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F O R S C H U N G S P R A X I S

Model Order Reduction for Redundant Driving Simulator Motion Systems

Problem description:

Motion Cueing Algorithms (MCAs) are used to calculate control signals for the complex motion systems of driving simulators. The goal is to create simulator motions which provide the test subject with the impression of a real drive. To this end, we want to develop advanced model predictive control (MPC) based motion cueing algorithms.
MPC MCAs allow to handle simulator constraints explicitly and can provide a high quality simulator motion. To do so, the algorithm uses a model of the simulator kinematics and combines it with a model of the human vestibular system. This being quite a large model, solving an optimization problem with required frequencies of more than $100\,\mathrm{Hz}$, becomes a challenge. The high computational complexity leads to a rare MPC MCA usage until now [1].
The goal of this project is to reduce the model complexity used in the MPC MCAs, by making use of model order reduction techniques [2]. The resulting computational complexity and motion cueing performance is analyzed and compared to that with the non-reduced model.

Work schedule:

- 2.5 weeks: Literature review on MPC based MCAs and model order reduction techniques
- 0.5 weeks: Preparation of a small overview presentation on model order reduction techniques and their respective advantages and disadvantages for use in MPC-based MCAs
- 3 weeks: Adaption and implementation of the most promising model order reduction techniques for their use in MCAs
- 1 weeks: Evaluation of the approaches' performance for MPC-based MCAs
- 2 weeks: Write report and prepare presentation

Requirements:

- Good knowledge in control theory, ideally in the area of model order reduction techniques
- Programming experience in MATLAB, C++ is a plus
- High motivation and the ability to work independently
- CV and current grade report
- Previous knowledge on motion cueing algorithms and driving simulators is **not** required

Bibliography:

[1] F. Ellensohn, M. Schwienbacher, J. Venrooij, and D. Rixen, "Motion Cueing Algorithm for a 9 DoF Driving Simulator: MPC with Linearized Actuator Constraints," pp. 2018–01–0570, Apr. 2018.

[2] G. Obinata and B. D. O. Anderson, *Model Reduction for Control System Design*. Communications and Control Engineering, London: Springer London, 2001.

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Start:	XX.XX.XXXX
Delivery:	XX.XX.XXXX

(M. Leibold)
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