Research Internship

Digital electronic design of a neuromorphic architecture for embedded learning

Context

The biological brain is able to perform high performance calculations with a much higher efficiency than our most powerful computers with very low energy consumption.
The aim of this work is to study the performance and the power consumption of models of artificial neural networks inspired from the behavior of the cortical areas in the brain. These models inherit from the theory of Self-Organizing Maps (SOM) [1] but exhibits natively high computational complexity [2]. The goal will be then to explore distributed implementations of this particular neural network onto embedded devices and hardware programmable devices (FPGA) [3] in order to reach efficient implementation onto autonomous systems. We will specifically focus on it's application in the domain of multimodal associations in robotic systems to deploy the neural network into the dynamics of a sensory-motor loop [4], on the SCALP board developed in the SOMA project [5].

Internship mission

The internship mission will be organized in several periods:

- Theoretical study of neural networks and neuromorphic engineering in the scientific literature,
- Design of the hardware architecture supporting distributed implementation of SOM-like models,
- Experiment and analysis of the complexity of the digital architecture onto a FPGA device target,
- Validation of the architecture with stimuli coming from multimodal sensors onto a robotic system.

References

[1] *T. Kohonen, "Self-organized formation of topologically correct feature maps," Biological Cybernetics, vol. 43, 1982.*

[2] *L. Rodriguez, L. Khacef, B. Miramond, A distributed cellular approach of large scale SOM models for hardware implementation, IEEE Int.l Conference on Image Processing Applications and Systems, special session on Circuits and systems for Self-organizing maps, 2018*

[3] *L Fiack, L Rodriguez, B Miramond, Hardware design of a neural processing unit for bio-inspired computing, - New Circuits and Systems Conference (NEWCAS), 2015*

[4] *A neuromorphic controller for a robotic vehicle equipped with a dynamic vision sensor, Hermann Blum et al.,* International Robotics Science and Systems Conference, *2017.*

[5] *Fabien Vannel, Diego Barrientos, Joachim Schmidt, Christian Abegg, Damien Buhlmann, Andres Upegui: SCALP: Self-configurable 3-D Cellular Adaptive Platform. SSCI 2018*

Practical information

Location : LEAT Lab, Sophia Antipolis
Duration : 6 months from March/April 2020
Grant : 529.20 € / month
Profile : Digital electronics, embedded systems, neural networks, sensors/actuators, robotics, VHDL, Python

Contact

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