Universität Stuttgart
Institut für Flugmechanik und Flugregelung

RL-based Altitude Control for Autonomous Landing of Multi-Rotor Vehicles on Moving Platforms

Master Thesis

Background

Autonomous drones show a huge potential in a variety of future applications (e.g. inspection tasks, precision agriculture, monitoring of wildlife and disaster sites). Unfortunately, their operating range is limited by factors such as battery capacity, disk space for data recording, etc. This problem can be addressed by autonomous landing procedures that enable a drone to connect to a docking port to replenish batteries and offload data.

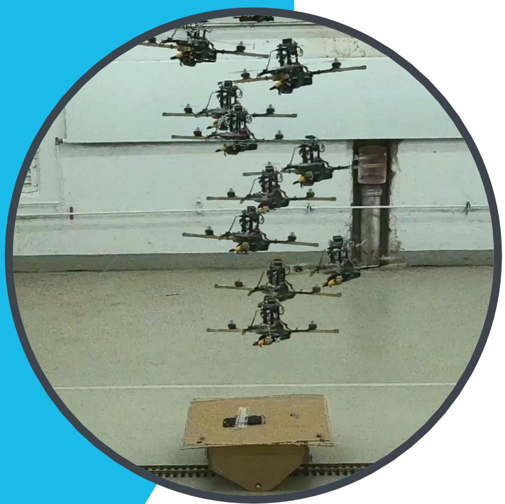
Classical control approaches suffer from the fact that they require accurate models of the plant and the environment for the controller design. Furthermore, they often involve manual tuning of parameters. Against this background, learning-based methods such as reinforcement learning (RL) offer the possibility to learn a suitable control policy exclusively through interaction with the environment during a training procedure. However, current methods for landing of multi-rotor vehicles on moving platforms suffer from a long training time and limited success rate.

Problem Definition

In previous work, a RL framework for generating an attitude controller capable of aligning a multi-rotor vehicle with a 2D moving platform has been developed. The framework features

- A training environment realized in the physics simulator Gazebo
- An implementation of the Double Q-Learning algorithm leveraging a multi-resolution approach for state space discretization as part of a sequential curriculum in combination with transfer learning
- Scripts for deploying the generated RL controllers in simulation and on real hardware

The next step is to create an extension of the framework to use the multi-resolution discretization technique in combination with Double Q-Learning for the generation of an altitude controller. For this purpose, a suitable state and action space must be defined as well as a kinematics model that relates the selected state variables in a way suitable for discretization. During implementation and testing, special attention should be paid to robustness of training and reproducibility of results.



Tasks

- Framing of the altitude control problem as a reinforcement learning task that can be structured as a sequential curriculum using multi-resolution discretization
- Implementation of the approach in the existing framework
- Conduction of a comprehensive experiment campaign in simulation to validate the applicability of the approach for different scenarios of platform movement
- Testing of the approach on real hardware in a flight experiment in the institute's Vicon room (Vicon is a camera-based system for motion capture of objects, such as aerial vehicles)

Requirements

- Interest in RL techniques
- Experience with ROS / Gazebo desired
- Good programming skills in Python / C++
- Good academic performance

If interested, please contact:

Pascal Goldschmid, pascal.goldschmid@ifr.uni-stuttgart.de, 0711 685-66676

iFR