Analysis of Breakdown of Synchronization in Chaotic Oscillators and Noisy Oscillators

Ryo Imabayashi
Dept. Electrical and Electronic Eng., Tokushima University
Email: bayashi@ee.tokushima-u.ac.jp

Yoko Uwate
Institute of Neuroinformatics(INI), University and ETH Zurich
Email: yu001@ini.phys.ethz.ch

Yoshifumi Nishio
Dept. Electrical and Electronic Eng., Tokushima University
Email: nishio@ee.tokushima-u.ac.jp

SUMMARY

In our previous research, we have investigated the breakdown of synchronization observed from four coupled chaotic oscillators. In order to understand the phenomenon, the model of coupled modified van der Pol oscillators with the additive white Gaussian noise (AWGN) was proposed. By computer simulations, we have confirmed that chaotic systems were synchronized more stably than the modified van der Pol oscillators with AWGN [6].

Moreover, because AWGN alone could not reproduce chaotic oscillators behavior, we tried to use other two types of noise for adding to the van der Pol oscillators. The first noise has two band characteristic, and the second noise is a scaled AWGN ($n_1 = n_2 = n_3 = n_4$, $\rho_k =$ different). By adding the scaled AWGN, the modified van der Pol oscillators become closer to the coupled chaotic circuit systems [7].

In this study, we have added another type of noise; a correlated AWGN ($n_k = a * n + b * d_k$ where n is a common Gaussian component and d_k is an uncorrelated component unique for each k), because the difference between chaos and noise should be more clarified. By adding the correlated AWGN, we confirm that the modified van der Pol oscillators with the correlated AWGN is more stably than with the non-correlated AWGN. However, the modified van der Pol oscillators with correlated AWGN could not reproduce chaotic oscillator behavior.

REFERENCES

[1] N. Platt, E.A. Spiegel and C. Tresser, "On-Off Intermittency: A Mechanism for Bursting," *Phys. Rev. Lett.*, vol. 70, no. 3, pp. 279-282, 1993.
[2] T. Kapitaniak and L.O. Chua, "Locally-Intermingled Basins of Attraction in Coupled Chua's Circuits," *Int. J. Bifurcation and Chaos*, vol. 6, no. 2, pp. 357-366, 1996.
[3] M. Wada, Y. Nishio and A. Ushida, "Analysis of Bifurcation Phenomena on Two Chaotic Circuits Coupled by an Inductor," *IEICE Trans. Fundamentals*, vol. E80-A, no. 5, pp. 869-875, 1997.
[4] Y. Nishio and A. Ushida, "Chaotic Wandering and its Analysis in Simple Coupled Chaotic Circuits," *IEICE Trans. on Fundamentals*, vol. E85-A, no. 1, pp. 248-255, 2002.
[5] Y. Hayakawa and Y. Sawada, "Effects of the Chaotic Noise on the Performance of a Neural Network Model for Optimization Problems," *Phys. Rev. E*, vol. 51, no. 4, pp. 2693-2696, 1995.
[6] R. Imabayashi, Y. Uwate and Y. nishio, "Breakdown of Synchronization in Chaotic Oscillators and Noisy Oscillators," *Proceedings of European Conference on Circuit Theory and Design (ECCTD'07)*, pp. 922-925, 2007.
[7] R. Imabayashi, Y. Uwate and Y. nishio, "Research on Coupled Systems of Chaotic Oscillators and Noisy Oscillators," *Proceedings of International Symposium on Nonlinear Theory and its Applications (NOLTA'08)*, (in printing).