Universität Stuttgart
Institut für Flugmechanik und Flugregelung

Reinforcement Learning-Based Autonomous Soaring with Memory Augmented Neural Networks

Master‘s Thesis

Background

Exploiting thermal updrafts can enable fixed-wing UAVs to reduce their energy consumption significantly while extending their endurance. At the iFR, we have successfully demonstrated an end-to-end reinforcement learning (RL) approach for autonomous updraft localization and exploitation, i.e. a glider learned how to process sensor inputs and compute control commands in order to detect updrafts and gain altitude within them. Our next goal is to combine this with a path tracking ability. This poses new requirements on the memorization capabilities of the underlying deep neural network, since this represents a long-term correlated decision-making problem: The glider needs to make a trade-off between tracking the path, searching for new updrafts, and exploiting previously detected, memorized updrafts.

Problem Definition

In the past, we have used a Long Short-Term Memory (LSTM) to capture updraft dynamics over time. Currently, we are examining Transformers for this task due to the limited memory timespan of LSTMs. However, Memory Augmented Neural Networks (MANNs), such as Differentiable Neural Computers, which allow the neural network to read to/write from external memory, seem to be a very promising alternative worth investigating. Hence, the goal of this thesis is to select, adjust, and assess a MANN architecture for the task of autonomous soaring.

Tasks

- Literature review of MANNs and familiarization with our RL-based autonomous soaring approach
- Comparative analysis of published MANN architectures and selection of a promising candidate
- Adjustment and implementation of the selected MANN architecture
- Training the MANN in a RL manner using our existing simulation setup
- Assessment of the MANN’s training behavior and resulting performance by comparison to our existing approaches

Requirements

- Strong interest in machine learning, basic understanding is required
- Programming experience, Python and PyTorch knowledge is ideal
- Good academic performance

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