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Biomimetic Spiking Neural Network for biohybrid systems

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Millions of people worldwide are affected by neurological disorders which disrupt connections between brain and body causing paralysis or affect cognitive capabilities. The realization of neuroprostheses implies that we know how to interact with neuronal cell assemblies, taking into account the intrinsic spontaneous activity of neuronal networks and understanding how to drive them into a desired state or to produce a specific behavior. The long-term goal of replacing damaged brain areas with artificial devices also requires the development of Spiking Neural Network (SNN) system. They will fit with the recorded electrophysiological patterns and will produce in their turn the correct stimulation patterns for the brain so as to recover the desired function. Our study describes the development of neuromorphic devices containing biomimetic neural networks.

Two designs are described, one using digital silicon neurons, and the other using microfluidic neurons, which is a new way to explore in neuromorphic engineering.

Firstly, the digital SNN implements biologically realistic neural network models, spanning from the electrophysiological properties of one single neuron up to network plasticity rules. Secondly, a new approach which is not yet in the state of the art is the design of biomimetic artificial neuron using microfluidic techniques.

