A kite-based generator for airborne wind energy: modelling and optimisation

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Using kites to collect wind power and generate energy has been intensively studied in the last decade, see *e.g.* the survey by M. Diehl *et al* in [1]. In the framework of the KEEP (Kite Electrical Energy Power) funded by CNRS and gathering researchers from ENSTA Bretagne (well acquainted with the topic after previous studies on kites [2], most notably for boats [3]) and Université Côte d'Azur, we are interested in the analysis of a simple device composed of a kite attached to an arm ; having the kite running along a well chosen curve will move the arm and generate electric power. We first build a simple point-mass mechanical model where the kite motion is prescribed to a conical surface modelled on an eight curve. The resulting differential equation can be expressed either as (i) a 5-dimensional second order DAE, or (ii) a dimension 2 second order ODE. For well chosen initial conditions, numerical integration of these two equivalent descriptions exhibit a limit cycle. Analysing this cycle allows to determine which type of force (control) must be employed in order to remain on such an eight-shaped periodic curve. We report on a preliminary sensitivity analysis of the power generated by this cycle *wrt.* finite dimensional parameters of the device.

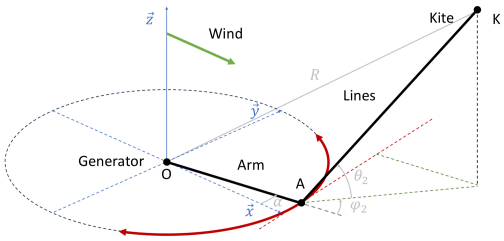

FIGURE 1 – arm + kite device. The generator in O is coupled to the kite in A through the rigid arm from O to A and the lines from A to K.

[1] U. Ahrens, M. Diehl, R. Schmehl, eds. *Airborne Wind Energy.* Green Energy and Technology. Springer, 2013. doi :10.1007/978-3-642-39965-7.

[2] K. Desenclos, A. Nême, J.-B. Leroux, C. Jochum. *A novel composite modelling approach for woven fabric structures applied to leading edge inflatable kites.* Mechanics of Composite Materials, **58(6)**, 867–882, 2023.

[3] V. Podeur, D. Merdrignac, M. Behrel, K. Roncin, C. Fonti, C. Jochum, Y. Parlier, P. Renaud. *Fuel economy assessment tool for auxiliary kite propulsion of merchant ship.* Houille Blanche, **1**, 5–7, 2018.

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