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).

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

(1)

\[
f(x) = \frac{1}{1 + e^{-x}}
\]

(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.

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 \(N_1\), \(N_5\) or \(N_2\), \(N_6\) or \(N_3\) and \(N_4\) 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.

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.