1-19

Comparison of Complexity of Chaos in Three Degrees of Freedom Chaotic Circuits

Naoto YONEMOTO Katsuya NAKABAI Yoko UWATE Yoshifumi NISHIO
(Tokushima University)

1. Introduction

In this study, we investigate comparison of the complexity of chaos generated in many degrees of freedom chaotic circuits. In the previous study, the circuit consists of two nonlinear subcircuits coupled by one linear negative resister has proposed [1]. We increase the number of connected subcircuits from 2 to 3 in order to produce more complex chaos. It leads to better effects when we applied such as improving the secrecy of chaotic communication.

2. System Model

The circuit model of the 3 degrees of freedom chaotic circuit is shown in Fig. 1.

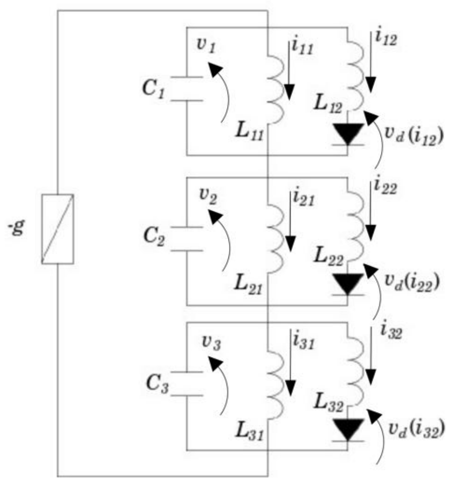

Figure 1: Circuit model of the 3 degrees of freedom chaotic circuit.

The normalized circuit equations are described as follows.

$$\begin{cases} \dot{x_1} = \alpha(x_1 + x_4 + x_7) - (x_2 + x_3) \\ \dot{x_2} = x_1 \\ \dot{x_3} = \beta_1(x_1 - f(x_3)) \\ \dot{x_4} = \alpha\gamma_1(x_1 + x_4 + x_7) - \gamma_1(x_5 + x_6) \\ \dot{x_5} = \beta_2 x_4 \\ \dot{x_6} = \beta_3(x_4 - f(x_6)) \\ \dot{x_7} = \alpha\gamma_2(x_1 + x_4 + x_7) - \gamma_2(x_8 + x_9) \\ \dot{x_8} = \beta_4 x_7 \\ \dot{x_9} = \beta_5(x_8 - f(x_9)) \end{cases} \tag{1}$$

The characteristic equation for the diode is described as follows

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

3. Results

In this study, we change the number of Inaba's circuit connected from 2 to 3. We show the experimental and computer simulation results of the 3 degrees of freedom chaotic circuit.

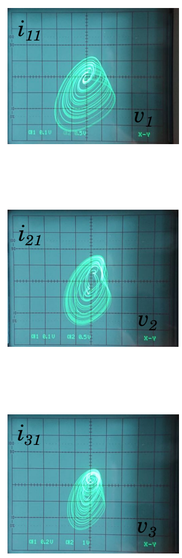

Figure 2: Experimental chaotic attractors.

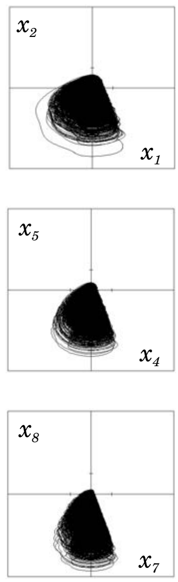

Figure 3: Numerical chaotic attractors.

In the computer simulation, the circuit parameters are chosen as $\alpha = 0.3$, $\beta_1 = 10.0$, $\beta_2 = 2.0$, $\beta_3 = 20.0$, $\beta_4 = 3.0$, $\beta_5 = 30.0$, $\gamma_1 = 2.0$, $\gamma_2 = 3.0$, and $\varepsilon = 0.01$. In this result, attractors are similar in shape, and become complicated.

In the circuit experiment, the circuit parameters are chosen as $C_1 = 15[nF]$, $L_{11} = 300[mH]$, $L_{12} = 30[mH]$, $C_2 = 7.5[nF]$, $L_{21} = 150[mH]$, $L_{22} = 15[mH]$, $C_3 = 5[nF]$, $L_{31} = 100[mH]$, and $L_{32} = 10[mH]$. In this result, the newly connected circuit generates more complex chaotic attractor.

4. Conclusion

In this study, we have investigated comparison of the complexity of chaos generated in multiple Inaba's circuit in series. The newly connected Inaba's circuit makes it possible to observe more complicated chaotic attractors. As our future works, we will clearly evaluate the difference in complexity.

References

[1] Katunori SUZUKI, Yoshifumi NISHIO, and Shinsaku MORI, "Twin Chaos - Simultaneous Oscillation of Chaos -", The Institute of Electronics, Information and Communication Engineers (IEICE), vol. j79-A, No. 3, pp. 813-819, Mar. 1996.