Relationship between Oscillatory Phenomena and the Number of Cells in Two-Template CNN

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I. SUMMARY

We have proposed a two template CNN as shown in following equation.

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

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

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

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

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

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

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.

This system was proposed in order to investigate a new class of coupled oscillatory systems. The system consists of using two kinds of oscillatory factor. Additionally, the two kinds of oscillatory factors are arranged in a checkered pattern. Factors of oscillation is shared each others. Namely, two kinds of oscillatory factors are needed for a simple oscillation. It is not so easy to implement this structure by using oscillatory circuit. Complex oscillatory phenomena are observed in the case that the number of cells are set as 49×49. However, in the case that the number of cells set as 3×3, only a simple synchronized pattern is observed.

In this study, the relationship between oscillatory phenomena and the number of cells is investigated. Investigated numbers of cells are 3×3, 5×5, 7×7, ..., 49×49. Namely, the cases that the numbers of rows and columns is set as odd numbers are investigated. In the case of even numbers, the system becomes an asymmetry and many complex phenomena are observed. For this reasons, we investigate the case of odd numbers only. By computer simulations, we could confirm that oscillatory phenomena were divided as two patterns. The two patterns are the case of oscillating and the case of oscillating boundary cells. Additionally, parameter regions of oscillators are investigated.

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