

Wave Propagation Phenomena in Modified Two Layer CNN

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1. Introduction

In this study, we propose modified two layer cellular neural network. The computer simulations show that the proposed system can generate similar phenomena which is observed from the two layer CNNs. Investigating these phenomena contributes to understand complex systems.

2. Modified Two Layer CNN

Figure 1 shows a system model in this study. 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, where $1 \leq i \leq M$ and $1 \leq j \leq N$. The coupling radius is assumed to be one in this study. In this proposed CNN, we use two kinds of template sets. Cells having one template set 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:

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

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

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

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

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

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

This proposed system is more complex than the normal CNN. This system has a peculiar characteristic in order to investigate a new class of cou-

pled oscillatory systems. Namely, a pair of cell α and cell β are needed for a simple oscillation. However, one cell α connects with four neighbor cells β and one cell β also connects with four neighbor cells α . Like this, these cells are sharing a factor of oscillation. This type of connection may be difficult to realize by coupling normal oscillators.

3. Computer Simulations

Figure 2 shows one of the computer simulation results in the case of stripe line pattern formation. We observe some corresponding results to two layer CNN.

4. Conclusions

We have proposed modified two layer CNN. In the proposed CNN, we could observe similar phenomena to the two-layer CNN. Investigating more complex phenomena which cannot be seen from the two-layer CNN is our future research.

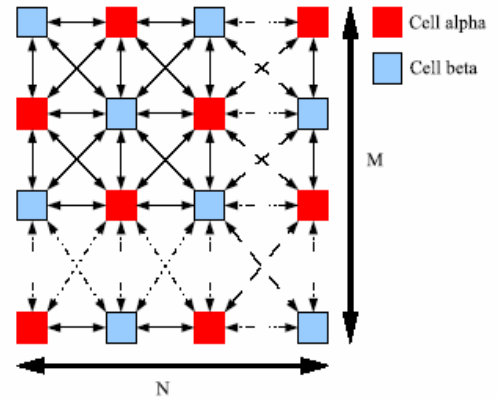


Figure 1: Structure of Modified Two Layer CNN

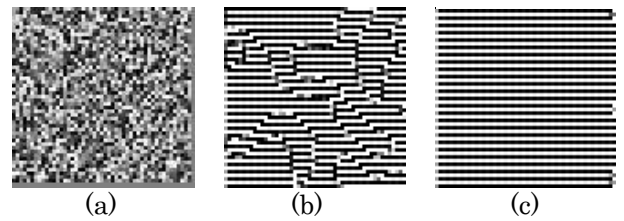


Figure 2: Stripe line pattern formation. (a) Initial state. (b) Transient state. (c) Stable state.

References

- [1] L. O. Chua and L. Yang, "Cellular Neural Networks: Theory," *IEEE Trans. Circuits Syst.*, vol. 35, no. 10, pp. 1257-1272, 1988.