Brain-Morphic AI to Resolve Social Issues

[Brain-Morphic AI]

Social Cooperation Programs, Institute of Industrial Science

Social Cooperation Programs

https://www.iis.u-tokyo.ac.jp/en/research/department_center/social_ai/

Abstract

The purpose of this laboratory is to generate a novel type of computing systems including algorithms and devices, which can achieve very high performance of AI information processing with low power consumption like the brain to solve various social problems. For this sake, we develop a novel fundamental technology of the information processing based on neuromimetic circuit development for the brain-morphic AI system which can execute fast intelligent-and-autonomous information processing with low energy.

Schematics of Our Project

Problems of the conventional AI implementation

Especially for edge-side usage, it needs high power consumption to solve social issues.

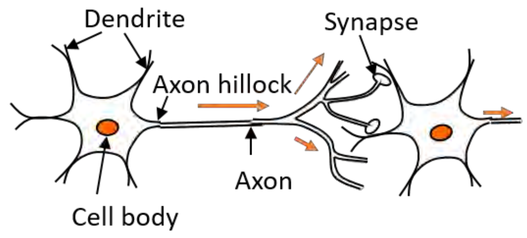
Our approach: Brain-Morphic AI

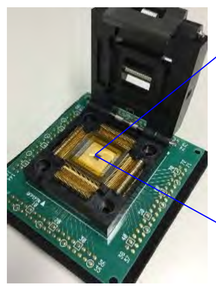
The Brain : Fast intelligent-and-autonomous information processing with low energy.

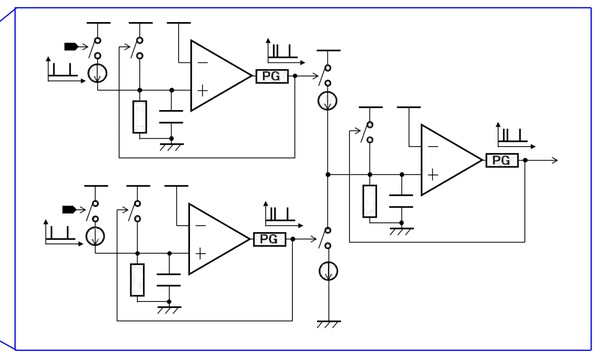
Brain-morphic circuits : implementation of AI information processing with low power consumption.

$$
\begin{aligned}
I &= C_m \frac{dV_m}{dt} + g_k n^4 (V_m - V_K) + g_{Na} m^3 h (V_m - V_{Na}) + g_l (V_m - V_l) \\
\frac{dn}{dt} &= \alpha_n(V_m)(1-n) - \beta_n(V_m) n \\
\frac{dm}{dt} &= \alpha_m(V_m)(1-m) - \beta_m(V_m) m \\
&\vdots
\end{aligned}
$$

(The Hodgkin–Huxley model)



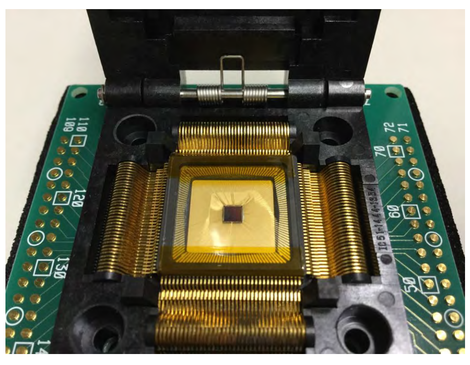




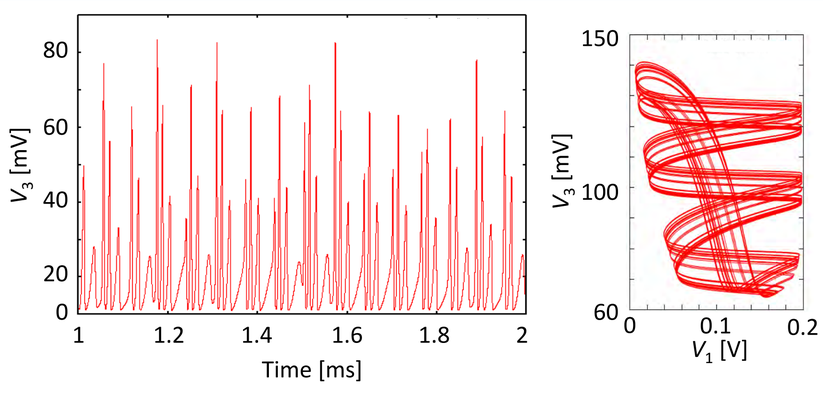
Novel fundamental technology of the information processing

1. Very high performance of AI information processing with low power consumption.
2. Solve various social problems.

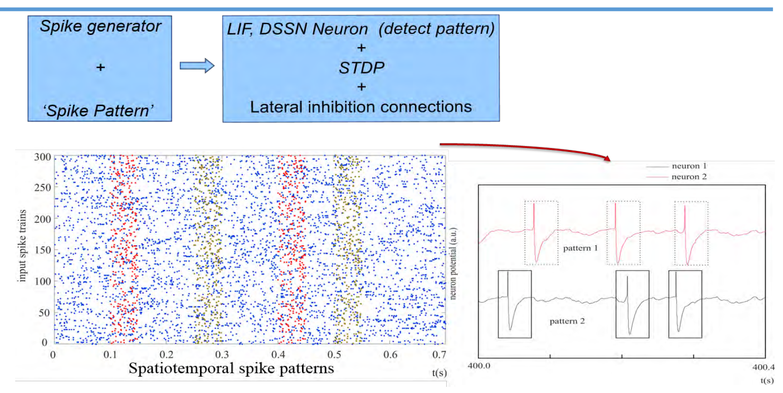
Recent Activities



A developed analog integrated circuit aiming at reproducing stochastic behavior of ion channels in real neurons and at generating pseudo-random number with low-power consumption.



Simulation results on an ultra-low-power pseudo-random-number-generator circuit model.
(Left: Time series, Right: Attractor)



Algorithm and simulation results of pattern recognition in a noisy environment using digital spiking silicon neurons (DSSN) and STDP learning. Only 9 neurons are needed to detect 3 different patterns.
STDP : Spike Timing Dependent Plasticity