Universität Stuttgart
Institut für Flugmechanik und Flugregelung

Autonomous Blimp Navigation with Data-Driven Model Predictive Control

Master Thesis

Background:
Robotic blimp is a lighter-than-air vehicle and it has the potential to execute a long-time mission. However, due to its large body surface, a blimp is more susceptible to wind disturbance. Our research aims at synthesizing high-performance control law to navigate the blimp without wasting excessive energy.

Problem Definition:
Classic optimal controller design pipeline usually assumes an accurate dynamic model of the plant. This assumption rarely holds due to parameter uncertainty. Therefore, the controller planning through this inaccurate model performance is also limited. To alleviate this problem, data-driven model predictive control (MPC) leverages data and learning techniques to iteratively improve a dynamic model with system identification methods. This allows MPC to gradually increases its performance over collected data.

Task:
We have created a blimp simulator based on our real robotic blimp [1]. A cascade PID controller is also designed to navigate the blimp in space. However, its performance degrades when a disturbance occurs. Given a blimp software-in-the-loop simulator, your goal is to develop a data-driven MPC to achieve a navigation task and outperform the PID controller concerning performance and energy saving.

Requirement:
- Interested in Reinforcement Learning, Control, and Robotics
- Familiar with Gazebo and ROS framework is desired
- Python, C++ (optional)

Contact:
Jun.-Prof. Dr.-Ing. Aamir Ahmad
aamir.ahmad@ifr.uni-stuttgart.de

Relevant Work:
[1] Simulation and Control of Deformable Autonomous Airships in Turbulent Wind., Price, E., Liu, Y.T., Black, M.J. and Ahmad, A., 2021. International Conference on Intelligent Autonomous System (IAS)

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