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

Modelling Uncertainties using Wishart Processes

Problem description:

Robots interacting with humans face the difficulty to react to unseen events in their environment in many real-world applications. One approach to tackle this issue is to acquire skills autonomously from observation and generalization. This concept initiated research at the intersection between machine learning and system identification for control.
One popular method for skill transfer from human to robot is Programming by Demonstration (PbD) which has shown very promising results recently [1]. A remaining challenge, which is often neglected, is to model the uncertainty in the demonstration data properly and exploit it in the robot control. It would allow for more intuitive robotic behaviour, by employing risk sensitive controllers or varying stiffness approaches [2].
One Bayesian nonparametric approach for modelling uncertainties in terms of covariance matrices are Wishart Processes (WPs) [3], which have not been applied in a robotic context. Therefore, this work aims to investigate the applicability of WPs in robotics and evaluate the results based on a robotic experiment.

Work schedule:

- **Week 1-2:** Literature review on uncertainty modelling for PbD and Wishart Processes
- **Week 3-4:** Implementation of a WP framework
- **Week 5-8:** Application WP modelling to recorded data and implement robotic experiment
- **Week 9:** Documentation of results

Bibliography:

[1] Aude Billard, Sylvain Calinon, RŘdiger Dillmann, and Stefan Schaal. *Robot programming by demonstration*. Springer, 2008.
[2] K. Kronander and A. Billard. Online learning of varying stiffness through physical human-robot interaction. In *International Conference on Robotics and Automation (ICRA)*, pages 1842–1849. IEEE, May 2012.
[3] Andrew Wilson and Zoubin Ghahramani. Generalised Wishart processes. In *Conference on Uncertainty in Artificial Intelligence*, pages 736–744, Corvallis, Oregon, 2011. AUAI Press.

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