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Simulation, state estimation, and aerodynamic parameter identification from in-flight data are actual research topics in AWE [1,2]. This work summarizes the status of four infrastructures developed at Universidad Carlos III de Madrid that are related with them: (i) a portable experimental rig for the acquisition of flight data like kite position, velocity, Euler angles, angular velocity, aerodynamic speed, angle of attack and sideslip angles, tether tensions, and wind velocity, (ii) an estimator of the state of the system, including the aerodynamic force and torque (iii) an optimization algorithm to compute the aerodynamic parameters from the estimated state variables, and (iv) the open-source simulator LAKSA, that contains modules aimed at the dynamic simulation and control of fly-gen and ground-gen generation systems, 2-line acrobatic kites, four-line kitesurf kites, and a train of N stacked kites.

These four tools have been applied to two four-line flexible kites of different surfaces and stiffness (Cabrinha switchblade, 10m^2, 5 struts and Cabrinha Contra, 13 m^2, 3 struts) and a 2-line acrobatic rigid frame kite (Fazer XXL, 3.6m wingspan). The full state vectors of the three kites were reconstructed and a data set with the aerodynamic force and torque, angle of attack and side slip angle for different maneuvers was created. However, difficulties arose for the aerodynamic parameter identification because the kites spent most of the time in a post-stall state during the flight. This conclusion, which is evident from the lift and drag coefficients versus angle of attack curves, was corroborated by the direct measurement of the angle of attack. Experimental and simulation results are presented together with a critical review of the capabilities of the infrastructures.

Flight testing of an acrobatic rigid framed kite.

References:

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