Topic for a

Project Work / Studienarbeit

Design of Recurrent Circuit for Neuro-Crossbar

At the Chair of Fundamentals of Electrical Engineering novel memristive/memcapacitive memory elements are investigated to enable non-conventional and low-power analog computing systems [1]. Memristive/memcapacitive devices have internal memory functions like a RAM and can be used in crossbar structures for highly parallel computations, especially for matrix multiplications, as they are massively used in artificial neural networks (ANN) [2]. In a current project a split-gate neuro-transistor with memcapacitive crosspoint array (neuro-crossbar) is designed and fabricated together with NaMLab gGmbH Dresden that aims to emulate spiking neural networks [3]. In this context, the development of the recurrent circuit is still an open research topic, which should enable the realization of recurrent spiking neural networks based on neuro-crossbars structures. Within the scope of a scientific work, a design of the recurrent circuit is to be developed based on the existing split-gate neuro-transistor model and is to be verified in circuit simulation.

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

- Literature research on the recurrent principle and its mathematical description for recurrent spiking neural networks
- Design of a recurrent circuit for the neuro-crossbar structure
- Verification of the recurrent neuro-crossbar structure in a circuit simulator, such as LTSPICE.
- Analysis of recurrent circuit variants for different memristive/memcapacitive device properties
- 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 memristive/memcapacitive neuro-crossbar structures can be acquired in the course of the student research project.

References:

[1] Tetzlaff, Ronald. *Memristors and Memristive Systems*. Springer, 2014
[2] R. Schroedter, A.S. Demirkol, A. Ascoli, R. Tetzlaff, E. Mgeladze, M. Herzig, S. Slesazeck, T. Mikolajick, “SPICE Compact Model for an Analog Switching Niobium Oxide Memristor”, IEEE International Conference on Modern Circuits and Systems Technologies (MOCAST), pp. 1–4, 2022
[3] Website of NeuroMCross research project, https://memristec.de/projekte/neuromcross/

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