Dynamics of two coupled electronic neuron-like generators

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Neuromorphic technologies are among the most actual interdisciplinary fields of science. Neuromorphic devices are developing to implement principles and algorithms of brain information processing in computational systems. Neuromorphic devices require development of electronic components: neurons and synapses.

In paper [1] electronic implementation of neuron-like generator based on phase-locked loop with bandpass filter in control loop was proposed. The oscillations generated by this circuit are similar to spiking and bursting oscillations of membrane potential of living neurons. Significant disadvantage of the proposed neuron-like generator based on PLL is the absence of non-oscillating dynamic mode. The excitability is a key feature of neurons. Neurons are excitable in the sense that they are typically at rest but can fire spikes in response to certain forms of stimulation.

To eliminate this disadvantage and implement excitable mode modified neuron-like generator was proposed [2]. The switch activated by the signal over threshold has been included in the circuit between lowpass and highpass branches of the loop filter.

The excitability of the proposed generator is studied under external pulse stimulation. Experimental study of electronic neuron-like generator with excitable and self-oscillating modes have conducted. Spiking and bursting self-oscillating modes known from numerical simulations were observed. Novel excitable dynamics was studied in presence of external pulse stimulation.

Dynamics of two coupled neuron-like generators have been studied experimentally.

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[1] M.A. Mishchenko, D.I. Bolshakov, V.V. Matrosov, “Instrumental implementation of a neuronlike generator with spiking and bursting dynamics based on a phase-locked loop” Tech. Phys. Lett., vol. 43(7), pp.596–599, 2017.

[2] M.A. Mishchenko, D.I. Bolshakov, V.V. Matrosov, I.V. Sysoev, “Excitation of electronic neuron-like generator with pulse stimulation”, Computational Biophysics and Nanobiophotonics, Vol. 1219407, № May. P. 12, 2022.