TECHNISCHE UNIVERSITÄT MÜNCHEN
NEUROWISSENSCHAFTLICHE SYSTEMTHEORIE
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MASTER THESIS

Benchmarking Cerebellar Models and Controllers

Problem description:

We are currently investigating models of the cerebellum as adaptive controllers[1] for soft, light-weight robots[2]. Literature has a number of cerebellar models of different detail and complexity. Only few of them are suitable to be implemented as an actual controller, however, mostly because their computational complexity prohibits their real-time execution.
We are using SpiNNaker[3], a neuromorphic computing system tailor-made for the simulation of spiking neural networks, to lift this computational limit or at least increase it by orders of magnitude. Thus, many models which previously were slow to compute on traditional PCs can now be executed in real-time.
We would like to develop a set of benchmarks to assess the performance of such models and compare them to more traditional adaptive controllers. The master candidate would need to provide a thourough understanding of control theory and adaptive control. The main tasks to tackle in this thesis are:

1. Get a functional understanding of the cerebellum, cerebellar networks and CMAC[4] controllers.
2. Get a detailed understanding of the biological and simulated cerebellum's input and output mechanisms.
3. In comparison to more traditional controllers, single out relevant performance metrics.
4. Develop benchmarks to assess cerebellar control in terms of those metrics, e.g. speed, accuracy, learning-rate, adaptability vs. retention, etc.
5. Implement, perform and evaluate those benchmarks for a selected set of existing cerebellar models.

Bibliography:

[1] P. van der Smagt: *Benchmarking cerebellar control*, Robotics and Autonomous Systems, 32 (2000)
[2] http://www.myorobotics.eu
[3] S.B. Furber, F. Galluppi, S. Temple, L.A. Plana: *The SpiNNaker Project*, Proceedings of the IEEE, 102, 5 (2014)
[4] J.S. Albus: *A New Approach to Manipulator Control: the Cerebellar Model Articulation Controller (CMAC)*, Trans. ASME, Series G. Journal of Dynamic Systems, Measurement and Control, 97 (1975)

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