Windswept and Interesting Ltd. rotary network AWES with rigid blades (15 September 2019)

Modeling Studies on Tensile Rotary Power Transmission for Airborne Wind Energy Systems

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Rotary airborne wind energy (AWE) systems are a class of AWE that utilize multiple wings arranged to form a rotor. They rely on auto-rotation to provide both aerodynamic lift and torque. There are several rotary systems currently under development, among them the Daisy Kite developed by Windswept and Interesting Ltd, introduced in [1]. A rotary AWE system must transfer power from the airborne components down to the ground, either mechanically or electrically. The Daisy Kite employs a mechanical method referred to as tensile rotary power transmission (TRPT) system.

TRPT takes the aerodynamic torque produced by the rotor, and through a series of taut lines held apart by rigid components, transmits the torque down to the ground. From model-based analysis of the steady state case of the Daisy Kite, it can be stated that the line tension, the diameter of the rings and the distance between the rings are the three key factors affecting torque transmission performance. By analyzing the steady state line drag it is found that the transmission efficiency varies greatly depending on the operating condition. Based on the operating conditions during field tests the current Daisy Kite prototype has drag losses of around 7% within the TRPT.

A dynamic representation of the Daisy Kite's TRPT was developed through derivation of the non-linear equations of motion. The dynamic response was then analyzed using a numerical integration method. While the steady state analysis gives the maximum allowable steady torque that the TRPT can transmit, the dynamic representation can additionally show the maximum change in torque that can be transmitted and the transmission time for a given operating state. The dynamic representation can be used to improve the Daisy Kite's design and optimize the systems operating strategy.

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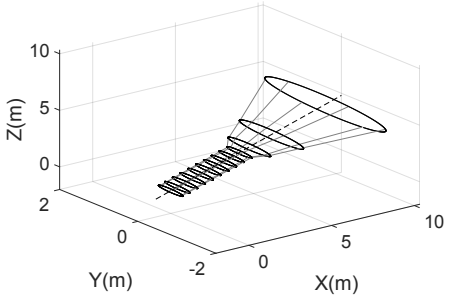

Graphical representation of the TRPT used in the Daisy Kite system.

References:

[1] Read, R.: Kite Networks for Harvesting Wind Energy. Airborne Wind Energy Advances in Technology Development and Research. Singapore: Springer, pp. 515-537 (2018). https://doi.org/10.1007/978-981-10-1947-0_21