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Anti-Phase Synchronization of Switching Phenomena in Coupled Chaotic Circuits as a Ring

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1. Introduction

Switching phenomena of attractors can be observed in some chaotic circuits. In this study, we investigate coupled chaotic circuits as a ring. Especially, we focus on the switching phenomena of attractors. By carrying out computer simulations, synchronization of switching phenomena are observed.

2. System model

The chaotic circuit is shown in Fig. 1. This circuit consists of three memory elements, one linear negative resistor, and bi-directionally-coupled diodes. The circuits are coupled by the resisters as shown in Fig. 2.

The normalized circuit equations of the system are given as:

$$\left\{\begin{array}{rcl} \dot{x}_n &=& \alpha x_n + z_n \\ \dot{y}_n &=& \beta\{z_n - (2u(y_n) - 1)\} \\ \dot{z}_n &=& -x_n - y_n \\ && -\delta\,(2z_n - z_{n-1} - zn + 1) \\ && (n = 1, 2, \cdots, N) \end{array}\right. \quad (1)$$

where

$$z_0 = z_N, \quad z_{N+1} = z_1. \quad (2)$$

Note that α and δ are corresponding to nonlinearity and the coupling strength respectivelly, and $u(y_n)$ is a step function.

3. Computer Simulation

Fig. 3 shows the coexisting attractors of the chaotic cirtuit as shown in Fig. 1. The color coding of the attractors are defined by Poincaré map. Fig. 4 and Fig. 5 show computer simulated results for $N = 4$. The colors of waves are corresponding to the colors of the attractor as shown in Fig. 3. It should be emphasized that each circuit is asynchronized and switches almost same time. Therefore these phenomena called synchronization of switching phenomena in this study.

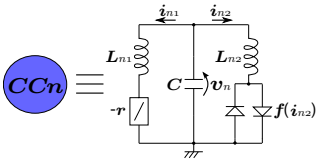

Fig. 1: Chaotic circuit used in this study.

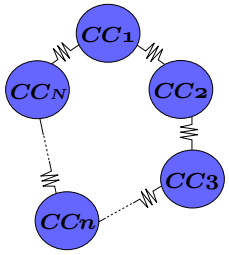

Fig. 2: System model.

These phenomena also can be observed in the case of increased the number of the circuit.

4. Conclusions

In this study, we have investigated the coupled chaotic circuits as a ring. By carrying out computer simulations, the synchronization of switching phenomena was observed. Additionally, the phenomena was observed in the case of increased the number of the circuit.

References

[1] Y. Nishio, N. Inaba, S. Mori and T. Saito, "Rigorous Analyses of Windows in a Symmetric Circuit," *IEEE Trans. Circuit and Systems.*, Vol. 37, No. 4, Apr. 1990.

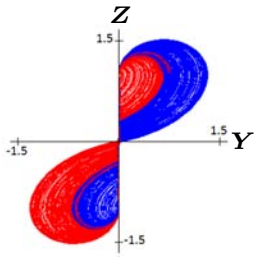

Fig. 3: Coexisting attractor. $\alpha = 0.36$ and $\beta = 3.00$.

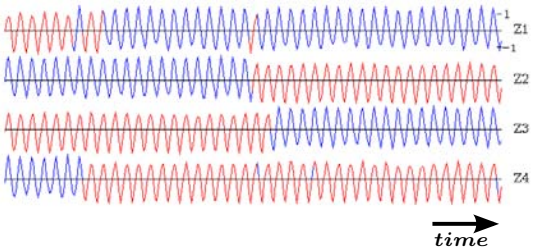

Fig. 4: Synchronization of switching phenomena for $N = 4$. $\alpha = 0.405$, $\beta = 3.00$ and $\delta = 0.20$.

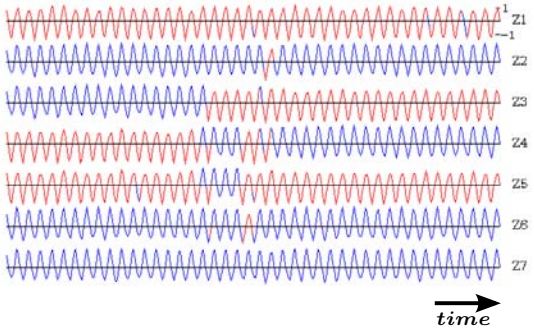

Fig. 5: Synchronization of switching phenomena for $N = 7$. $\alpha = 0.405$, $\beta = 3.00$ and $\delta = 0.20$.