Relationship between Oscillation Frequency and Phase Difference of Coupled Chaotic Circuits

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SUMMARY

The synchronous phenomena are observed as not only fields of natural science but also various fields. For example, we can confirm the flashing of fireflies (a firefly is able to match frequency of other fireflies), metronome, heartbeat of the human, and so on. The synchronous phenomena have been researched extensively in physics [1] and biology [2]∼[3]. In addition, applying synchronous phenomena to medical technology are developed. These synchronous phenomena are known as one of the nonlinear phenomenon. For the future engineering application, we consider it is important to investigate synchronous phenomena of coupled chaotic circuits.

Synchronous discrimination of the chaotic circuit uses the phase difference generally. Not only the phase difference but also period and oscillation frequency exist in the coupled chaotic circuit. We pay attention to oscillation frequency in the coupled chaotic circuit. We can consider that entire circuits synchronize when oscillation frequency included in a certain circuit converges on a certain value. In this study, we compare synchronous discrimination by using phase difference and oscillation frequency. We assume that oscillation frequency converges on a steady value when the coupled chaotic circuits synchronize.

As simulation result, we confirm that synchronous state of chaotic circuits has no relationship with the oscillation frequency, although oscillation frequency converges on a steady value conclusively. Next, we compare from the other perspective whether there is relationship both side. In this circuit system, all chaotic circuits do not synchronize at the same time by increasing the coupling strength. Certain parts of circuits are synchronized depending on the circuit parameters. From these, we focus on timing of synchronization of among the coupled chaotic circuits. We investigate whether there is relationship in the timing of synchronization as we determine synchronous state of circuit by using oscillation frequency or phase difference.

REFERENCES

[1] I. Belykh, M. Hasler, M. Lauret and H. Nijmeijer, “Synchronization and graph topology,” Int. J. Bifurcation and Chaos, vol.15, no.11, pp.3423-3433, Nov. 2005.
[2] R. M. May, “Simple mathematical models with very complicated dynamics,” Nature 261, 459 467 (10 June 1976).
[3] J. Cosp, J. Madrenas, E. Alarcon, E. Vidal and G. Villar, “Synchronization of nonlinear electronic oscillators for neural computation,” IEEE Trans. Neural Networks, vol.15, no.5, pp.1315-1327, Sep. 2004.