Guaranteed Collision Avoidance in Multi–Kite Power Systems

Fernando A.C.C. Fontes[1], **Luís Tiago Paiva**[1,2]
[1]University of Porto
[2]Polytechnic of Porto

Fernando A.C.C. Fontes

Associate Professor
University of Porto
Department of Electrical and Computer Engineering
SYSTEC – Institute of Systems and Robotics

Rua Dr. Roberto Frias
4200–465 Porto
Portugal

faf@fe.up.pt
www.upwind.pt

Kite power systems that aim to harvest high altitude winds may have long tethers that span areas with a radius of several hundreds of meters. An efficient use of land, not using wings with huge areas, is obtained when multiple kite systems are used. When a set of kites is densely packed in an area to further increase the efficiency in the use of land, a collision avoidance system must be developed.

One of the main challenges of the collision avoidance system involves guaranteeing that the constraints imposed along the trajectories of each kite are in fact satisfied for all times. The problem is relevant and non–trivial due to the fast moving of the kites and the fact that it is only possible to verify the constraints at a discrete set of times, with a limited sampling rate.

Here, we adapt to the multiple–kite system scenario a recently developed condition for state constrained optimal control problems, that when verified on a finite set of time instants (using limited computational power) can guarantee that the trajectory constraints are satisfied on an uncountable set of times. For the constrained nonlinear optimal control problem that results from the multi–kite maximal energy problem, we develop an algorithm which combines a guaranteed constraint satisfaction strategy with an adaptive mesh refinement strategy.

References:

[1] Paiva, L.T. and Fontes, F.A.C.C. : Adaptive Time-Mesh Refinement in Optimal Control Problems with State Constraints. Discrete and Continuous Dynamical Systems ***35****(9), 4553–4572 (2015).*

[2] Fontes, F.A.C.C. and Frankowska, H.: Normality and nondegeneracy for optimal control problems with state constraints. Journal of Optimization Theory and Applications ***166****(1), 115–136 (2015).*

[3] Fontes, F.A.C.C. and Paiva, L.T.: Guaranteed Constraint Satisfaction in Continuous–Time Control Problems. (In review, 2017).

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO