Contribution ID: **18** Contribution code: **K-5** Type: **Keynote**

A spiking neural network control system for the investigation of sensori-motor protocols in neurorobotic simulations.

Friday 24 June 2022 15:00 (45 minutes)

We propose a functional bio-inspired multi-area model in NEST [1] for motor control where the information is frequency-coded and exchanged between spiking neurons.

Our model consists of a controller, representing the central nervous system, and an effector, modelled as an arm and implemented with PyBullet [2] (Fig 1).

Different functional areas build up the controller, each one modelled with spiking neuronal populations, which we implemented ad-hoc to perform mathematical operations (e.g., Bayesian integration [3]). Additionally, to study cerebellar role in motor adaptation, we included a detailed model of the cerebellum [4], consisting of EGLIF neurons [5], and ad-hoc Spike-Timing-Dependent Plasticity rules [6].

Finally, to manage the communication between the brain and the arm, we make use of the MUSIC interface [7].

We used the model for the control of a single degree of freedom in the elbow joint. Preliminary simulations show proper signals transmission among areas in the model, bioinspired encoding/decoding of end-effector signals, and learning capability driven by the cerebellum. Finally, the MPI-based setup enables the use of distributed resources (i.e., we tested the system with 10 parallel MPI processes). This allows to address the computational requirements of simulations, facilitating also the control of multiple DoFs in future studies.

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Preferred form of presentation

Talk & (optional) poster

Topic area

models and applications

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Yes

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Yes

References

[1] Jordan, R. Deepu, J. Mitchell, J. M. Eppler, S. Spreizer, J. Hahne, E. Thomson, I. Kitayama, A. Peyser, T. Fardet et al., "Nest 2.18. 0,"J ̈ulich Supercomputing Center, Tech. Rep., (2019).

[2] Coumans, Erwin, and Yunfei Bai. "Pybullet, a python module for physics simulation for games, robotics and machine learning." (2016).

[3] Grillo M., Geminiani A., Alessandro C., D'Angelo E., Pedrocchi A., Casellato C., "Bayesian integration in a spiking neural system for sensorimotor control", Neural Comput, (2022) accepted.

[4] De Schepper, Robin, et al. "Scaffold modelling captures the structure-function-dynamics relationship in brain microcircuits." BioRxiv, (2021).

[5] Geminiani, Alice, et al. "Complex dynamics in simplified neuronal models: reproducing golgi cell electroresponsiveness." Frontiers in neuroinformatics (2018).

[6] A. Antonietti, V. Orza, C. Casellato, E. D'Angelo and A. Pedrocchi, "Implementation of an Advanced Frequency-Based Hebbian Spike Timing Dependent Plasticity," 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), (2019).

[7] Djurfeldt, M., Hjorth, J., Eppler, J.M. et al. "Run-Time Interoperability Between Neuronal Network Simulators Based on the MUSIC Framework."Neuroinform. (2010).

Speaker time zone

UTC+2

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cerebellum, embodiment, sensorimotor integration

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