Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2018-46-SC5, 2018

WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Aerodynamic characterization of a soft kite by in situ flow measurement" *by* Johannes Oehler and Roland Schmehl

M. De Lellis

marcelo.lellis@ufsc.br

Received and published: 15 August 2018

This paper addresses an important topic for the further development of AWE technology: the aerodynamic characterization of soft kites, such as the leading-edge inflated (LEI) tube and the ram-air kites. Even though a significant number of players in the AWE community have migrated in recent years to "rigid" (airplane-like) wings, AWE concepts based on soft kites continue to be developed and studied by some groups due to advantages such as low materials cost and facilitated transportation, assembly and maintenance/replacement.

As well pointed out by the authors, differently from what is common for the rigid wing

case, wind tunnel tests are very difficult (if not unfeasible) to be carried out for the identification of the coefficients of aerodynamic lift and drag of a soft kite. However, for tasks such as flight trajectory optimization, it is of fundamental importance to know such aerodynamic properties of the kite. In other words, one question to be answered is: "how do the angle of attack and the coefficients of lift and drag (which impact the tether traction force and hence the reel-out/in power) depend on control inputs such as the steering and the powering/pitching commands"? Understanding how these variables are correlated would allow us to design more efficient and robust flight trajectories in a pumping cycle.

This paper, which is rich in technical details about the prototype setup, methodology and discussion of the results, sheds some light on the problem based on field-test data with LEI tube kites. Plots of the lift-to-drag ratio (CL/CD) and the lift coefficient (CL) are presented and discussed, in real flight situations involving different heading angles, apparent wind speeds, powering settings and steering inputs. The presented results seem to corroborate a behavior so far assumed for the soft kites: as the powering setting is reduced in order for the reel-in phase to begin, the CL/CD falls, allowing for the tether to be recovered with only a minor expense of energy. Also, the behavior of the CL/CD ratio as function of the angle of attack seems to roughly match, in a span from -5 deg to 15 deg, some curves found in the literature and so far assumed representative for soft wings, which were adapted from the rigid wing case in an ad-hoc fashion. Also, from the results it can be clearly seen that steering commands of high intensity cause a significant decrease in CL/CD as well, which is something to keep in mind when defining the curvatures of the flight trajectories in the reel-out phase (usually a "lying eight" figure).

In my opinion the analysis performed in this work could be further refined by using filters, such as the Kalman Filter and its variations (the Extended and the Unscented Kalman Filter, for instance). The idea is that these filters incorporate what is known about the system (flight) dynamics, perhaps based on dynamic models such as the point-mass kite. In this way not only problems such as outliers in the plots could be better handled, but also the uncertainty/variance in the variables directly measured could be minimized. The more inputs (measurements) are available (fed) to the filter, the better is the filtering performance. A preliminary work in this direction was carried out by Schmidt et. al. (2017).

Congratulations to the authors on the excellent work.

References:

E. Schmidt, M. De Lellis, R. Saraiva, and A. Trofino. State estimation of a tethered airfoil for monitoring, control and optimization. In Proceedings of the 20th IFAC World Congress, volume 50–1, pages 13246 – 13251, Toulouse, France, July 2017. IFAC. doi: 10.1016/j.ifacol.2017.08.1960

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2018-46, 2018.