1 Paper

1.1 Summary

The paper [2] introduces the notion of dynamic soaring for a small gliding aircraft. It gives two first-order models for boundary layer and shear pattern wind flows. This is used to develop a flight logic/strategy that will extract the most energy possible (if there is energy to be extracted – and presuming that the cost of extraction is negligible and independent).

Nick then gave some newer results. Path planning is performed using a 3-way (convexified) path-set structure (left, straight, and right motions) for each of the 3 angular DOFs (roll, pitch, and yaw). Estimation of the local wind-gradients using a GP regression from local wind measurements (which are obtained by comparing Pitot tube and IMU velocity measurements) along with recent work on the applications of the GP to the energy equations was also presented.

1.2 Discussion

New, particularly small UAVs are being developed. These platforms offer greater stealth and agility (compare an albatross to a Cessna), but limited payload. More importantly, they are affected by shear disturbance. But, this can be exploited! In this light, the work is trying to tackle two main flight problems simultaneously: (1) how to go further with a limited amounts of fuel and (2) how to capture energy from the environment.

The paper presents a first-order analytic model based on a single mass kinetic energy balance. As dynamics suggests, energy gain is maximized as speed is increased. The paper then presents a GP regression of the wind profile.

Doing this outside ideal linear shear profiles is complex. Ideas for factoring mixed effects (both shear and boundary layer flows) and terrain correlations were also raised. While the path planning idea is “simple,” it is effective for showing the concept with later extensions to more complex planners possible.

It was noted that the:

- reward function is always in energy
- to factor thermal layers might require a non-parametric approach
- this is similar in some ways to the “mountain-car” problem in RL
- that one option might be to learn a set of trajectories and then use these to adopt the path-set (instead of keeping a fixed set).
- a spatial differentiation is needed to estimate the $\nabla$ of the field.
- a temporal covariance function might be needed to adopt to changing wind patterns.
- models can be factored by pseudo-observation.

2 Logistics

- Next meeting: February 16. (moved from February 9)
- Next paper: “Million Module March: Scalable Locomotion for Large Self-Reconfiguring Robots” [1].
3 BibTeX

@INPROCEEDINGS{LawranceSukkarieh2009,
author = {Lawrance, Nicholas R. J. and Sukkarieh, Salah},
title = {A guidance and control strategy for dynamic soaring with a gliding UAV},
year = {2009},
pages = {3632–3637},
month = {May},
abstract = {Soaring is the process of gaining energy from the atmosphere in-flight using an aerodynamic free-flying platform. Dynamic soaring utilizes the energy available in vertical wind gradients and is commonly used by soaring birds. This research aims to develop a guidance and control strategy to utilize dynamic soaring for a fixed-wing gliding UAV. The basic strategies for dynamic soaring in vertical wind shear are explored and a simple piecewise trajectory based controller is developed to identify regions suitable for soaring and attempt traveling energy-neutral trajectories.},
doi = {10.1109/ROBOT.2009.5152441},
issn = {1050-4729}
}

References
