

Referee Comment #3 - WES-2024-170

Summary

The paper presents the significant extension of an existing small-scale test bed for airborne wind energy.

The choice of wing structure is a rigid-framed delta kite, a concept which is also being pursued by the company Enerkite, one of the more advanced AWE companies. The kite is controlled from a ground station via three lines, allowing steering and pitching of the wing and reeling in and out. Next to the advancements with respect to hardware (adding the third line, line tensionmeters and load cells), the main contribution is the development and experimental validation of a PID-controller based on a mixed waypoint/continuous reference path. The flight experiment data are then utilized to develop models for some of the system subcomponents.

The paper is written very well and provides an extensive overview of the existing literature and state-of-the-art. Overall, it is a novel and interesting addition to the existing body of experimental AWE work and can provide a useful resource for practitioners and researchers alike.

We are glad to know this positive opinion of the Reviewer about our work.

Minor comments:

- Some more context could be provided to motivate the choice of control strategy. Why was this specific strategy chosen, what are its advantages and limitations, in particular in comparison with existing (published) strategies for delta kites?

We thank the Reviewer for raising this point because probably it was not highlighted enough in the Introduction. To the best of the authors' knowledge, most of the previous scientific articles on AWE guidance and control was focussed on single-line soft kites and fixed-wing aircraft and the available (open) literature on multi-tethered delta kites is scarce. We decided to choose a guidance strategy based on attractor points because it is simple and it has been extensively validated in several experimental setups using leading edge inflatable kites (both ground-actuated and fly-actuated). The main disadvantage is that the kite does not follow a prescribed trajectory (although one could adjust the actual trajectory to a prescribed one by tuning the parameters of the guidance module).

Following this comment by the Reviewer, we added a few more sentences to the paragraph starting in line 40 of the Introduction.

- While the third kite line for pitch control (as well as the option for reeling in and out) is mentioned as a contribution of the paper, I could not find a corresponding block in the control block diagram (Fig. 4). It would therefore be useful to devote a paragraph outlining a possible extension of the controller to allow for these extra built-in features of the hardware setup.

As pointed out by the Reviewer, the pitch control was not incorporated into the autonomous controller but rather tuned by the human operator if necessary. Following the Reviewer's advice, a paragraph has been added at the end of Sec. 3 (line 226) noting this circumstance and discussing future extension of the controller to leverage these capabilities present in the hardware. Our group has updated the Ground Station (we are now in the integration phase), and in the next flight campaign the pitch control will be tested.