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Pulsed Neural Networks Consisting of Single-Flux-Quantum Spiking Neurons

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We developed the method of constructing pulsed neural networks with single-flux-quantum (SFQ) circuits. The network consists of single-flux-quantum (SFQ) spiking neuron devices we had developed and reported in [1]. The neuron device is based on the integrate-and-fire neuron (IFN) model and uses a SFQ pulse as an action signal or a spike of neurons. Using this SFQ neuron, we constructed neural networks that can perform pulse-based computation for intelligent, brain-like information processing.

As a sample network system, we constructed the *inhibitory neural network* in which IFNs are coupled to each other through all-to-all inhibitory connections of equal strength. The network consists of many IFNs and a global inhibitor. Each IFN circuit accepts input pulses and produced the corresponding output pulses. The global inhibitor receives the sum of the IFN outputs and produces an inhibitory output for all neurons.

Computer simulation showed that IFNs receiving frequent pulse inputs remained active, while IFNs receiving infrequent pulse inputs became inactive. This is caused by the fact that IFNs receiving frequent input generates output pulses, and the output pulse suppresses the internal state of the other IFNs receiving infrequent input pulses. This caused by the network-inhibition phenomenon.

[1] Hirose T., et.al., the 18th International Symposium on Superconductivity, p.327, Tsukuba, Japan, 2005.