Synchronization Phenomena and Oscillation Death in Star-Coupled van der Pol Oscillators by Adding Different Frequency Oscillators

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Summary

Synchronization has grown to a considerable research field in recent years. Synchronization phenomena in large populations of interacting elements are the subject of intense research efforts in physical, biological, chemical, and social systems.

Studies of synchronization phenomena have been reported in many fields: electrical and electronic engineering, physics, biology, chemistry, etc. Furthermore, the applications of synchronization phenomena have also found in chemical, physical and biological fields: about chaos synchronization of chemical models, about synchronization and coupling analysis of applied cardiovascular physics in sleep medicine, or about multistate and multistage synchronization with excitatory chemical and electrical synapses, etc. In addition, in the organism, synchronization phenomena has been observed in the activity of the brain and the operation of the heart. It is considered to have become an important role. In the future, analysis of brain activity and analysis of heart activity are very important. Its application to engineering fields such as the realization of brain computer is expected.

The van der Pol oscillator was originally proposed by the Dutch electrical engineer and physicist Balthasar van der Pol, van der Pol found stable oscillations, which he called relaxation-oscillations, and are now known as limit cycles, in electrical circuits employing vacuum tubes. In common, van der Pol oscillator is a non conservative oscillator with non-linear damping. It evolves in time according to the second order differential equation:

$$\frac{d^2x}{dt^2} - \varepsilon(1 - x^2)\frac{dx}{dt} + x \quad = \quad 0$$

In this study, we investigate the effect to three star-coupled oscillators by adding another oscillator with different frequency. In this work, we confirm the case of four oscillators and the case of five oscillators in the system. First, we change the parameter α of the fourth oscillator and investigate the effect to the star-coupled circuits with three oscillators. Next, we add the fifth oscillator and investigate the effect to the star-coupled oscillators. We consider that many unknown phenomena remain in such systems. Therefore, it is very important to investigate such systems.

References

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