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Layout of Cells for CNN Using Three Kinds of Cloning Templates

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1. Introduction

Cellular Neural Networks (CNNs) using three cells can generate double scroll type attractors. In our previous study, CNN using three kinds of cloning templates was proposed as one of chaotic oscillatory system. Various phenomena can be observed. However, relationship between differences of observed phenomena and the number of cells could not be revealed. This system to share the elements of the oscillation. Because this system share the elements of oscillation. Therefore, parameters include various the elements of oscillation in this system. In this study, new system is proposed. This system that cells layout method is changed. Parameters can divide into various elements in this system. Phenomena of previous system and new system are compared.

2. CNN Using Three Kinds of Cloning Templates

The system consists of three kinds of cells which names are Cell α, Cell β or Cell γ. The difference of three kinds of cells is only values of cloning templates. The number of cells is defined as $M \times N$. Cells are coupled as triangle lattice. The boundary condition is set as a periodic condition. Namely, this system has a torus structure. Structures of previous and new CNN using three kinds of cloning templates are shown in Table 1. Cloning template parameters of previous system and new system are set as follows.

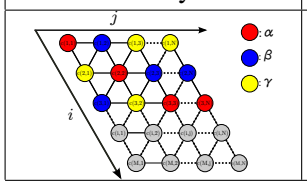
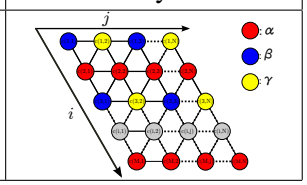
Previous system	New system
	

Table 1: Structure of CNN using three kinds of cloning templates.

$$\boldsymbol{A}_\alpha = \begin{pmatrix} & k & & l & \\ l & & 1.24 & & k \\ & k & & l & \end{pmatrix},\ \boldsymbol{A}_\beta = \begin{pmatrix} & m & & k & \\ k & & 1.1 & & m \\ & m & & k & \end{pmatrix},$$

$$\boldsymbol{A}_\gamma = \begin{pmatrix} & l & & -m & \\ -m & & 1.0 & & l \\ & l & & -m & \end{pmatrix}$$

$$\boldsymbol{A}_\alpha = \begin{pmatrix} & o & & o & \\ n & & 1.24 & & n \\ & 0 & & 0 & \end{pmatrix},\ \boldsymbol{A}_\beta = \begin{pmatrix} & 0 & & 0 & \\ k & & 1.1 & & k \\ & m & & m & \end{pmatrix},$$

$$\boldsymbol{A}_\gamma = \begin{pmatrix} & 0 & & 0 & \\ -m & & 1.0 & & -m \\ & l & & l & \end{pmatrix}$$

where k, l, m, n and o show the coupling strengths between Cell α and Cell β, Cell α and Cell γ, Cell β and Cell γ, Cell α and Cell α, Cell α and Cell β or Cell γ, respectively.

3. Simulation

Figure 1 shows computer simulation of case of six cells ($M = 2$, $N = 3$) in previous system. By changing a parameter, some periodic orbits, bifurcation phenomena and chaotic phenomena are observed. However, observed phenomena are not controlled by changing parameter when the number of cells are increased. Figure 2 shows computer simulation of case of one hundred cells ($M = 10$, $N = 10$) in new system. Chaotic phenomena are observed. And this phenomena can be observed in wide range of parameters as compared to the previous system.

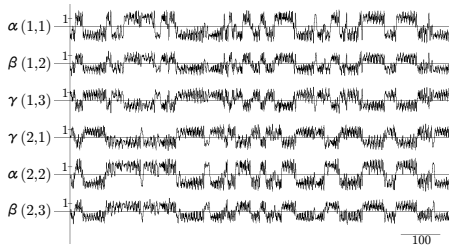


Fig. 1: Waveforms are case of six cells ($M = 2$, $N = 3$). Step size is 0.01. k = l = 1.06, m = 1.47.

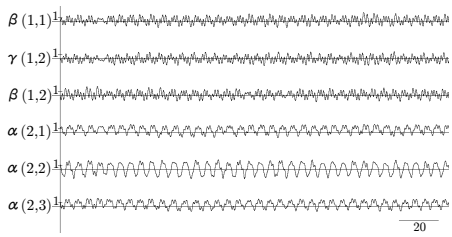


Fig. 2: Waveforms are case of Cell(1, 1), (1, 2), (1, 3), (2, 1), (2, 2) and (2, 3) in one hundred cells ($M = 10$, $N = 10$). Step size is 0.05. k = 1.20, l = 1.36, m = 5.5, n = 0.0, o = 2.2.

4. Conclusions

In this study, Cellular Neural Networks using three kinds of cloning templates were investigated. And new system which cell layout method is changed is proposed. Phenomena of previous system and new system are compared. As results, new system can be controlled between cells by parameters. For the future works, phenomena of previous system and new system are investigate in detail.