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# Airborne Wind Energy Farm Layout and Optimization

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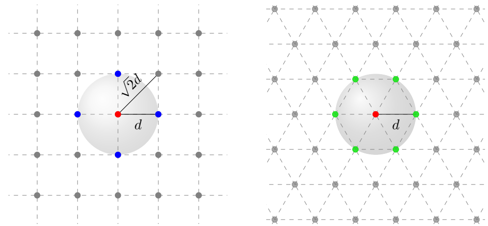
We address the design and optimization of an airborne wind energy farm. In particular, we study the problem of deciding the number, location, and flight envelope, of each AWE unit, aiming to maximize power production while avoiding collision among kites.

We consider a conic shaped flight envelope within which each kite system is allowed to fly. We parameterize this envelope by the azimuth angle span, the elevation angle span, the elevation angle offset, as well as the maximum and minimum tether lengths. While a broad flight envelope and low elevation angle permits a large power production per kite, a narrow envelope and high elevation angle allows to place more kites within a terrain area. Given a specific land area, we optimize the combination of the farm layout with the flight envelope of each kite in order to maximize the total power production.

In a first stage, the total power production of each kite is estimated by an explicit formula that takes into consideration the kite characteristics, the envelope constraints, the loss of efficiency due to the cubic cosine law as well as the loss of efficiency due to the actuation on the kite roll angle. Initial estimates for the number of kites in each of the land dimensions, the envelope parameters, and the corresponding power generated are computed by an heuristic method. We explore two possible layout patterns, a squared layout (the most standard layout) and a hexagonal/triangular layout (our proposal), since each of these might allow to place more kites within the area for different ratios between the land area dimensions and the minimum distance.

In a second stage, the obtained estimates are used as initial solutions in a population based global optimization method, a Biased Random Key Genetic Algorithm [1]. In this algorithm, several combinations of the number of kite units, location, envelope parameters are evolved, evaluated and ranked, in order to maximize the total power production of the kite wind farm [2].




*Wind farm layout with squared pattern (25 kites) and hexagonal pattern (39 kites) for the same minimum distance among kites, d, and the same land area.*

*References:*

*[1] Roque, L.A.C., Fontes, D.B.M.M., Fontes, F.A.C.C.: A Hybrid Biased Genetic Algorithm Approach for the Unit Commitment Problem. Journal of Combinatorial Optimization, 28, pp. 140–166 (2014).*

*[2] Roque, L.A.C., Paiva, L.T., Fernandes, M.C.R.M., Fontes, D.B.M.M., Fontes, F.A.C.C.: Layout optimization of an airborne wind energy farm for maximum power generation. Energy Reports, 6, pp. 165–171 (2020).*