System Identification, Adaptive Control, and Experimental Measurements of a Pumping Kite Power System

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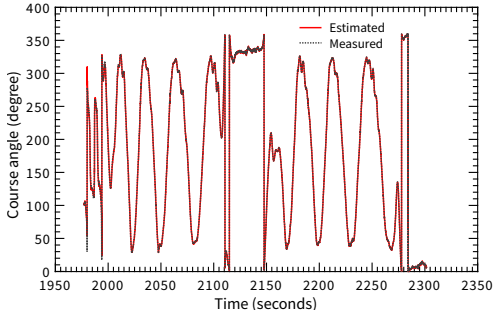
This work demonstrates the derivation of the equations governing the operation of a kite power system, followed by adaptive control with time-varying gains. Because the available mathematical kite models are generally derived with aggressive assumptions, we use least square estimation as a system identification (SI) algorithm [1] to predict the kite parameters in real-time and compare between the measured and expected course angle to check the accuracy of the model as shown in the figure. The SI algorithms are chosen to minimize the computational effort per time step.

Two different controllers are tested separately to stabilize the kite motion; the first controller is a fuzzy controller which is chosen due to its strength in stabilizing non-linear systems. The other controller is an adaptive pole placement controller which updates its control gains in real-time depending on the parameters generated from the SI algorithms. The SI algorithms with fuzzy and adaptive controllers are compared with the mathematical model of the fixed-tether-length kite system with PID controller at different wind conditions.

The novelty of this work is to predict the governing equation of the kite in real-time. Thus, the change in kite's size, wind speed, and tether length [2] would be updated in the mathematical model of the kite. Moreover, the governing equations resulting from the SI algorithms are used to design an adaptive controller that adapts its gains in real-time based on the change of the governing equations of the kite.



Time history of the estimated and the measured course angle.

References:

[1] De Groot, S. G. C., Breukels, J., Schmehl, R., and Ockels, W., "Modelling Kite Flight Dynamics Using a Multibody Reduction Approach". Journal of Guidance, Control, and Dynamics, Vol. 34, No. 6 (2011), pp. 1671–1682. DOI:10.2514/1.52686

[2] Jehle, C. and Schmehl, R., "Applied Tracking Control for Kite Power Systems". Journal of Guidance, Control, and Dynamics, Vol. 37, No. 4 (2014), pp. 1211–1222. DOI:10.2514/1.62380