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Relationship between Synchronization Rate and the Number of LC Resonators in Modified Shinriki-Mori Circuits

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1. Introduction

In coupled chaotic circuits, many interesting phenomena, for instance, chaotic synchronization phenomena, intermittency chaos, spatio-temporal chaos and so on are observed. Therefore, there are many studies about coupled chaotic circuits. In almost these studies, some of famous chaotic circuits have been applied. One of famous chaotic circuits is Shinriki-Mori circuit. There are many investigations of coupled chaotic circuits using Shinriki-Mori circuit.

In this study, two modified Shinriki-Mori circuits coupled by a resistor are investigated. Especially, relationships among LC resonators are paid attention.

2. Proposed System

Figure 1 shows the Modified Shinriki-Mori Circuit. Two modified Shinriki-Mori circuits are coupled by a resistor. Resistors added to bidirectionally coupled diodes can change a parameter of nonlinearity. Bidirectionally coupled diodes and resistors are modeled as a piecewise linear function.

Normalized circuit equation is shown as follows.

$$
\begin{cases}
\dot{x}_{A1} &= \alpha_{a1} f'(x_{A3} - x_{A1}) - x_{A4}, \\
\dot{x}_{A2} &= \beta_{a2} \left\{ \alpha_{a2} f'(x_{A3} - x_{A2}) - x_{A5} \right\}, \\
\dot{x}_{A3} &= \beta_{a3} \left\{ \delta_a x_{A3} - \alpha_{a1} f'(x_{A3} - x_{A1}) \right. \\
&\quad \left. - \alpha_{a2} f'(x_{A3} - x_{A2}) - \varepsilon (x_{A3} - x_{B3}) \right\}, \\
\dot{x}_{A4} &= x_{A1}, \\
\dot{x}_{A5} &= \gamma_{a2} x_{A2}, \\
\dot{x}_{B1} &= \beta_{b1} \left\{ \alpha_{b1} f'(x_{B3} - x_{B1}) - x_{B4} \right\}, \\
\dot{x}_{B2} &= \beta_{a2} \left\{ \alpha_{b2} f'(x_{B3} - x_{B2}) - x_{B5} \right\}, \\
\dot{x}_{B3} &= \beta_{b3} \left\{ \delta_b x_{B3} - \alpha_{b1} f'(x_{B3} - x_{B1}) \right. \\
&\quad \left. - \alpha_{b2} f'(x_{B3} - x_{B1}) + \varepsilon (x_{A3} - x_{B3}) \right\}, \\
\dot{x}_{B4} &= \gamma_{b1} x_{B1}, \\
\dot{x}_{B5} &= \gamma_{b2} x_{B2},
\end{cases}
\tag{1}
$$

where

$$
f'(x) = x + (|x - 1| - |x + 1|)/2. \tag{2}
$$

3. Computer simulations

Figure 2 shows one of computer simulation results. In these investigation, basically, all subcircuits are not synchronized because this system includes parameter mismatches. In subcircuit A1-A2, synchronous rate is decreased by increasing the coupling strength. In subcircuit B1-B2, synchronous rate is increased by increasing the coupling strength. On the other hand, subcircuit A2-B1 remains asynchronization state. It can be observed from this statistical data. As these results, synchronous rate different in each LC resonators.

4. Conclusion

In this study, two modified Shinriki-Mori circuits coupled by a resistor have been investigated. As a result, the interesting phenomenon by synchronous rate and coupling strength are observed. The reasons for this phenomenon are currently investigating.

In the future works, the case of increasing combination will be investigated. In addition, we will study in detail the synchronization rate of between circuits.

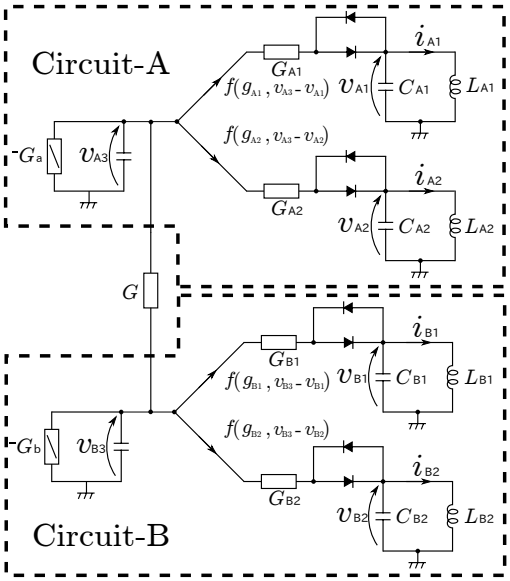

Figure 1. Modified Shinriki-Mori Circuit.

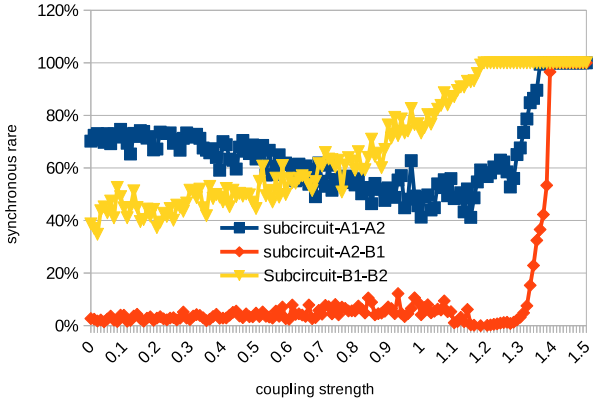

Figure 2. Synchronous Rate of Circuit A and B.