Application of the Estimation-Before-Modeling Method to the Aerodynamic Characterization of Power Kites

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The aerodynamic characterization of kites is of paramount importance in the analysis of kites applied to wind energy generation because it is a key component of flight simulators. However, due to flexibility effects of the kite structure and the typically large sideslip and attack angles, severe difficulties arise.

This work applies a Estimation-Before-Modeling (EBM) method, a widespread technique in aerospace engineering that makes use of data obtained during flight testing, to the aerodynamic characterization of power kites with four control lines. The procedure includes two main steps: an estimation phase and a modelling phase.

The estimation phase involves a Kite Estimator (KE) that receives a comprehensive set of measurements and provides the time history of the state vector of the system. In this phase, aerodynamic forces and moments are components of the extended state vector of the kite and they are estimated from the measurements by using stochastic filtering and smoothing techniques. The KE has been fed with experimental data obtained during a test campaign with two different power kites (10 m^2 and 13 m^2).

In the modelling phase, a multivariable regression algorithm has been used to determine the nonlinear coefficients of the aerodynamic model. The regression algorithm compares the aerodynamic forces and torques provided by the KE and the one computed theoretically with a flight simulator of a four-line kite.

The accuracy of the aerodynamic model obtained with the EBM technique was assessed by comparing time histories of the experimental trajectories and the one provided by the kite simulator updated with the new aerodynamic model.

Flight tests of an instrumented 13 m^2 *COTS kite.*

References:

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