Switching Synchronization Phenomena of a Ring of Coupled Chaotic Circuits with One-Direction Time-Delayed Effects

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SUMMARY

Studies on synchronization state are extensively carried out in various fields [1]-[3]. Recently, in particular, the synchronization states in chaotic oscillators are studied by many researchers. The behavior of chaotic oscillators is interesting. Then, the chaos phenomena are quite dependent on initial values and not periodical and predictable. Moreover the synchronization states have caused very interesting phenomena. A synchronization and the related the bifurcation of chaotic systems are good methods to describe various high-dimensional nonlinear phenomena in the field of natural science. However, many synchronization states of coupled chaotic oscillators have not been solved yet. The synchronization phenomena in the electric circuit make clear the mechanism of the synchronization phenomena in our daily life. There are many nonlinear systems containing time delay, such as neural networks, control systems, meteorological systems, biological systems and so on in the natural world. Thus, the investigation of the stability in such time-delayed systems is important [4]. The generation of chaos has been reported in all self excited oscillation systems containing a time delay [5]. The oscillators have feedback systems which control gains in this study. Such a chaotic circuit can be easily realized by using a simple electric circuit element and can be analyzed exactly. The coupling switch connects alternately with one subcircuit and other with a fixed time interval. On the other hand, there are examples of nonlinear phenomena, chaotic synchronization and so on [6]. In particular, many studies on the synchronization of coupled chaotic circuits have been reported [7].

In this study, we devise the novel coupling method that takes advantage of the features of time-delayed chaotic circuits. The novel coupled method utilizes the characteristics of circuits having time-delayed feedback. Then, we observe switching the synchronization state. We carry out computer calculations for three coupled auto gain controlled oscillators and investigate time-delayed subcircuits effects a change of the synchronization state and the time waveform. The switching synchronization state is changed by each time-delayed subcircuit. We focus on relationships between the switching synchronization state and the pattern of time delay. Moreover, we investigate the cycle of the switching synchronization state.

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