

Investigation of Synchronization in Complex Networks by Coupled Parametrically Excited Oscillators with Mismatch

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SUMMARY

Synchronization is one of the fundamental phenomena in nature and it is observed over the various fields. Studies on synchronization phenomena of coupled oscillators are extensively carried out in various fields, physics [1], biology [2], engineering and so on. Synchronization generated in the system can model certain synchronization of natural rhythm phenomena. Parametric excitation circuit is one of resonant circuits, and it is important to investigate various nonlinear phenomena of the parametric excitation circuits for future engineering applications. In simple oscillator including parametric excitation, Ref. [3] reports that the almost periodic oscillation occurs if nonlinear inductor has saturation characteristic. Additionally the occurrence of chaos is referenced in Refs. [4] and [5].

In our research group, we have investigated synchronization of parametrically excited van der Pol oscillators [6]. By carrying out computer calculations for two or three subcircuits cases, we have confirmed that various kinds of synchronization phenomena of chaos are observed. In the case of two subcircuits, the anti-phase synchronization is observed. In the case of three subcircuits, self-switching phenomenon of synchronization states is observed.

However, we have investigated the only simple network models. It is important to investigate more complex network for the broad-ranging future engineering applications. In our previous study, we have challenged to investigate the synchronization and clustering in more complex network modified from "Dolphin social network" [7] by using parametrically excited van der Pol oscillators with small mismatch [8]. We have confirmed that the network with hubs can induce synchronization. Though, we have only investigated the effects on synchronization offered by the location and number of pieces of the hubs, and we have only added small mismatch (dispersion) in whole.

In this study, in order to more particular investigation of synchronization in complex network, we focus on relationship between the structural metrics in subset of the nodes including larger mismatch and synchronization in complex network. In order to research this relationship, we investigate synchronization in complex network by changing structural metrics (degree and path length) corresponding to the subset of the nodes adding larger mismatch than other nodes. 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.

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