Imperial College London

NeMo, SpikeStream, iSpike:

Three Tools for Biologically-Inspired Spiking Neural Networks and Robotics

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Introduction

In the Department of Computing at Imperial College London we have developed a number of open source tools for the simulation and analysis of spiking neural networks. These include NeMo, a CUDA-based simulator of spiking neural networks, SpikeStream, a visual interface to NeMo that provides network creation and analysis tools, and iSpike, which enables networks to be connected to the iCub robot. Each of these tools can be used independently, and they work well together, as shown in Figure 1.

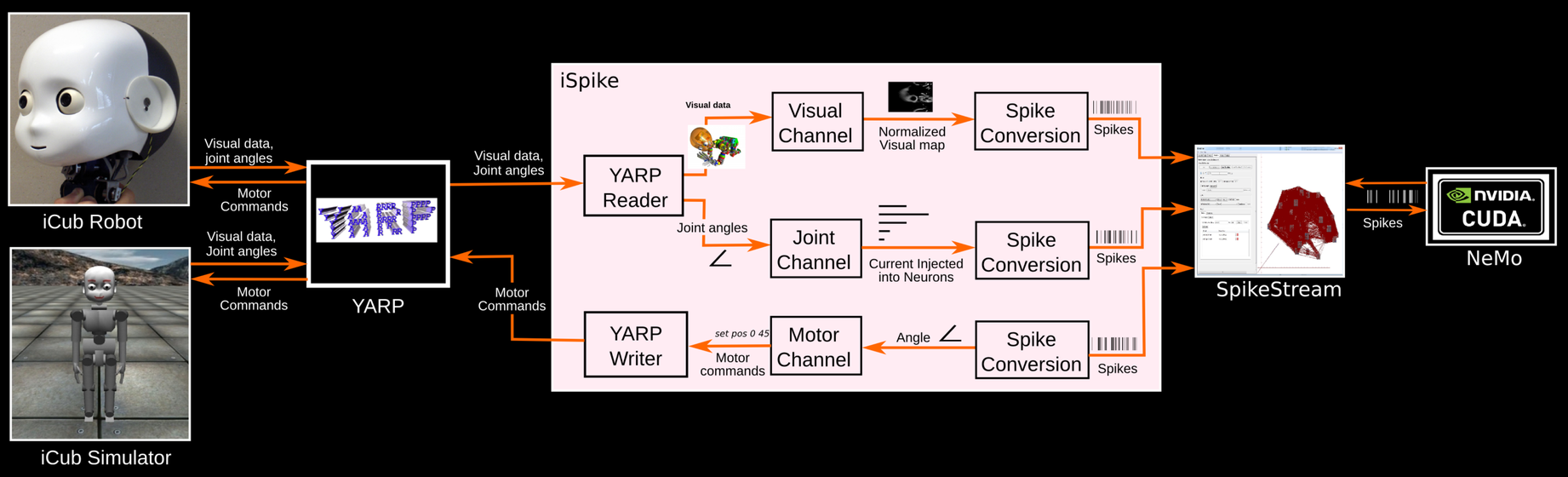

FIGURE 1. Combined architecture with NeMo, SpikeStream and iSpike

NeMo (http://nemosim.sf.net)

NeMo is a high-performance spiking neural simulator that simulates networks of Izhikevich neurons on CUDA-enabled GPUs. It supports real-time simulation of ~100,000 realistically connected neurons on a single GPU. NeMo is a C++ class library with APIs for Python (including PyNN), Matlab, and pure C. Learning is supported through spike time dependant plasticity (STDP). NeMo's architecture is shown in Figure 2; performance measurements for NeMo are given in Figure 3.

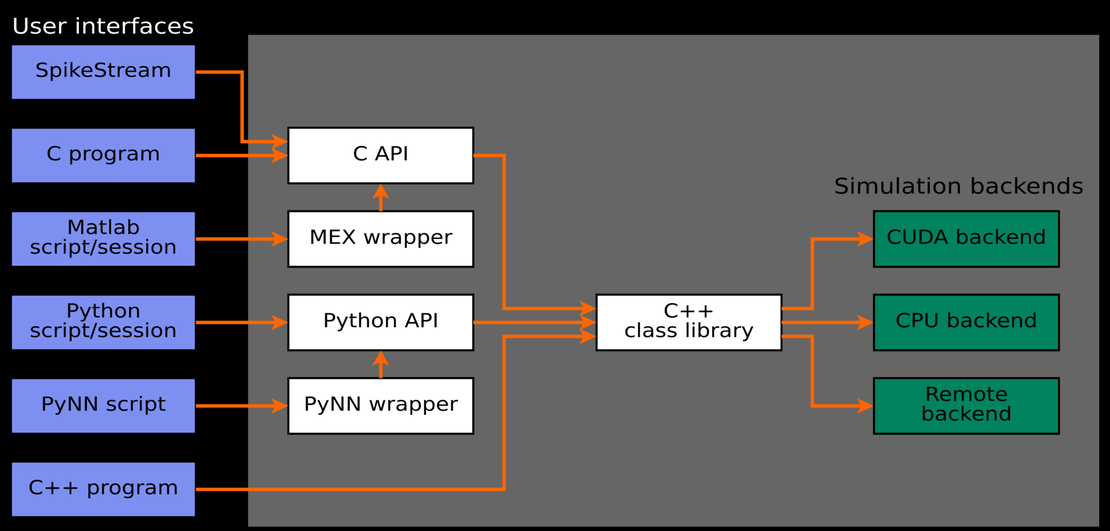

FIGURE 2. NeMo architecture

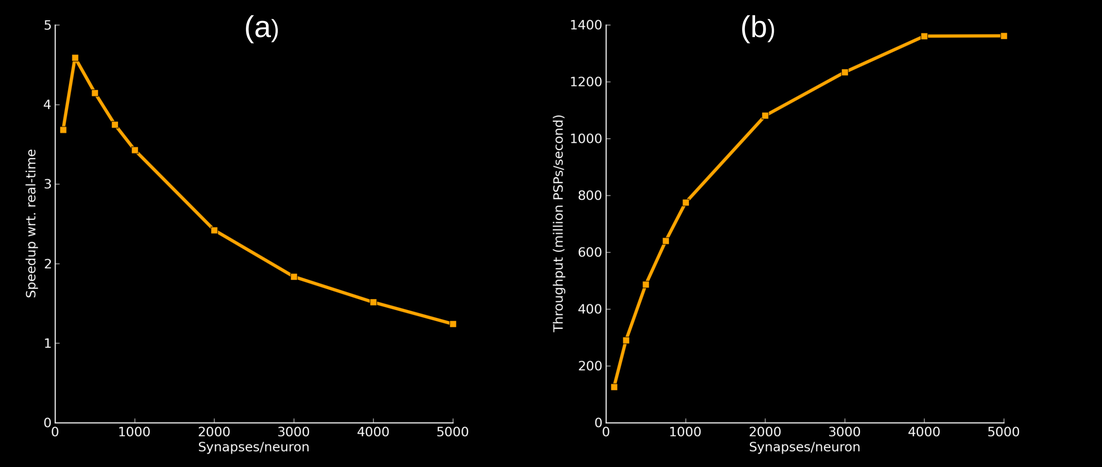

FIGURE 3. A) NeMo performance for a network of 30,000 neurons with a variable number of synapses per neuron, running on a C2070 GPU. (a) Speedup measured wrt. real time performance; (b) Throughput measured in terms of spikes delivered per second.

SpikeStream (http://spikestream.sf.net)

SpikeStream provides a graphical interface to NeMo and iSpike, and has the following key features:

- *Sophisticated visualization and editing tools*. An intuitive graphical user interface (see Figure 4) has been developed for the creation and editing of neuron and connection groups and to control the simulation and archiving. Neural activity and archived simulation runs can be viewed in three dimensions.
- *Database storage*. SpikeStream is based around a number of databases that hold the neurons, connections, parameters, archives and analyses.
- *Plugin architecture*. Key functions, such as network creation, simulation and analysis are implemented as plugins, which makes it easy to customize and extend the functionality.
- *C++ / Qt*. The simulator is written in C++ using Qt for the GUI.

The 3D graphical interface of SpikeStream is shown in Figure 4.

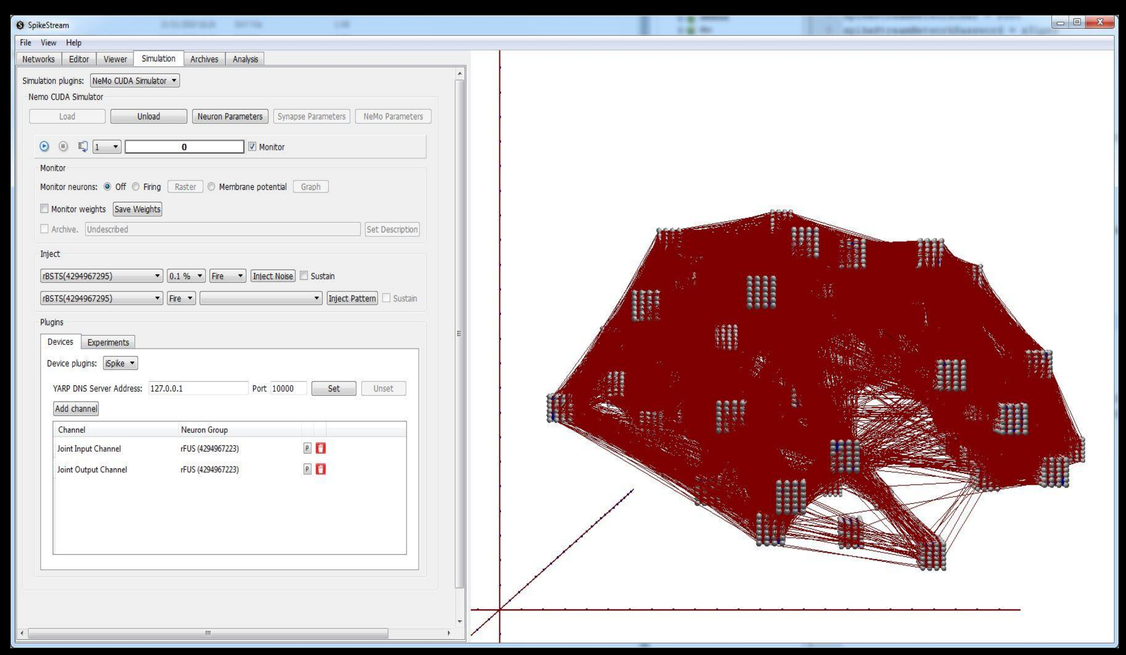

FIGURE 4. SpikeStream 3D graphical interface

iSpike (http://ispike.sf.net)

iSpike provides a spiking neural interface to the real and virtual iCub humanoid robots. This system uses a biologically plausible spike coding scheme to convert the iCub's visual and proprioceptive data into spikes, and it converts spikes from the neural simulator back into real values that are used to control the iCub robot.

Software

All of the software is open source and available for free download under a GPL licence.

NeMo: http://nemosim.sf.net

SpikeStream: http://spikestream.sf.net

iSpike: http://ispike.sf.net

Acknowledgements

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