Master Thesis

Transitioning Control of a Drag Power Kite

Contact/Applications to:

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Motivation

Power generating kites have the potential to generate clean energy with 10x less material demand and at a very low cost (see e.g. [1, 2, 3] and references therein). "Drag power" kites generate power with onboard wind turbines and generators by flying fast crosswind motions, see Fig. 1 with video link in the description. Electrical power is transmitted to the ground at a medium voltage level via electric cables in the tether.

Figure 1: Flying Kitekraft demonstrator. (Video available online: https://youtu.be/42jvQpgfm94, accessed: Jan 11, 2022).

Tasks, Suggested Solution Approach, Expected Results

The TUM spinoff and project Kitekraft is developing and researching drag power kites. In the beginning of a power generation flight mission, the kite hovers, then transitions into crosswind

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flight (figure eights flight), transitions back to hovering when the wind dies, and lands. For hovering and flying figure eights, a vast number of publications exist and is basically solved satisfactory. However, no publications are known dedicated for transitioning. A basic well working and experimentally demonstrated control scheme for transitions exists in this project. However, the control scheme must be extended and statistically checked (Monte Carlo Simulations), which shall be the task of this master thesis. For example, launch manuever must be extended to for higher wind speeds in which the kite is positioned at downwind and must accelerated diagonally (slightly right or left) upwards instead of straight upwards as currently implemented. It is highly desirable to have a fundamentally/theoretically backed approach including theoretically backed parametrization, possibly also formally proven for stability (control theory/system theory), tested in simulation, and tested on our flying demonstrators. Besides the documented software, the master thesis as theory documentation and tests report are important outcomes. This multidisciplinary task is supported by the members of the Kitekraft team.

Starting Point

This announcement, the literature list below, and additionally provided internal documents upon start.

Report and Presentation Guidelines

One report (or thesis) and at least one presentation of the results are required. Guidelines and templates can be downloaded from https://github.com/floba/StudentGuidelines.

Your Profile

This student work will be jointly supervised by the Institute for Electrical Drive Systems and Power Electronics and the TUM startup project Kitekraft. The ideal candidate

- is a student in flight dynamics engineering, control, math, robotics, mechatronics, electrical engineering, mechanical engineering, informatics, or related fields,
- has good skills/background knowledge in control theory, math, MATLAB, C/C++, Office, LaTeX,
- is motivated in the respective field of science and engineering,
- has good English and German language skills.

References

[1] M. Loyd, "Crosswind kite power," Journal of Energy, vol. 4, no. 3, pp. 106–111, 1980.

[2] U. Ahrens, M. Diehl, and R. Schmehl, Eds., Airborne Wind Energy, ser. Green Energy and Technology. Springer Berlin Heidelberg, 2013.

[3] Kitekraft: Website, https://www.kitekraft.de, accessed: Jan 11, 2021.