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Synchronization in Complex Networks of Parametrically Excited Oscillators with Parameter Mismatch

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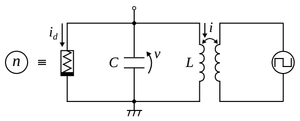
1. Introduction

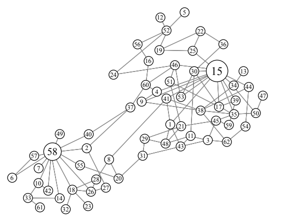
In this study, in order to research the relationship between the structural metrics in subset of the nodes including larger mismatch and synchronization in complex network, we investigate synchronization in complex network by adding large mismatch in three nodes. These nodes are elected by the value of structural metrics (degree and path length) in complex network. First, we investigate the synchronization probability in the network by changing the degree of the three nodes added larger mismatch. Next, we investigate the synchronization probability in the network by changing the path length among hubs, three nodes with larger mismatch.

2. System model

The circuit model of parametrically excited oscillator is shown in Fig. 1 (a). Complex network model is shown in Fig. 1. (a). In Fig. 1. (a), n express the circuit number of the complex network is shown in Fig. 1 (b).



(a) Circuit model.



(b) Complex network model.

Figure 1: System model.

The normalized circuit equations of this circuit equations are given by the following equations.

$$\begin{cases} \dfrac{dx_n}{d\tau} = \varepsilon(x_n - x_n^3) - y_n + \delta \displaystyle\sum_{k \in S_n} (x_k - x_n) \\ \dfrac{dy_n}{d\tau} = \dfrac{1}{\gamma(\tau)} x_n \end{cases} \qquad (1)$$

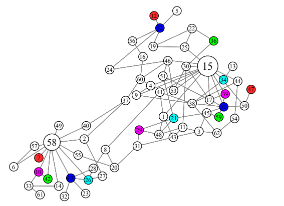
where $n = 1, 2, 3, ..., 10$. S_n is the set of nodes which are directly connected to the node n.

3. Simulation results

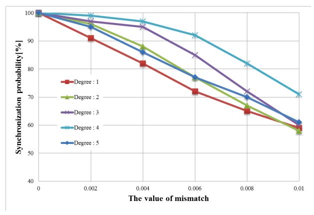
In this simulation, we investigate the synchronization probability in complex network by change the value of mismatch M from 0.002 to 0.01.

First, we add the M in three nodes which have the 5 types degrees (1 to 5). Figure 2 (a) shows the 5 types nodes with the value of mismatch M, and these colors are corresponding to the number of degree in Fig. (2) (b).When three nodes have 4 degrees, we can confirm the synchronization probability maintains the highest condition. On the other hand, when three nodes have 1, we can confirm the synchronization probability maintains the lowest condition.

Next, we investigate in what way the synchronization probability in complex network draw influence from the path length among hubs and three nodes with larger mismatch M. We investigate this influence in 3 cases. The results of this

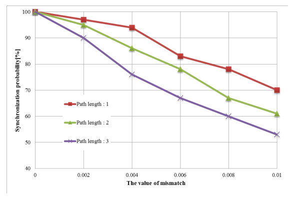


(a) The location of the 5-color nodes with larger mismatch M.

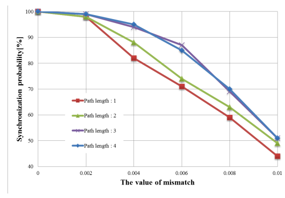


(b) Synchronization probability.

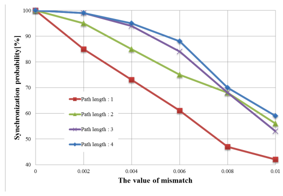
Figure 2: The location of the 5-color nodes and synchronization probability.



(a) Synchronization probability (case 1).



(b) Synchronization probability (case 2).



(c) Synchronization probability (case 3).

Figure 3: The synchronization probability in 3 cases.

investigation are shown in Fig. (3). In the case 1, we investigate the passage of the synchronization probability by changing larger mismatch M and the path length between hubs and each of three nodes with M. In the case 2, the hubs (15th and 58th node) are not connected to any of three nodes with M. Based on the acknowledgment, we investigate the passage of the synchronization probability by changing larger mismatch M and the path length among each of three nodes with M. In the case 3, the hubs (15th or 58th node) are connected to any of three nodes with M. On that basis, we investigate the passage of the synchronization probability by changing larger mismatch M and the path length among each of three nodes with M.

4. Conclusions

In this study, in order to more particular investigation of synchronization in complex network, we investigated synchronization probability in complex network by changing structural metrics (degree and path length) of the nodes corresponding to the subset of the nodes adding larger mismatch than other nodes.

We could observe the various change of the synchronization probability by changing structural metrics.