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Oscillation in Two-Template CNN with Periodic Boundary Condition

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1. Introduction

In our previous study [1], we have proposed a two-template CNN. This system was proposed in order to investigate a new class of coupled oscillatory systems. It is not so easy to implement this structure by using oscillatory circuits. We consider that investigating this system is important to understand the new class of coupled oscillatory systems. We investigated the two-template CNN with several conditions. As a result, the oscillatory phenomena were observed only in the case of the fixed boundary conditions [2].

In this study, we apply a different condition for the template from that in the past study and investigate oscillatory phenomena in the case of the periodic boundary condition.

2. Two-template CNN

Two-template CNN in this study is defined by the following equations.

1: The case that $i+j$ is an even number.

$$\begin{aligned}\frac{dx_{ij}}{dt} =& -x_{ij} + I_\alpha \\ &+ \sum_{c(k,l)} A_\alpha(i,j;k,l)y_{kl} \\ &+ \sum_{c(k,l)} B_\alpha(i,j;k,l)u_{kl}\end{aligned} \tag{1}$$

2: The case that $i+j$ is an odd number.

$$\begin{aligned}\frac{dx_{ij}}{dt} =& -x_{ij} + I_\beta \\ &+ \sum_{c(k,l)} A_\beta(i,j;k,l)y_{kl} \\ &+ \sum_{c(k,l)} B_\beta(i,j;k,l)u_{kl}\end{aligned} \tag{2}$$

$A_{\{\alpha\beta\}}(i,j;k,l)$, $B_{\{\alpha\beta\}}(i,j;k,l)$ and $I_{\{\alpha\beta\}}$ are called as the feedback coefficient, the control coefficient and the bias current, respectively. The output equation of the cell is given as follows:

$$y_{ij} = f(x_{ij}). \tag{3}$$

where,

$$f(x) = 0.5(|x+1| - |x-1|). \tag{4}$$

The variables u and y are the input and output variables of the cell, respectively.

3. Computer simulation

We carried out computer simulations by using the following conditions. Boundary condition is periodic. Initial state values are set as random values. The number of cells is fixed as 8×8. The parameters of the template are given as the following form.

$$\boldsymbol{A}_\alpha = \begin{pmatrix} -u & v & -u \\ v & w & v \\ -u & v & -u \end{pmatrix}, \quad \boldsymbol{A}_\beta = \begin{pmatrix} u & -v & u \\ -v & -w & -v \\ u & -v & u \end{pmatrix},$$
$$\boldsymbol{B}_\alpha = 0, \quad \boldsymbol{B}_\beta = 0, \quad I_\alpha = 0, \quad I_\beta = 0. \tag{5}$$

The condition of the template was more limited in the past study.

Figure 1 shows one of the computer simulation results. Oscillatory phenomena are observed and some cells are synchronized.

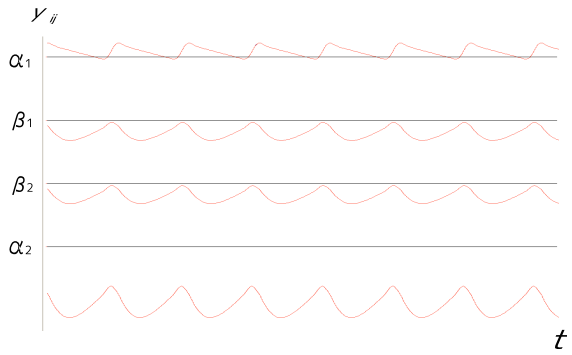

Fig. 1: Oscillatory phenomena in the case of $u = 1$, $v = 1.1$ and $w = 1$. Vertical axes are synchronized groupes of cells. Horizontal axes are time. Cells are divided into four groups.

4. Conclusions

In this study, we investigated the oscillation phenomena in two-template CNN with the priodic boundary condition. We will investigate a range of the oscillation region.

References

[1] J. Fijii, Y. Hosokawa and Y. Nishio, "Wave Phenomena in Cellular Neural Networks Using Two Kinds of Template Sets," *Proc. of NOLTA'07*, pp. 23–26, 2007.

[2] J. Fujii, Y. Hosokawa and Y. Nishio, "Oscillatory Phenomena in Cellular Neural Networks Using Two Kinds of Templates," *Proc. of NOLTA'08*, pp. 688–691, 2008.