Production Cycle Optimization for Pumping Airborne Wind Energy

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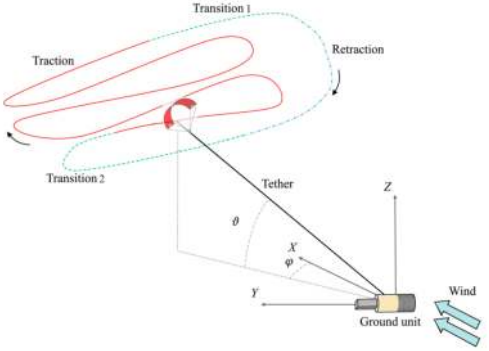
The work aims at increasing the efficiency of an airborne wind energy (AWE) system with soft wing flying in cross-wind motion while avoiding that the force on the tether and on the sail increases during the transition phase.

In this AWE systems, power generation occurs in cycles, each consisting of a traction phase where the cable is unwound and a phase called retraction where the cable is rewound. Transition phases are required to go from the traction phase to the retraction phase (Transition 1) and vice versa (Transition 2).

The simulation model adopted follows the approach presented in [1]. The implementation of a control strategy for the Transition 1 phase ensuring the desired tether force behaviour is a crucial aspect affecting the component's lifetime and the system safety. Two different control strategy were developed. The first one exploits the measure of the wind and ensures that the winch controller follows the desired reeling speed profile. The second implementation does not rely on wind measurements, which are often unreliable and not suitable for real world applications.

Once a solution to this problem was found, an optimization routine was run in order to determine the optimal trajectory for the kite during the transition phase and the optimal reeling-in and reeling-out speeds. Simulations results show an increase on the average cycle power of 3-5%. The optimization was performed considering varying the wind speed in given range and the results show that a sub-optimal trajectory can be found independently from the wind speed without losing efficiency on average cycle power.



Production cycle phases of a pumping AWE system equipped with a soft kite. Adapted from [2].

References:

[1] Fagiano Lorenzo Mario. Control of Tethered Airfoils for High-Altitude Wind Energy Generation. PhD thesis, Politecnico di Torino, 2009.

[2] L. Fagiano and S. Schnez. On the take-off of airborne wind energy systems based on rigid wings. Renewable Energy, 107:473–488, 7 2017.