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► **To cite this version:**

Farad Khoystatee, Timothée Levi, Sylvain Saïghi. FPGA Implementation of the Hodgkin-Huxley Model for Neurological Disease study. The 2nd International Symposium on Neuromorphic, non-linear, Neurofluidic Engineering, ISNNE, Mar 2017, Bordeaux, France. hal-01567567

HAL Id: hal-01567567

<https://hal.science/hal-01567567>

Submitted on 24 Jul 2017

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FPGA Implementation of the Hodgkin-Huxley Model for Neurological Disease study

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Neurological disorders affect millions of people around the world which influence their cognitive and/or motor capabilities. The realization of a prosthesis must consider the biological activity of the cells and the connection between machine and biological cells. Biomimetic neural network is one solution in front of neurological diseases. The neuron replacement should be processed by reproducing the timing and the shape of the spike. Several mathematical equations which model neural activities exist. The most biologically plausible one is the Hodgkin-Huxley model. Among them, multicompartmental models allow to increase the accuracy of the membrane voltage computation and take into account of the nerve fiber around the neuron. The connection between electrical devices and living cells require a real-time system. In addition, studying neurodegenerative troubles requires a tunable appliance. The FPGA is one of the best component including flexibility, speed and stability. Here we propose a biomimetic neuron composed of a FPGA as a central processing unit and a DAC as the spike generator. This work introduces the implementation of a real-time SNN (Spiking Neural Network) serving as a presage for a modulating network opening a large scale of possibilities. The conception of neuroprosthesis as damage cells replacement and the study of the effect of the cells disease on the neural network are the main objectives.

