2016 International Symposium on Nonlinear Theory and Its Applications,
NOLTA2016, Yugawara, Japan, November 27th-30th, 2016

Qualitative Behavior of Nonideal Switching Circuit with Two-periodic Inputs

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Abstract—This paper studies the dynamical effect of spike noise in a switching circuit with two-periodic inputs. We explain behavior of the circuit. Then, we consider the dynamical effect of spike noise by comparing the system with ideal switching and the system with nonideal switching.

1. Introduction

Power conversion circuit, such as a converter circuits and inverter circuits are the typical example of the interrupted electric circuit. Nonlinear phenomena in these circuits are analyzed from nonlinear dynamics in the interrupted electric circuit from numerical and experimental viewpoints [1]. Interrupted dynamical systems are analyzed under the assumption of ideal switching. On the other hand, it was reported that Banerjee et al reported that the spike noise arises immediately after the switching action and greatly influences the bifurcation structure of the systems[2].

In this paper, we examine the dynamical effect of spike noise in a interrupted electric circuit with tow-periodic inputs.

2. Interrupted electric circuit and spike noise

We consider the following two differential systems.

$$\frac{dy}{d\tau} = \begin{cases} -y + B, & \text{system-a} \\ -y + A\sin\Omega\tau, & \text{system-b} \end{cases} \tag{1}$$

The system has two different periodic external forces: the clock pulse and the sinusoidal signal. T_{f} and$T_{\mathrm{S}} = NT_{\mathrm{f}}$ denote the period of the clock pulse and that of the sinusoidal signal, respectively. Figure1 shows the examples of the waveform with non ideal switching. We assume that spike noise arise when system is replaced.

Now, The system-a changes to system-b when the waveform reaches the reference value y_{r}. Following, the system-b changes to system-a when the next clock pulse arrives. Note that switching action from system-b to system-a does not occur if the spike noise reaches to reference value as shown in gray colored area in Fig. 1. Here, We use the parameter: $N = 30, A = 0.1, B = 1.0, T_{\mathrm{S}} = 0.8, h = 0.1$.

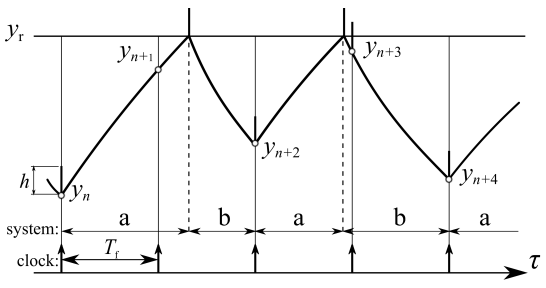
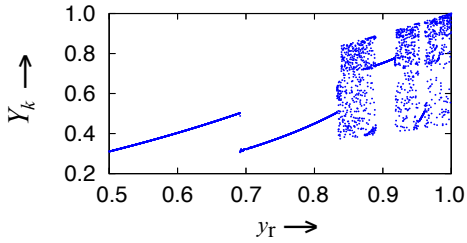


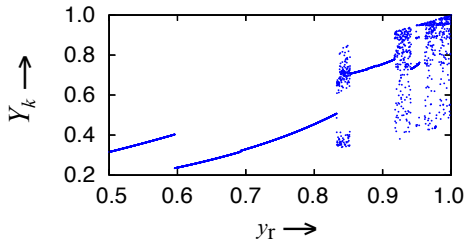
Figure 1: Orbit with spike noise

3. Effect of spike noise

Figure2 shows the 1-parameter bifurcation diagram. The new bifurcation phenomena arises when the spike noise occurs. We know that the new types of the orbit behavior which is caused by the spike noise makes the coexistence region.



(a)ideal switched dynamical system



(b)non ideal switched dynamical system

Figure 2: 1-parameter bifurcation diagram

4. Conclusion

This paper studied the dynamical effect of spike noise by comparing the system with ideal switching and the system with nonideal switching.

References

[1] Y. Izumi, H. Asahara, T. Kousaka, ”Experimental Investigation of an Interrupted Electric Circuit with Fast-Slow Bifurcation.” Proc. of NDES 2012, pp.112-115, 2012.

[2] S. Banerjee, S. Parui, and A. Gupta, “Dynamical Effects of Missed Switching in Current-Mode Controlled dc-dc Converters,” IEEE Trans, Circuit and Syst. part I I, Vol. 51, No. 12, pp. 649–654, 2004.