

Synchronization Phenomena of Coupled Chaotic Circuits with Buffer

Akari OURA Kyohei FUJII Shuhei HASHIMOTO Yoko UWATE Yoshifumi NISHIO
 (Tokushima University)

1. Introduction

Synchronization phenomena are observed everywhere. For example, flashing firefly, crowing tree frogs, beating rhythm of the heart. Recently, a lot of scientists study synchronization phenomena of chaos. Studying synchronization of chaos is expected useful in a variety of fields.

In this study, we investigate synchronization phenomena of coupled chaotic circuits in one direction. Each node is applied chaotic circuit and connected with resistance via buffer. By computer simulations, we observe interesting synchronization phenomena between circuits.

2. System Model

Figure 1 shows basic circuit. A proposed network model is shown in Fig. 2. In this study, chaotic circuits are applied to nodes of the network. Each node is coupled by resistance with buffers.

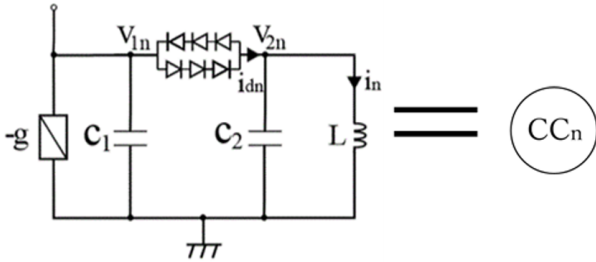


Figure 1: Circuit model.

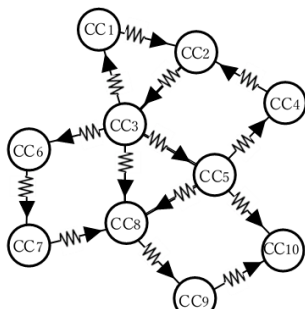


Figure 2: Network model.

The normalized circuit equations are given as follows:

$$\begin{cases} \dot{x} = z_n \\ \dot{y} = \alpha\gamma y_n - \alpha\beta f(y_n - z_n) - \alpha\delta f(y_n - y_k) \\ \dot{z} = \beta f(y_n - z_n) - x_n. \end{cases} \quad (1)$$

Where the nonlinear function corresponding to the characteristics of the nonlinear resistor of the diodes and are described as follows:

$$f(y_n - z_n) = \begin{cases} y_n - z_n - 1 & (y_n - z_n > 1) \\ 0 & (|y_n - z_n| \leq 1) \\ y_n - z_n + 1 & (y_n - z_n < -1). \end{cases} \quad (2)$$

3. Simulation results

In this study, we fix parameters as $\alpha = 0.5$, $\beta = 20$, $\gamma = 0.5$ and $\delta = 0.22$ on all circuits. The simulation results are shown in Figs. 3 to 5. Figures 3 and 4 show the phase difference. We observe in-phase state, in CC1-CC2 to CC5 (Fig. 3.). However, we did not observe in-phase state in CC1-CC6 to CC10 (Fig. 4.). Figure 5 shows the voltage difference. We did not observe difference of voltage in CC1-CC2 to CC5. However, we observed difference of voltage in CC1-CC6 to CC10.

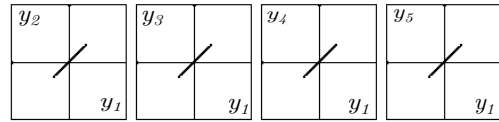


Figure 3: Phase difference (CC1-CC2, CC1-CC3, CC1-CC4, and CC1-CC5). $\delta = 0.22$.

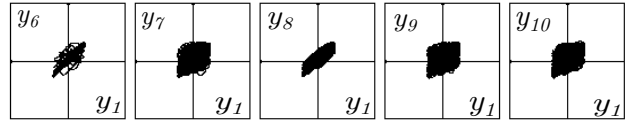


Figure 4: Phase difference (CC1-CC6, CC1-CC7, CC1-CC8, CC1-CC9, and CC1-CC10). $\delta = 0.22$.

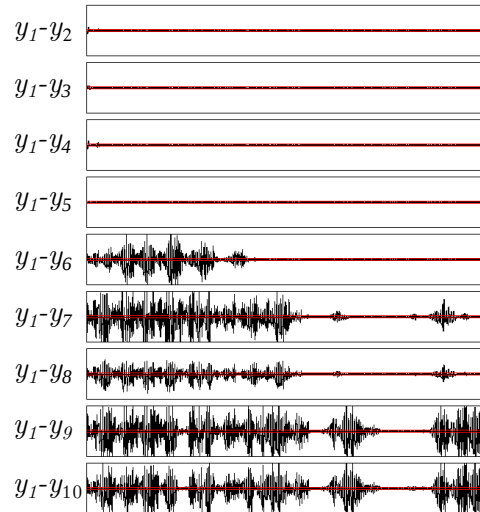


Figure 5: Voltage difference. $\delta = 0.22$.

4. Conclusion

We studied synchronization phenomena of coupled chaotic circuit in one direction. Synchronization phenomena were observed synchronized part of the circuit. In this study, we used ten chaotic circuits. We will use a number of chaotic circuits.