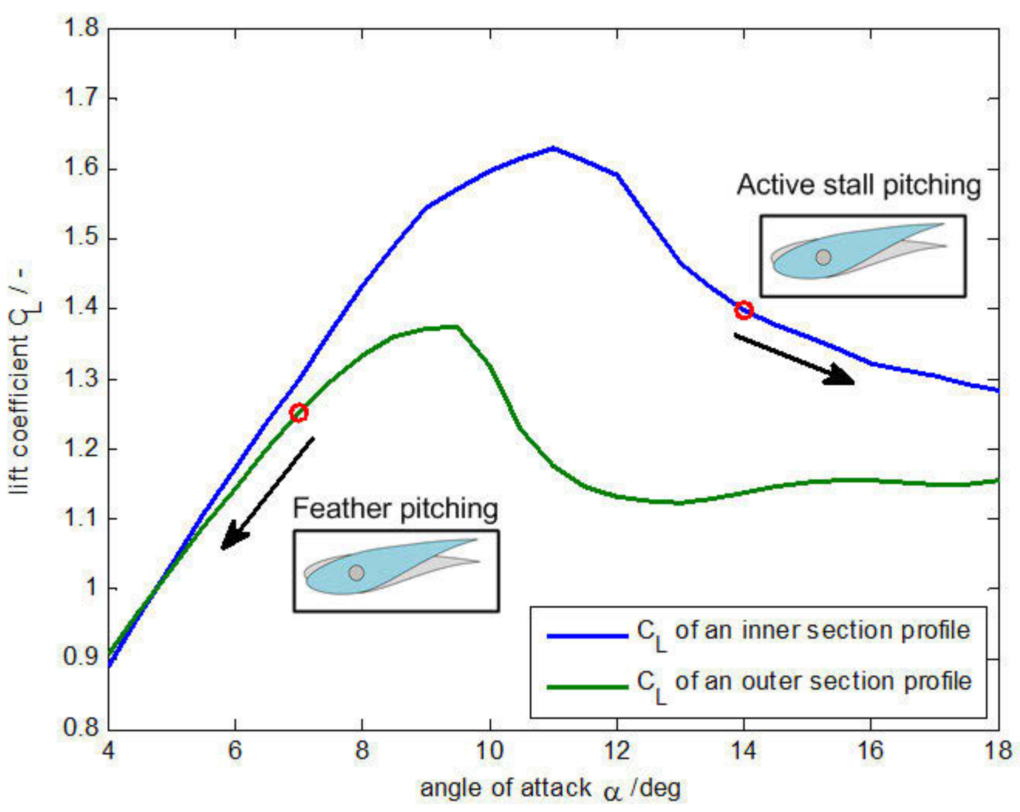
PO.109

Dual pitch revisited: Overspeed avoidance by independent control of two blade sections

P. Brosche, B. Fischer, P. Loepelmann, M.Shan
Fraunhofer IWES Kassel, Dept. Control Engineering

Fraunhofer IWES

Summary



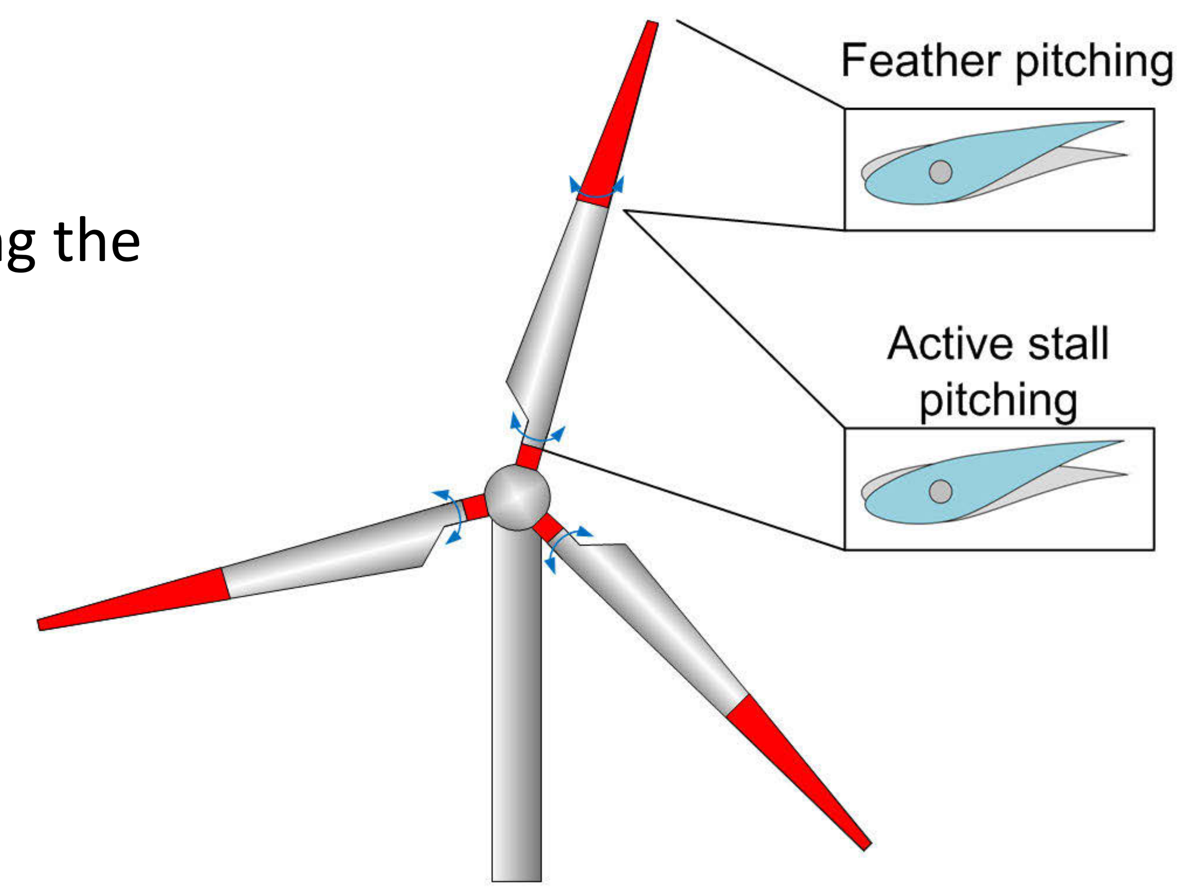
Lift coefficients for outer and inner section profiles.

Fast, coherent changes of wind speed during normal operation typically challenge the wind turbine's control system and can lead to

- ultimate loads
- and overspeed trips.

Here, we demonstrate that independently controlling the aerodynamic forces along the blades' span can significantly reduce the risk of overspeeds in such situations.

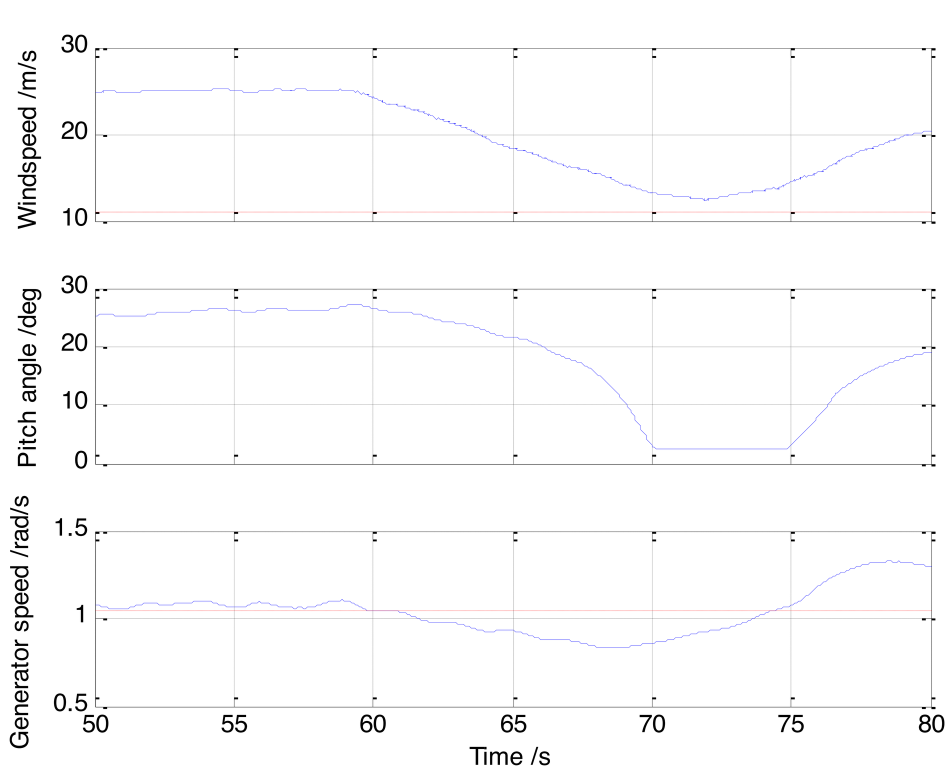
Reductions of the maximum rotor speed of more than 10% of rated speed are feasible.



Division of blade sections on large-scale wind turbine for dual pitch

In our research project on control systems for the reduction of extreme loads of large-scale wind turbines we consider pitching the outer section of the blade independently from the inner section. This provides the potential to improve the effectivity of the control system during this operating condition.

Background



Changes in wind speed, pitch angle and generator speed during considered extreme event including rated values.

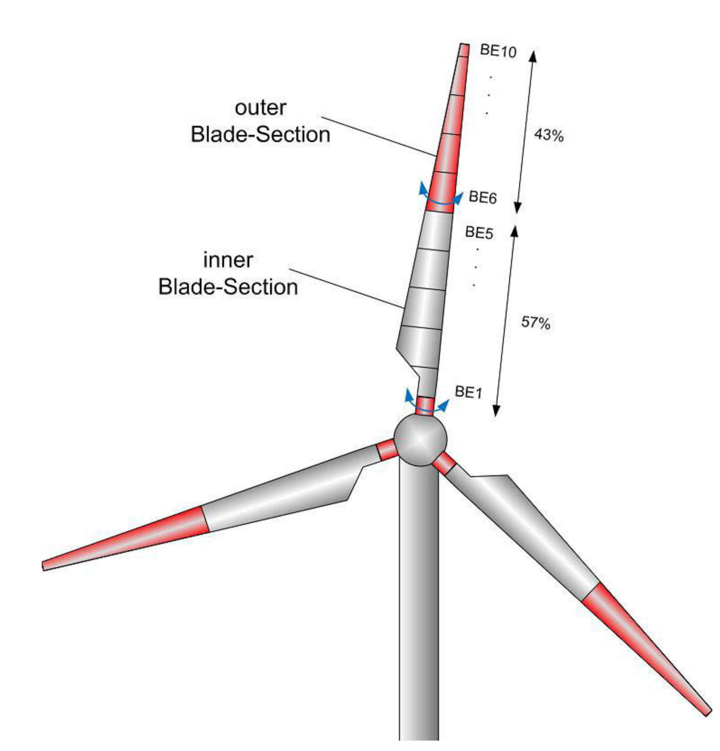
The large loads and rotor speeds are the result of the pitch controller acting too slow. During such an event there is a point in time at which the rotor speed is low, the blade pitch angle is small, and the wind speed increases rapidly. This leads to high rotor thrust force and aerodynamic torque.

Thus, in this extreme event situations, pitching the outer part towards feather and the inner part in the opposite direction (active stall) leads to better results regarding overspeed prevention and tower load reduction.

Approach

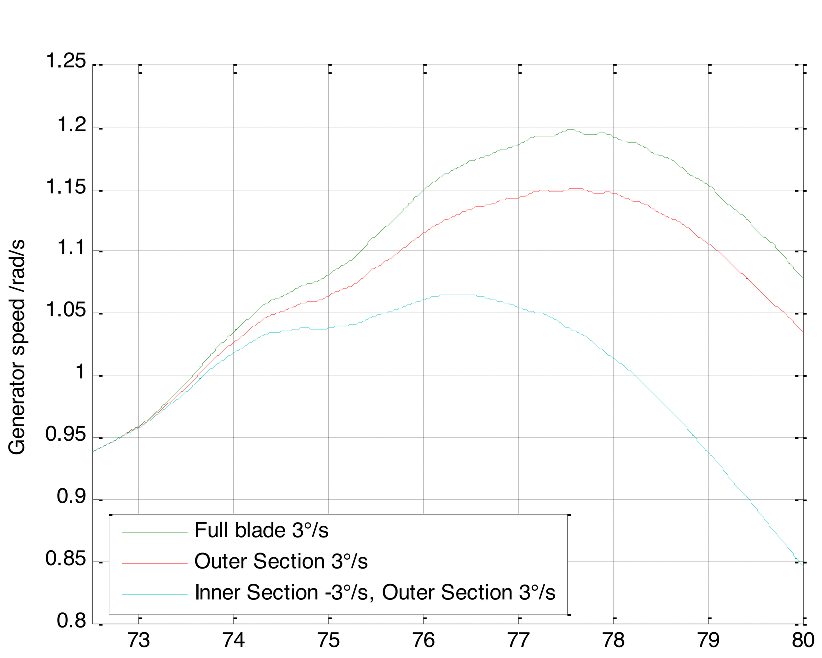
The blade is divided into two sections: the outer section from element 10 (blade tip) to element 6 and the inner section from element 5 to element 1 (blade root). Three kinds of feed-forward pitch manoeuvres are being investigated:

a. Full Blade 3 deg/s: pitching the entire blade towards feather with a constant rate of 3 degrees per second
b. Outer section 3 deg/s: pitching only the outer blade section towards feather with a constant rate of 3 degrees per second
c. Inner section -3 deg/s, Outer section 3 deg/s: pitching the outer blade section towards feather with a constant rate of 3 degrees per second and counter-rotate the inner blade section towards stall



Numerical Results

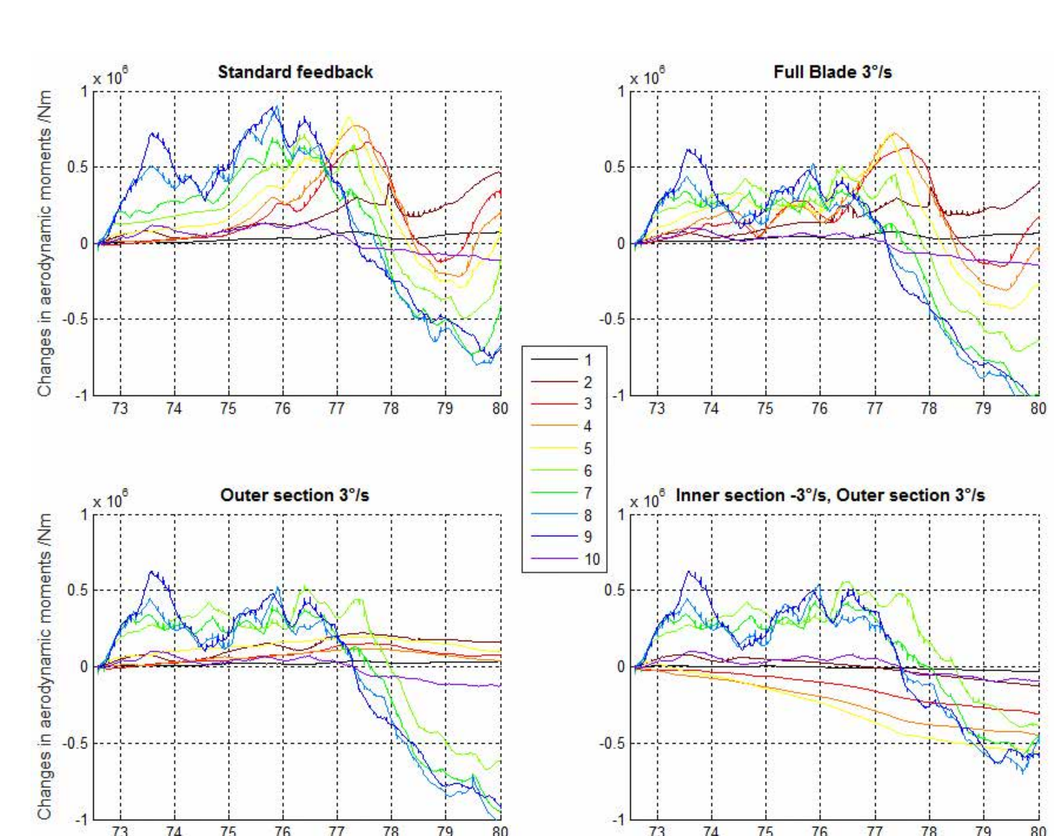
The development of the generator speed beginning at the trigger point 6 s before the extreme event occurs at 78.58 s.



Generator speed during an extreme event using different strategies of section movements

a. One would expect that this manoeuvre leads to the greatest reduction of the aerodynamic moment as well as generator speed.
b. Fixed inner section pitch leads to improved aerodynamic moment reduction.
c. Counter-rotating the two blade sections: The reduction of generator speed is even greater.

The corresponding changes in aerodynamic forces.



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