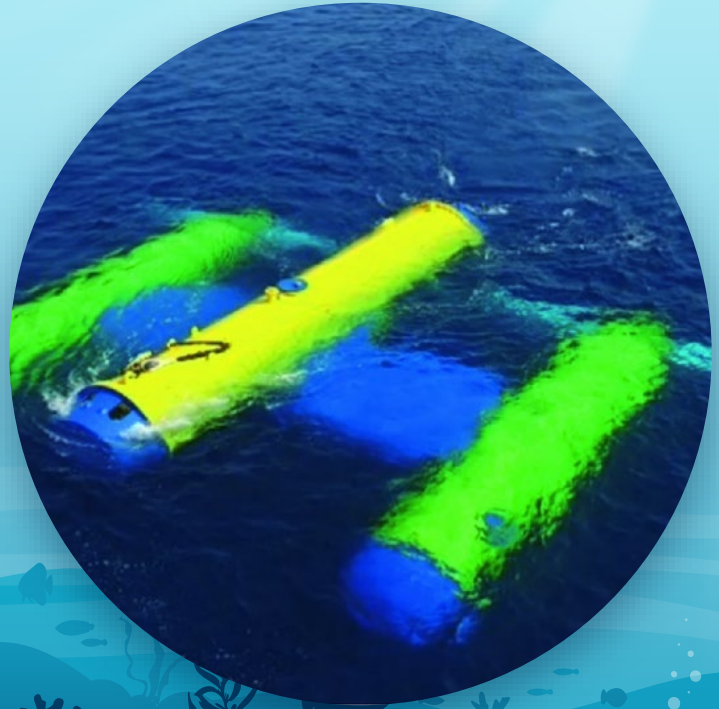
Marine Hydrokinetic Turbine Optimization through Control Co-Design

Presenter: Austin Snyder

Advisors: Dr. Yufei Tang, Arezoo Hasankhani

Marine Hydrokinetic Turbines



"KAIRYU" Ocean Current Turbine System[2]

Advantages

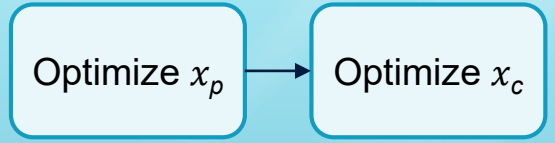
- Renewable
- "Clean"
- Consistent

Challenges

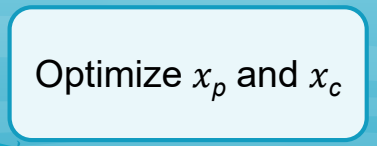
- Cost of Components
- Complex Environment

Control Co-Design

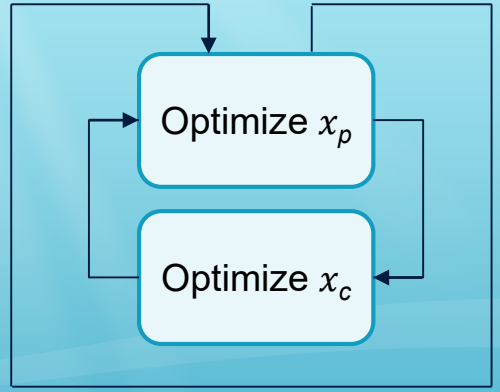
Traditional Design



Simultaneous Design



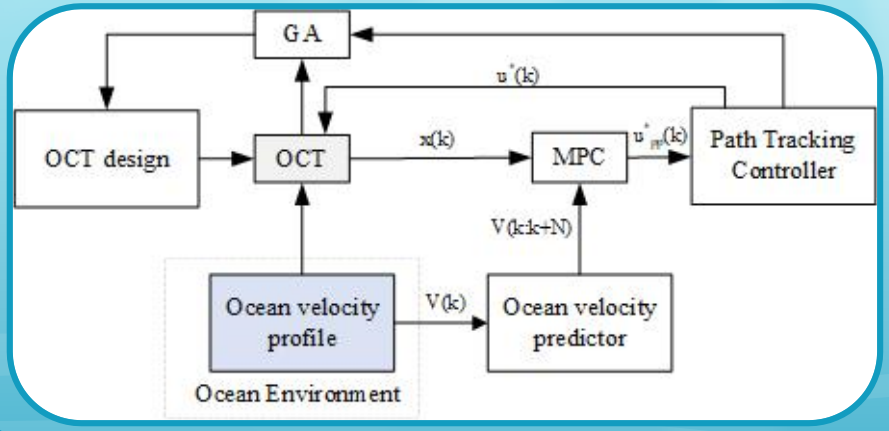
Nested Control Co-Design



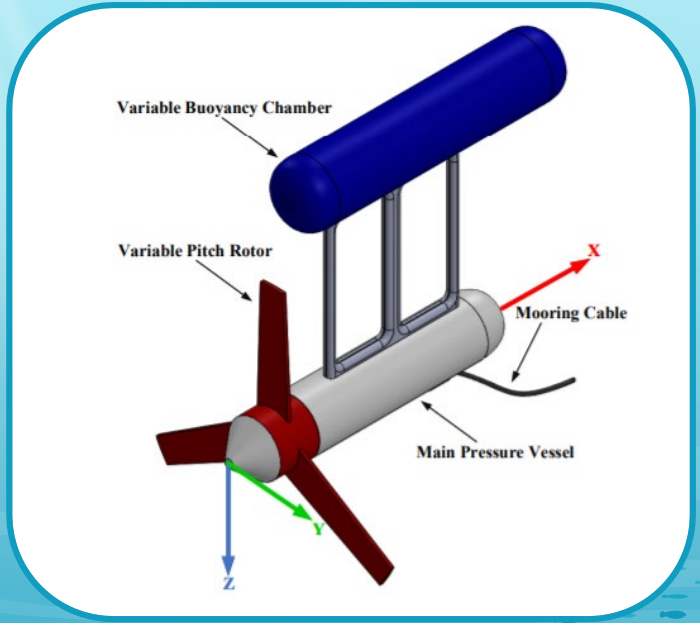
Designs inspired by Daniel R. Herber[3]

Optimization Problem Setup

Objective: minimize cost-to-power ratio



Control Co-Design Schematic for Buoyancy-Controlled OCT



Design Schematic for Buoyancy-Controlled OCT[4]

Preliminary Results

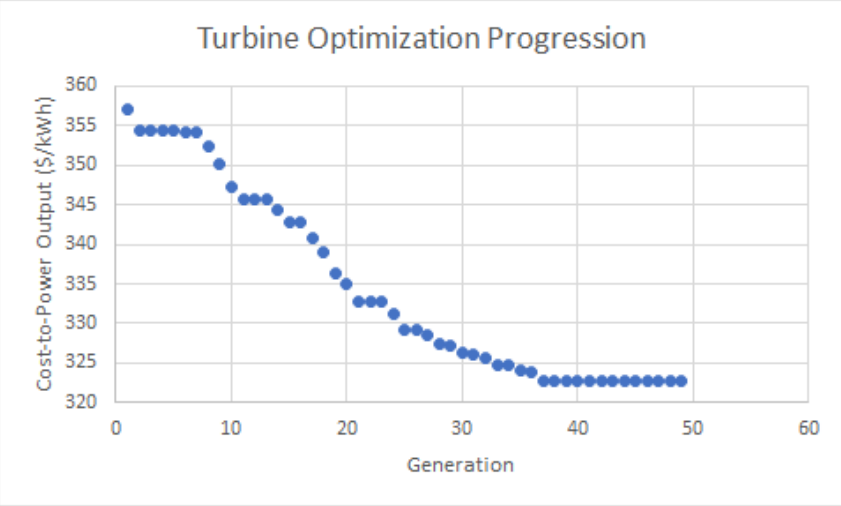
Initial Design

- P_{rated} = 700 kW
- P_{pump} = 18.8 kW
- d_{rotor} = 20.0 m
- V_{buoy} = 31.25 m^3

Scope

- Time Horizon: 1 week
- Prediction Horizon: 3 hours

Output



Conclusions & Next Steps

Future Plans

- ACC Paper Submission
- Generalized Application

ACC 2022 Logo[5]

Ongoing Work

- Reduce Time Complexity
- Linear Model Approximations
- Standardize Cost & Weight

References

[1] Catalina, J. (n.d.). Blue Ocean. Slides Carnival; Piensa en Pixels. https://www.slidescarnival.com/thaisa-free-presentation-template/10437

[2] Dodo, Y., et al. (2019). Development and Design of a Floating Type Ocean Current Turbine System. *Practical Design of Ships and Other Floating Structures*, 732–755. https://doi.org/https://doi.org/10.1007/978-981-15-4680-8_49

[3] Herber, D. R. *Control Co-design Direct Transcription Solution Strategies: Overview and Challenges* [PowerPoint slides]. Department of Systems Engineering, Colorado State University. https://www.engr.colostate.edu/~drherber/files/IDADS-Herber.pdf

[4] Hasankani, A., et al. (Unpublished). Modeling and Numerical Simulation of a Buoyancy Controlled Ocean Current Turbine

[5] American Control Conference (2022). [American Control Conference 2022 Logo]. Retrieved from https://acc2022.a2c2.org/