Raining Drones: Mid-Air Release & Recovery of Atmospheric Sensing Systems

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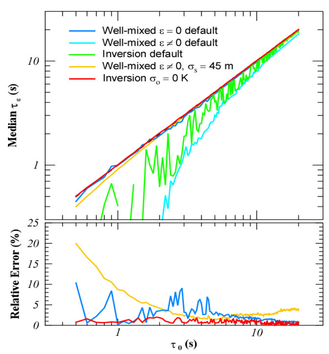
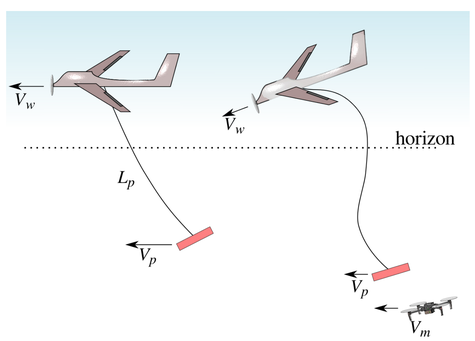
Vision: Develop techniques & foundations to aerially launch, and later aerially recover unmanned systems that profile Earth's lower atmosphere.

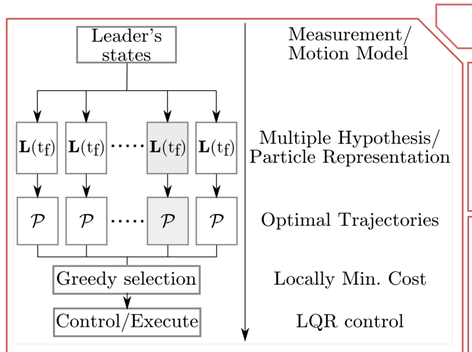
Objectives: Mid-air capture and release of several aerial systems, by,

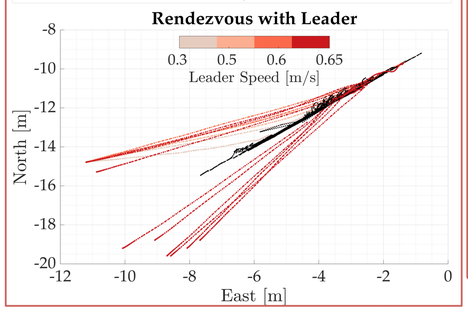
- Planning & control for UASs docking and undocking mid-air;
- Matched maneuvers between heterogeneous classes of aerial robots;
- Strategies for rapid deploy-capture-redeploy cycles for teams of UASs;
- Run time inference of protocols and global plans to orchestrate interactions;
- Estimating aerial-sensor responses and studying better profile patterns.





Activities, Contributions

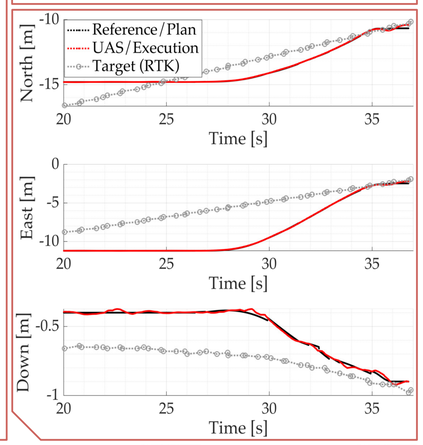




UAS docking with a moving platform

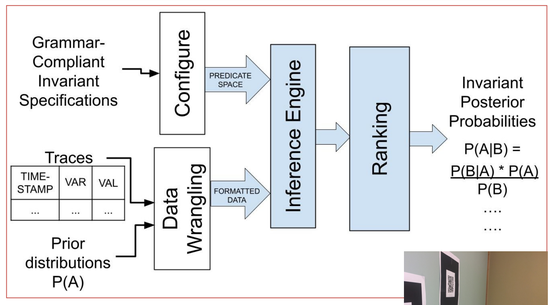
- Plan optimal docking trajectories
- Domain awareness: avoid downwash
- Precise localization, control outdoors

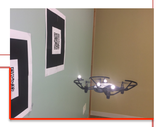
➢ github.com/unl-nimbus-lab/Freyja



Automatically inferring **System Invariants** that are:

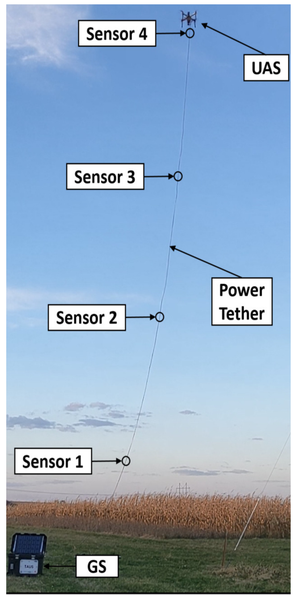
- Conditioned by complex system states
- Defined probabilistically to capture uncertainty





Sample invariants:

- $P(UserCommand{=}\texttt{ReturnHome} \mid MachineS{=}\texttt{Target} \;\&\; x\text{-}velocity \geq 0.25) > 0.52$
- $P(UserCommand{=}\texttt{Hover} \mid Machine{=}\texttt{Sweeping} \;\&\; y\text{-}velocity \geq 0.25) > 0.03$



Estimating **airborne-sensor's response**, τ_ε, with synthetic ascent/descent profiles

- Highest accuracy for well-mixed constant profiles in ascent/descent ($\varepsilon = 0$).
- Mostly insensitive to vertical variability (σ_b) or observation error(σ_o).
- Profile inversions likely to create poorer estimates even with proper filtering.

Broader Impact: Science, Society and Students

- Integrating teams of UASs into routine & periodic aerial profilings; directly impacting atmospheric science, and the ability to create accurate, descriptive and data-supported models of atmosphere.
- Generating unprecedented datasets that capture atmospheric thermodynamics over large geographical scales.
- The underlying techniques and systems will be applicable to other domains such as surveillance, hazard assessment, reconnaissance and other forms of multimodal exploration.
- Educational and outreach programs will help in expanding the audience for this work by disseminating curated knowledge to students & general public.

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