Topic for a

Project Work / Studienarbeit

Learning and spike propagation with locally active neuristor cells

At the Chair of Fundamentals of Electrical Engineering novel memristive memory elements with locally active regions are investigated to enable non-conventional and low-power analog computing systems [1]. An electrical neuristor cell can be built that behaves similarly to biological neurons by combining a locally active memristor with a capacitive element and a suitable biasing [2]. Moreover, by placing a non-volatile memristor between two neuristor cells, different learning mechanisms can be emulated exploiting its spike timing. Nevertheless, a current challenge is the proper circuit design that enables efficient learning and propagation of spike signals through a network of non-volatile memristors and neuristor cells.
Within the scope of a scientific work, different learning mechanisms and multi-cell spike propagation are to be analyzed using a neuristor model and verified in a circuit simulation.

The student research project should include, but not be limited to, the following:

- Literature research on the learning mechanisms for spiking neural networks, such as STDP and SDDP
- Implementation of a circuit simulation (e.g. in LTSPICE) for these learning mechanisms considering a non-volatile memristor surrounded by neuristor cells
- Verification of the learning mechanisms and efficient spike propagation
- Documentation of the results

For this thesis a very good knowledge of the basics of electrical engineering and circuit design is required. In-depth knowledge of neuristor cells and non-volatile memristors can be acquired in the course of the student research project.

References:
[1] Tetzlaff, Ronald. *Memristors and Memristive Systems*. Springer, 2014
[2] Demirkol, A.S., Messaris, I., Ascoli, A., Tetzlaff, R. (2022). *Pattern Formation in an M-CNN Structure Utilizing a Locally Active NbOx Memristor*. In: Chua, L.O., Tetzlaff, R., Slavova, A. (eds) Memristor Computing Systems. Springer, Cham.

Contact:
Dr.-Ing. Richard Schroedter
TOE 313, Tel.: 0351 463 40505
richard.schroedter@tu-dresden.de

Prof. Dr. phil. nat. habil. Ronald Tetzlaff
TOE 312, Tel.: 0351 463 33326
ronald.tetzlaff@tu-dresden.de