Use of HD Video to investigate stall on a wind turbine

Nigel Swytink-Binnema and David Johnson

Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, Canada

Wind turbines must withstandand operate reliably installed flow conditions. Hence, it is useful to quantify the amount and nature of the stall which develops on a blade under different inflow conditions. While others have studied this using pressure data combined with short (15 minutes) flow visualisation (ex. [1]), the present study uses only long time-period (14 hours) flow visualisation to investigate this phenomenon. Tufts of yarn were attached to the blade of a 10 m diameter instrumented wind turbine installed west of the city of Waterloo. A GoPro HD camera was mounted at the base of the blade to record the tufts during wind turbine operation. Camera control and subsequent video retrieval was achieved through a local wireless network. An algorithm was developed in MATLAB to determine, in video of the outer 40% of the blade span, which tufts were oriented in a direction other than the main flow direction. These tufts were tagged as stalled and the fraction of stalled tufts was calculated for each frame of video. Results from 3.5 hours of video on May 12, 2013 show a consistent trend in the stall fraction, ζ: the highest ζ was observed on the downward-moving blade; the lowest on the upward-moving blade. It is unclear whether this is a result of dynamic stall, wind shear profile, or another parameter. However, this trend remains strong when filtering based on other monitored parameters. Further, statistical analysis shows a significant difference between the means, with a p-value of much less than 0.001. Video from other days will be analysed to confirm the trend.

[1] A. Bruining, Observations of unsteady aerodynamic effects from pressure distributions on a rotating wind turbine blade, in EWEC 1994 Conference Proceedings, 1994, pp. 675480.