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Ring Inhibitory Neural Network with Polygonal Structure

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1. Introduction

In this paper, we propose a ring inhibitory neural network with polygonal structure. Some oscillation models of neural networks were studied by many researchers. In particular, the ring inhibitory neural network is one of the oscillation models with simple structure. We focus on synchronization phenomena of ring inhibitory neural networks with polygonal structure based on three-phase model and terms.

2. Ring inhibitory Neural Network

The ring inhibitory neural network is composed of annularly-linked neurons. Figure 1 shows the ring inhibitory neural network model. This model produces m-phases state if the number of neuron is m. Moreover, This model is imposed some conditions on oscillation. some terms to oscillate. Neurons are combined basically one way inhibitory. In addition, it is capable of observed oscillation that this system have an odd number of neurons without $m = 1$. There are equations of this models as follows Eqs.(1) and (2).

$$\tau \frac{dx_i}{dt} = -x_i + \sum_{j=1}^{m} w_{ji} f(x_j) \tag{1}$$

$$f(x) = \frac{1}{1 + e^{-x}} \tag{2}$$

Figure 2 shows oscillation for $m = 3$. In this study, we deal with discrete time modeling. In this study, the weight W_{ji} is set to $W_{ji} = -25.0$. The polygonal model is based on combination of three-phase ring inhibitory network.

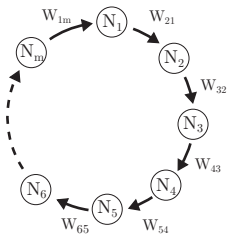

Figure 1: Oscillation system of ring neural network.

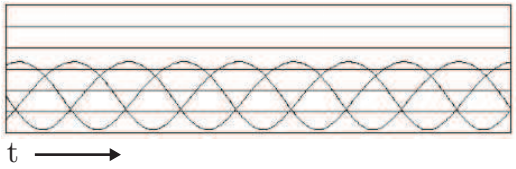

Figure 2: Oscillation of conventional model for $m = 3$.

3. Simulation results

The simulation models with polygonal structure are shown in Figs. 3 and 4. As a results of simulation, waveforms were observed as Figs. 5 and 6. It was indicated that both $m = 6$ and $m = 7$ model oscillates three-phase alternating current. In $m = 6$ model, N_1 and N_5 or N_2 and N_6 or N_3 and N_4 neurons output aspect wave patterns. In addition, waveforms of all neurons were phase synchronization. In constant, different waveforms from N_1, N_5 and N_6 or N_2, N_3 and N_7 or N_4 neurons were appeared in $m = 7$. We consider that the causes of the oscillatory difference are whether the model has a symmetry or neurons circulate with three.

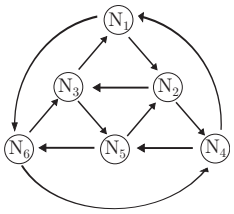

Figure 3: Oscillation system of polygonal model for $m = 6$.

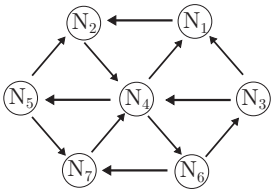

Figure 4: Oscillation system of polygonal model for $m = 7$.

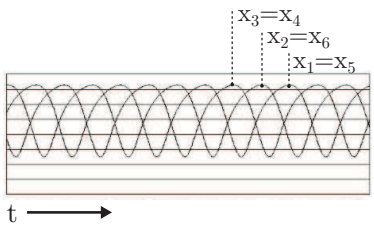

Figure 5: Oscillation of polygonal model for $m = 6$.

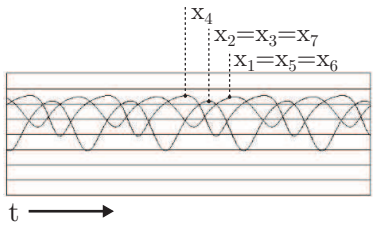

Figure 6: Oscillation of polygonal model for $m = 7$.

4. Conclusions

In this study, we proposed ring inhibitory neural network with polygonal structure. Different synchronization were appeared between the conventional model and the polygonal structure model. Moreover, the polygonal model that circulates with three oscillated phase synchronization.