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Relationship between Oscillatory Phenomena and Initial Values in Two-Template CNN

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1. Introduction

In our earlier study, we proposed Two-Template CNN[1]. Two kinds of templates are used in this CNN. Cells having one template and the other are placed as checkered. This system is proposed in order to investigate a new class of coupled oscillatory system. Namely, by using two kinds of templates, oscillatory factors are coupled checkered. Realizing this structure using oscillatory circuits is not so easy. In this system, we observed oscillatory phenomena. The phenomena mean that this system is a new class of coupled oscillatory system.

In this study, we investigate the relationship between oscillatory phenomena and initial values.

2. System Model

Figure 1 shows a system model of our proposed system. We assume that the system has a two-dimensional M by N array structure. Each cell in the array is denoted as $c(i,j)$, where (i,j) is the position of the cell, $1 \leq i \leq M$ and $1 \leq j \leq N$. The coupling radius is assumed to be one. In this proposed CNN, two kinds of templates are used. Cells having one template are called as Cell α and the other are called as Cell β. These two types of the cells are placed as checkered. The state equations of the cells are given as follows:

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.

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

$A_{\{\alpha\beta\}}(i,j;k,l)y_{kl}$, $B_{\{\alpha\beta\}}(i,j;k,l)u_{kl}$ 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:

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

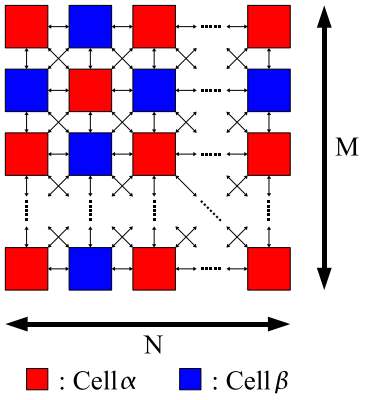

Figure 1: System model of Two-Template CNN.

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. $\boldsymbol{A}_\alpha$, $\boldsymbol{B}_\alpha$, $\boldsymbol{A}_\beta$ and $\boldsymbol{B}_\beta$ are 3 times 3 matrices.

3. Oscillatory Phenomena and Initial Values

We investigate a relationship between oscillatory phenomena and initial values in this system. The number of cells are set as 15×15. We define two parameters which concern oscillatory phenomena. Some patterns of initial values are investigated. As a result, we confirmed that there are two cases. One is the case that oscillatory phenomena are observed in all patterns of initial values. Additionally, in this case, we confirmed that the ratio of two parameters is a constant. The other is the case that oscillatory phenomena are observed by depending on initial values. In this case, the region shown as two parameter is changed by initial values.

4. Conclusions

In this study, we investigate a relationship between oscillatory phenomena and initial values in Two-Template CNN. As a result, we confirmed that there are two cases.

References

[1] Junji Fujii, Yasuteru Hosokawa and Yoshifumi Nishio, "Wave Phenomena in Cellular Neural Networks Using Two Kinds of Template Sets," Proc. of 2007 International Symposium on Nonlinear Theory and its Applications, pp. 23-26, Sep. 2007.