

January 31st, 2019

F O R S C H U N G S P R A X I S
for
N.N.
Student ID XXXXXXXX, Degree XX-XX

Enhancing Uncertainty-based Control for Gaussian Processes

Problem description:

Research at the intersection of machine learning and control made impressive advances over the past years. Data-driven identification using Gaussian processes has been successfully employed in various control tasks [1]. However, data-based models are only precise near the available training data, which is so far rarely considered.

Among other favorable properties, the Gaussian process provides a measure for the fidelity of the model. This allows to employ uncertainty-dependent control strategies. These show higher reliability under input power constraints by avoiding areas of the state space, where model fidelity is low due to sparse data and by favoring areas where data density is high [2]. However, this approach is currently limited to a particular class of systems and its advantages have not been properly visualized.

Therefore, the goal of this research internship is to generalize and improve the existing approach and to design and implement an application scenario which demonstrates the benefits of uncertainty-dependent control laws. An appealing visualization of the control strategy should be provided.

Work schedule:

- **Week 1-2:** Review of uncertainty-based control approaches
- **Week 3-4:** Generalization and improvement of existing technique
- **Week 5-7:** Design and implementation of an application scenario
- **Week 8-9:** Documentation and visualization of results

Bibliography:

- [1] Carl Edward Rasmussen and Christopher KI Williams. *Gaussian Processes for Machine Learning*. MIT Press, Cambridge, MA, USA, January 2006.
- [2] J. Umlauf, L. Phler, and S. Hirche. An uncertainty-based control Lyapunov approach for control-affine systems modeled by Gaussian process. *IEEE Control Systems Letters*, 2(3):483–488, July 2018.

Supervisor: M. Sc. Jonas Umlauf
Start: xx.xx.xxxx
Delivery: xx.xx.xxxx

(S. Hirche)
Univ.-Professor