Optimal Control for a Dual-Kite System in Pumping-Cycle Operation

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AWE Research at ALU-Freiburg

optimal control research applied to rigid-wing, rotation-launch AWE

1 Postdoc

+

5/10 PhDs

+

research staff

+

many RAs

Prof. Dr. Moritz Diehl

ITN AWESCO &
ERC-grant HIGHWIND

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optimal control research applied to rigid-wing, rotation-launch AWE

me

background in:

aerodynamics
& wind energy
(vortex methods)

most recently,
for LEI kites

Prof. Dr. Moritz Diehl

Tether Drag and Dual-Kite Systems

Tether drag proportional to frontal tether area

Significant loss in system efficiency.

What to do?

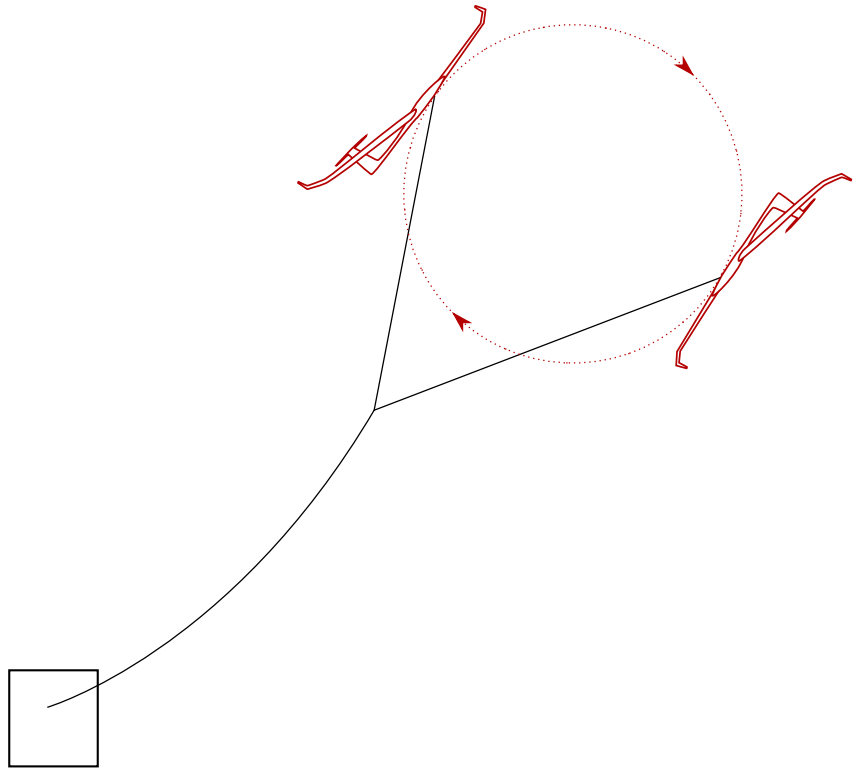
Tether Drag and Dual-Kite Systems

Tether drag proportional to frontal tether area

↓

Significant loss in system efficiency.

Dual-Kite Systems



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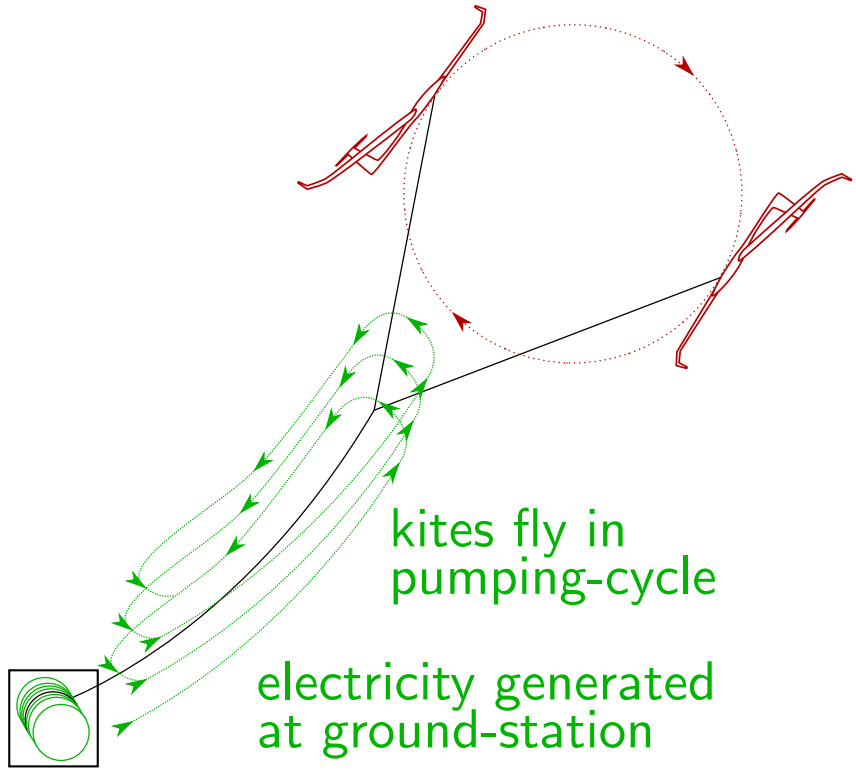
Dual-Kite Systems



For a **dual-kite pumping-cycle** system, what is the optimum system geometry and flight path to maximize the mechanical power output?

Recent Literature: "Fly-Gen" Dual-Kites

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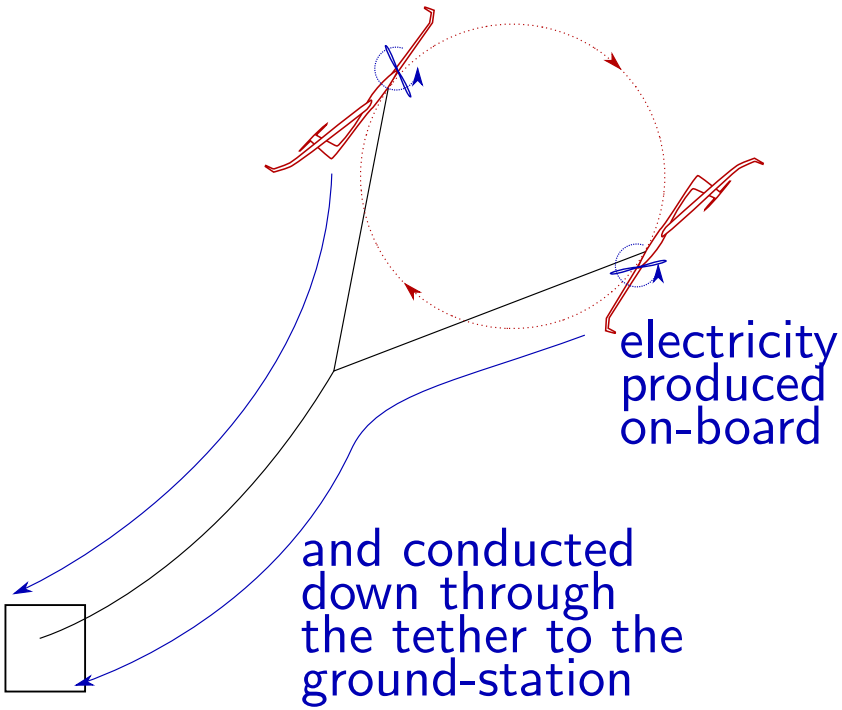

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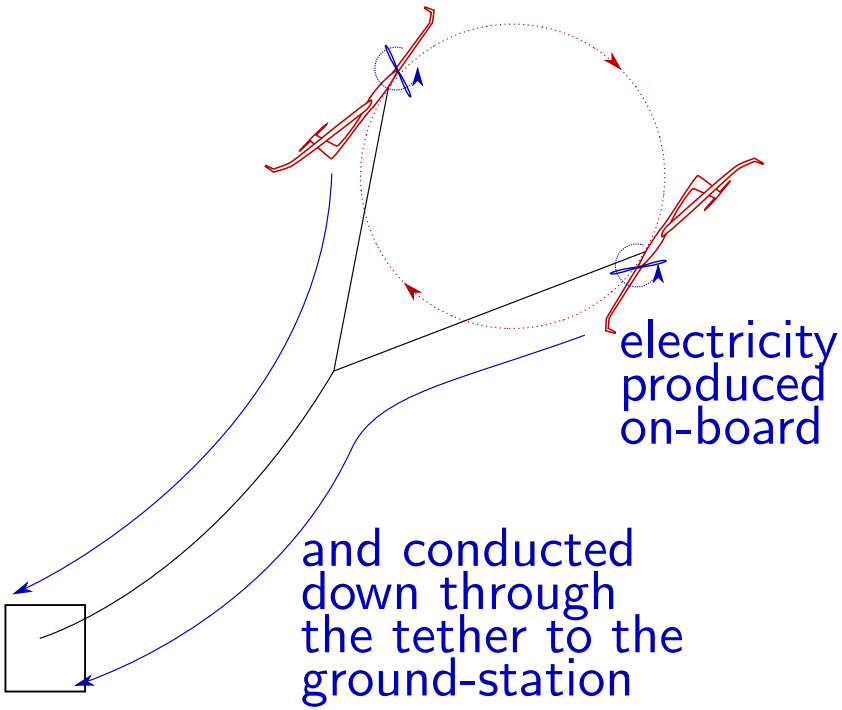

Lagrangian DAE* Dynamics
- **Lifting-Line Aerodynamics**
- **No Wake Effects**
- Logarithmic Wind-Shear
- Piecewise Cylindrical Tether

Optimal Control Problem
- **Periodic Formulation**
- NMPC** to Track Flight-Path
- MHE*** for State Estimation

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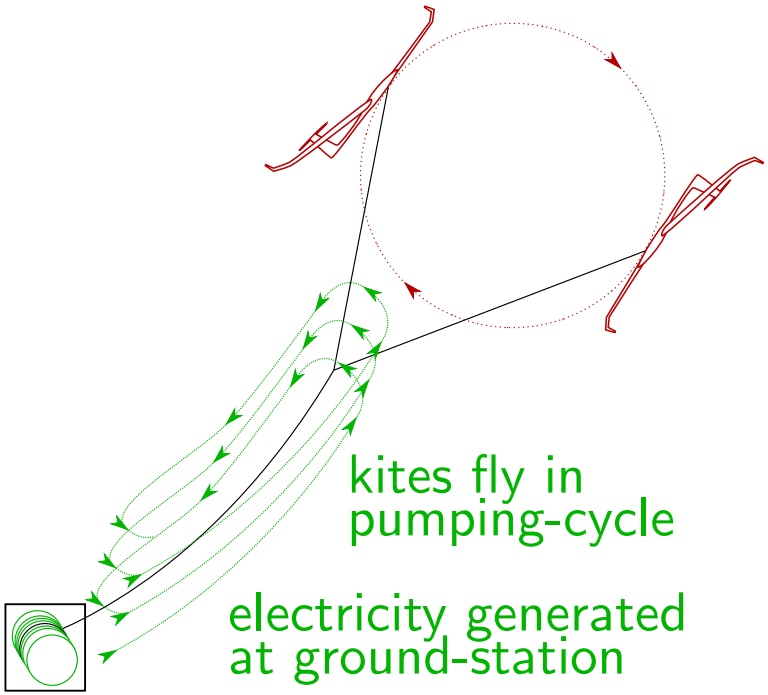
* Differential Algebraic Equation
** Nonlinear Model Predictive Control
*** Moving Horizon Estimation

First Step: Adapt Method to Pumping Cycle



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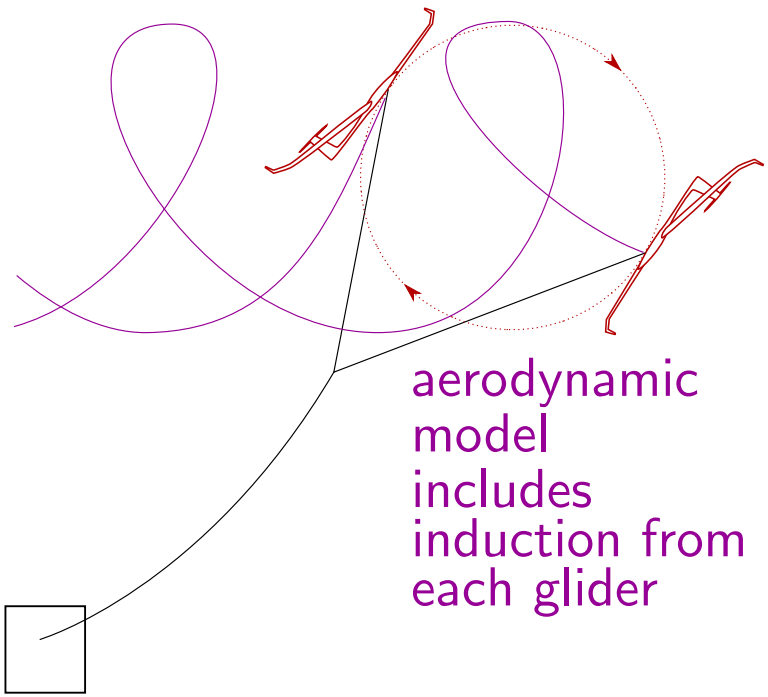
(with secondment to Chalmers)

Second Step: Aerodynamic Model Update



Lagrangian DAE Dynamics
- **Alternate Vortex Method**
- **Limited Wake Tracking**
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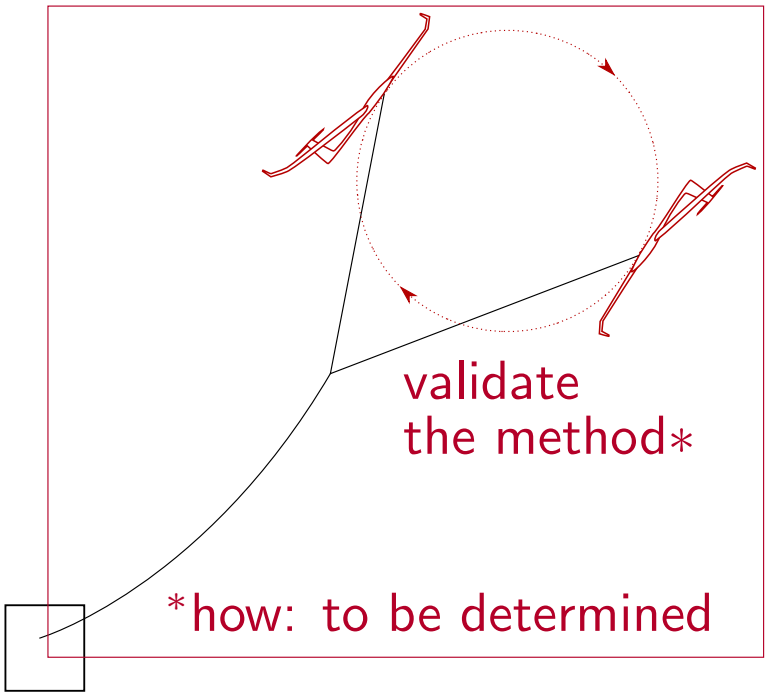
Third Step: Optimization and Validation



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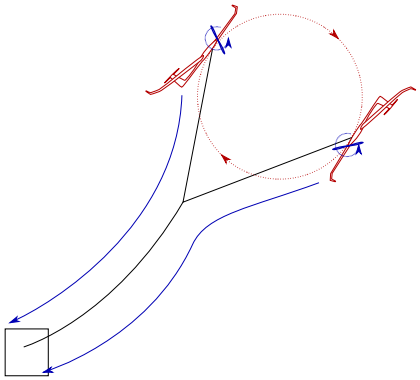
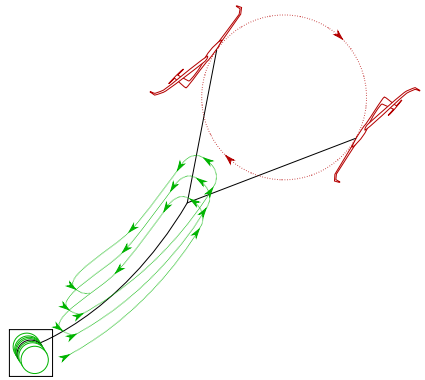
Validation
- Optimize Design
- Construct a **Simple** System
- Check Behavior

Summarizing the Steps

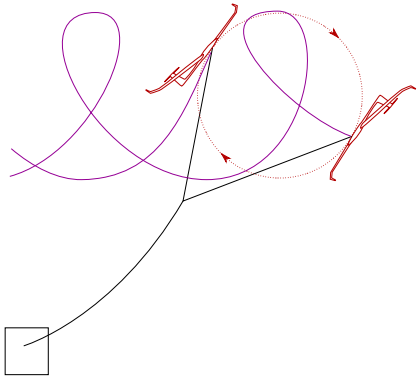
0. From Literature



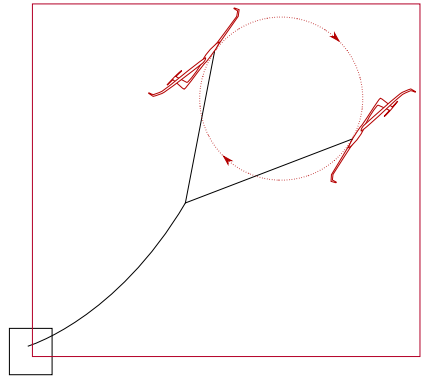
1. Ground-Gen Update



2. Aerodynamics



3. Run and Validate



Conclusion and Immediate Focus

Research Question

For a dual-kite pumping-cycle system, what is the optimum system geometry and flight path to maximize the mechanical power output?

Next Task

Build the Lagrangian formulation of the pumping-cycle dual-kite system dynamics.

Some Questions

- How do I increase the chance of success?

  ie. What sort of problems can you foresee that I might have, and how do you suggest that I avoid them?

- Is there anyone who has expertise in the following topics that would be interested in collaborating?
  - the combination of optimal control problems and vortex methods
  - validation of rigid-kite models