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Three Cross-Coupled Using Simple Chaotic Circuit

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1. Introduction

In our previous study, we have investigated the cross-coupled chaotic circuits using two chaotic circuit [1]. In this study, three Shinriki-Mori chaotic circuits cross-coupled by inductors are investigated. We investigate the phenomenon synchronization by using computer simulations and circuit experiments.

2. Circuit Model

Figure 1 shows the circuit model. In the circuit, three Shinriki-Mori chaotic circuits are cross-coupled via inductors L_2.

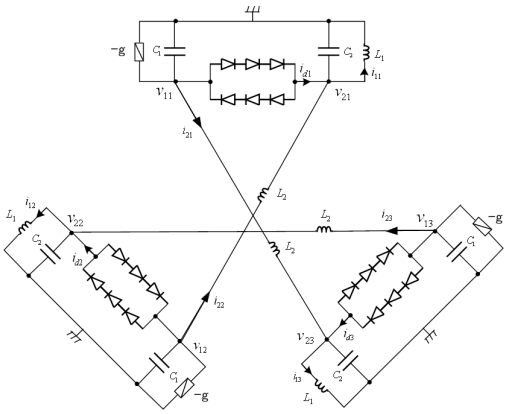


Figure 1: Circuit model.

The normalized circuit equations are given as follows.

$$\begin{cases} \dot{x_n} = z_n \\ \dot{y_n} = \alpha(\gamma y_n - \omega_n - \beta f(y_n - z_n) \\ \dot{z_1} = \beta f(y_1 - z_1) + \omega_3 - x_1 \\ \dot{z_2} = \beta f(y_2 - z_2) + \omega_1 - x_1 \\ \dot{z_3} = \beta f(y_3 - z_3) + \omega_2 - x_1 \\ \dot{\omega_1} = \delta(y_1 - z_2) \\ \dot{\omega_2} = \delta(y_2 - z_3) \\ \dot{\omega_3} = \delta(y_3 - z_1) \end{cases} , \quad (1)$$

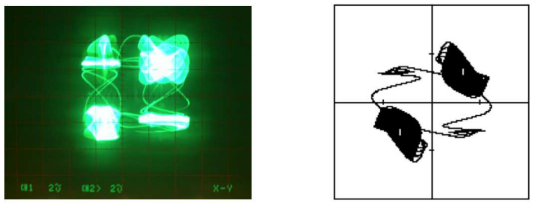
$$(n = 1, 2, 3)$$

Where f is the nonlinear function corresponding to the $v - i$ characteristics of the nonlinear resistors consisting of the diodes and are assumed to be described by the following 3-segment piecewise-linear functions:

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

3. State Transition Phenomenon

We carry out circuit experiment and computer simulations for the cross-coupled chaotic circuits using three chaotic circuit. Figure 2 shows the phase state between 1st and 2nd chaotic circuits. We observe that the phase state is switched between four areas in the phase space. We confirm that both the circuit experiment and the computer simulation agree well. Next, Fig. 3 shows the phase state between 1st, 2nd and 3rd chaotic circuits obtained by computer simulation. From this figure, we observe the interesting synchronization phenomena. Namely, the phase state is switched between six areas in the phase space.



(a) (b)

Figure 2: (a) Circuit experimental results on $v_{11} - v_{12}$ phase. C_1=22nF, C_2=47nF, L_1=1.0mH, L_2=500mH and g=1.96mS. (b) Computer calculated results on $v_{11} - v_{12}$ phase. $\alpha = 2.14$, $\beta = 4.0$, $\gamma = 0.15$ and $\delta = 0.002$.

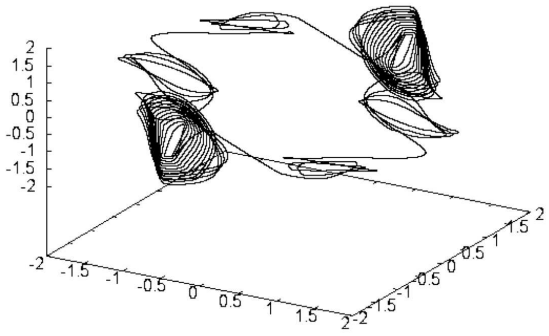


Figure 3: Computer calculated results on $v_{11} - v_{12} - v_{13}$ phase. $\alpha = 2.14$, $\beta = 4.0$, $\gamma = 0.15$ and $\delta = 0.002$.

4. Conclusions

In this study, we have investigated the interesting state transition phenomenon observed from three Shinriki-Mori chaotic circuits cross-coupled by inductors. In the future works, we will carry out computer simulations and theoretical analysis for the proposed circuit.

References

[1] Y. Uchitani and Y. Nishio "Investigation of State Transition Phenomena in Cross-Coupled Chaotic Circuits," Proc. of ISCAS'08, pp. 2394-2397, May 2008.