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Synchronization Phenomena of Coupled Chaotic Circuits with Symmetrical and Asymmetric Structures

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1. Introduction

Nonlinear phenomena of coupled chaotic circuits are drawing attention from many researchers[1],[2]. In this study, we investigate the synchronization phenomena of coupled two symmetrical structures and the influence of the network topology when we use chaotic circuits. One structure generates chaotic attractors and the other structure generates three-periodic attractors. Moreover, we observe the synchronization phenomena of networks with asymmetrical structures and we compare networks with symmetrical structures to networks with asymmetrical structures.

2. Circuit model

The chaotic circuit is shown in Fig. 1 and the system model is shown in Fig. 2. This chaotic circuit consists of two inductors L1 and L2, one capacitor C, negative resistor −r and two diodes.

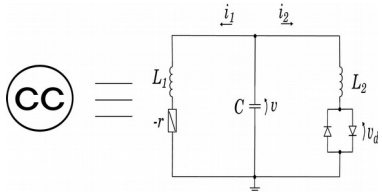


Fig.1 Chaotic circuit.

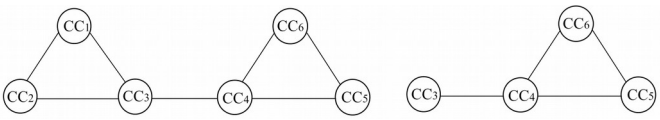
The normalized equations of chaotic circuits are given as follows:

$$\begin{cases} \dfrac{dx_i}{d\tau} = \alpha x_i + z_i \\ \dfrac{dy_i}{d\tau} = z_i - f(y_i) \\ \dfrac{dz_i}{d\tau} = -x_i - \beta y_i - \displaystyle\sum_{i,j=1}^{6} \gamma_{ij}(z_i - z_j) \end{cases}$$

$(i, j = 1, 2, \cdots, 6).$

where γ is the coupling strength.

Figure 2 shows the proposed system models. We propose the system models that the two symmetrical structures are coupled by a resistor in Fig. 2(a). In addition, we propose the system models that the two asymmetric structures are coupled by a resistor in Fig. 2(a'). In Fig. 2(a) and (a'), we set CC1 to CC3 as chaotic solution and CC4 to CC6 as three periodic solution. In this study, we set the coupling strength γ as 0.2, the coupling strength γ1 between the topologies as 0.1 and γ2 as 0.01 in all models.



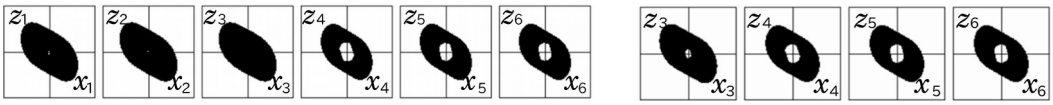
(a) 3-3Coupled model. (a') 1-3Coupled model.

Fig.2 System model.

3. Simulation results

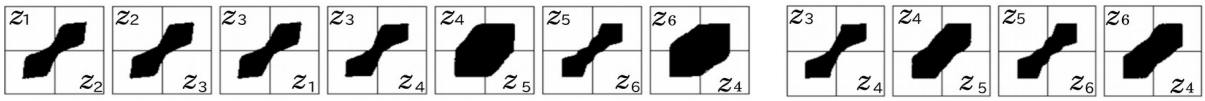
We investigate the synchronization phenomena in each model and the influence of topology. Figure 3 shows attractor of each chaotic circuit, Fig. 4 shows lissajous figures and Fig. 5 shows the volage of different waveform. In both model(a) and model(a'), CC4, CC5 and CC6 are generated chaotic attractor. Also, between

CC3 and CC4 are synchronized. CC4-CC5 and CC4-CC6 are asynchronous. CC5 and CC6 are chaotic synchronization in the model(a). Therefore, in CC5 and CC6, synchronous and asynchronous states changes irregularly in the simulation time.



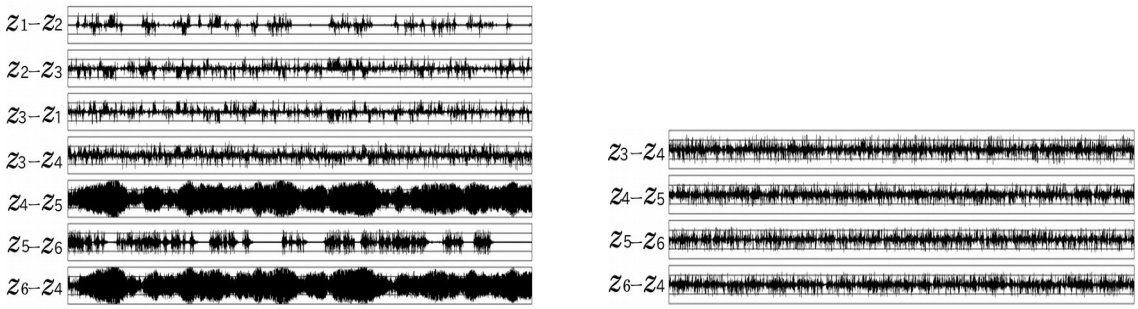
(a) 3-3Coupled model. (a') 1-3Coupled model.

Fig.3 Attractors.



(a) 3-3Coupled model. (a') 1-3Coupled model.

Fig.4 Lissajous figures.



(a) 3-3Coupled model. (a') 1-3Coupled model.

Fig.5 Different waveform.

4. Conclusion

In this study, we have proposed system models using two symmetrical structures and asymmetrical structures that are coupled by a resistor. We have investigated the synchronization phenomena by influence of topology of the system. By the computer simulations, we have observed synchronization phenomena in each model. As a result, network with coupled symmetrical structures (model(a)) has a strong influence on one circuit that are coupled between the structures. However, network with coupled asymmetric structures (model(a')) has the influence on all of the circuits in topology.

In the future works, we will investigate the synchronization phenomena by changing the coupling strength. Moreover, we observe the influence for the topology of the network.

Acknowledgment

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References

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