primary difficulties of this approach is controls-related: the floating system is more dynamic and potentially closed-loop unstable. Wind turbine controllers must now, on top of their existing objectives of power production and load regulation, avoid large platform oscillations and accommodate wave disturbances. We invite papers which examine solutions to this complicated problem.

4. Wind farm control

Until recently, wind turbine control has been optimized at the single turbine level. However, it is known that turbines collocated in a farm interact with each other through their wakes. Studies have shown that because of this interaction, control strategies that are optimal for individual turbines can be sub-optimal at the wind farm level. Designing a wind farm controller, or turbine-to-turbine distributed control strategy, which can outperform individual turbine only control is the focus of research at several centers. We invite papers documenting new results in the wind farm control area.