Universität Stuttgart
Institut für Flugmechanik und Flugregelung

Comparison of Simulators for UAVs: ROS / Gazebo vs. MATLAB / Simulink

Bachelor Thesis

Background

Simulators play an important role in numerous ways in research and industrial development. They often form the basis of controller design with classical or learning-based methods (e.g. reinforcement learning - RL). However, different simulation environments have different capabilities, strengths and weaknesses. Among these are the achievable real time factor (important for time-consuming RL training) or the accuracy of the aerodynamics model (important to bridge the “sim-to-real” gap).

Problem Definition

The aim of this thesis is to find qualitative differences between the simulators ROS / Gazebo and MATLAB / Simulink for typical implementations of fixed-wing and multi-rotor UAVs by evaluating them in predefined control tasks. The UAVs chosen for implementation should correspond to real aircraft that are part of the institute’s UAV fleet. Whereas Gazebo relies on multi-body model definition via urdf-files, Simulink provides predefined blocks for 6DOF-modelling of atmospheric vehicles. Once the creation of the Gazebo and Simulink model is completed, identical PID controllers shall be designed for performing attitude and altitude control as well as path following. For basic reference trajectories such as steady-state horizontal flight, steady-state curves or hover flight, experiments shall be conducted in simulation first. If time allows, real flight experiments can be conducted to compare the flight behaviour of the real UAVs with the simulation results.

Finally, the results generated with the different simulators shall be compared to qualitatively evaluate differences in their performance.

Tasks

- Implement the model of a multi-rotor and a fixed-wing UAV in Gazebo and Simulink.
- Setup PID-controllers for attitude / altitude control and path following.
- Perform experiments in simulation for reference trajectories.
- Optional: Perform real flight experiments.
- Compare the results to evaluate the simulator’s performance.

Requirements

- Interest in simulation techniques
- ROS / Gazebo experience is beneficial
- Good programming skills in Python and MATLAB

Contact

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