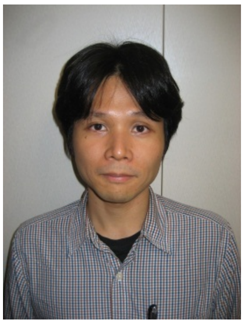
Tutorial speakers:

Introduction to silicon neuron and neuronal networks



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Abstract:

The silicon neuronal network is an electronic circuit system designed to mimic the biophysical functions in the nerve system, which is realized by interconnecting the silicon neurons and synapses, electronic counterparts to the neurons and the synapses. It has three major application fields; the hybrid system, the real-time neural network simulator, and the neuromorphic system. The hybrid system between the nerve system and the silicon neuronal networks have been playing crucial roles as neurophysiological research tools as well as are expected to realize novel biomedical devices. The neuromorphic system is expected to provide a robust, autonomous, and energy-efficient computation and controlling platform whose operating principle is similar to the nerve system.
Most of the silicon neurons are implemented using the Complementary Metal Oxide Semiconductor (CMOS) technology to simulate in real-time the activities of the membrane potential in neuronal cells. A wide variety of implementations have been tried in the aspect of their circuitry and the neuronal models they are based on. For the biomedical applications, a detailed ionic conductance neuron model has been implemented using ultra-low-power consuming circuitry, whereas more configurable models and circuitry with more precise operation were selected for the real-time simulators. Another most historical trend is to adopt an ultimately simplified model, the Leaky Integrage-and-Fire (LIF) model, to avoid difficulty of implementation and realize relatively large-scale network. Though it succeeded in the implementation aspect, the over-simplifed model seemed to provide very few functionality. In these years, several efforts based on the nonlinear mathematics are made to find the silicon neuron models with sufficient dynamics that are feasible for implementation of large-scale silicon neuronal networks.

Biography:

Takashi Kohno, M.D., Ph.D., received the B.E. degree in medicine and the Ph.D. degree in mathematical engineering from University of Tokyo, Japan, in 1996 and 2002, respectively. After experiencing designing of medical care information systems in Hamamatsu University School of Medicine, took the job of a group leader in Aihara Complexity Modeling Project, Exploratory Research for Advanced Technology (ERATO), Japan Science and Technology Agency (JST), Japan. He is currently an associate professor in Institute of Industrial Science, University of Tokyo, Japan.
His research interests include the construction of the silicon neuronal networks, an artificially realized nerve system, and nonlinear dynamics in the models of the neuronal cells and the synapses. Based on his knowledge over the three academic fields, applied nonlinear mathematics, neurophysiology, and electronic circuit design, he is realizing a simple, compact, and low-power consuming silicon neuron circuit whose dynamics are qualitatively equivalent to several classes of neuronal cells and can be selected at run-time. His main interest is moving to construction of small silicon neural networks and autonomous regulation of the silicon neuron circuit. The final goal of his research is to realize a brain-like computing system that is at least comparable to the human brain.
In his private life, he has a long history of developing digital circuits including an original microprocessor and electronic circuit development tools such as a logic analyzer and a ROM emulator. It started in the mid-1980s and his first personal FPGA device board was with him in the early 1990s. He has a number of contributions to Japanese industry journals on digital circuit design.