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Relationship Between Ratios of Synchronization Time And Small Parameter Mismatches on Asymmetrically Coupled Chaotic Maps

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1. Introduction

In our previous study [1][2], some kinds of asymmetrically coupled chaotic systems are investigated. Especially, we paid our attentions to the relationships between synchronization phenomena and small parameter mismatches. In all the systems, the same interesting phenomenon is observed. The phenomenon is that the ratio of the synchronization time increases in spite of increasing parameter mismatches in the other system.

In this study, in order to investigate these phenomena, asymmetrical coupled chaotic maps are investigated. The logistic map is used as a chaotic map. Asymmetry of the system is realized by using two parameter values. We pay our attentions to the relationship between the ratio of synchronization time and parameter mismatches.

2. Asymmetrically Coupled System

This system consists of two kinds of subsystems and coupling elements. Subsystems are coupled globally. An asymmetry of the system is realized by using two kinds of subsystems. In this study, the logistic map is applied as subsystems. The asymmetry is realized by using two parameter values.

$$SubsystemA \quad (1 \le i \le p):$$
$$f_A(x_n(i)) = 1-(1+Q_a i)a_1 x_n(i)^2 \tag{1}$$

$$SubsystemB \quad (p+1 \le k \le p+q):$$
$$f_B(x_n(i)) = 1-\{1+Q_b(i-p)\}a_2 x_n(i)^2 \tag{2}$$

where i is the index number of the maps. n is the number of iterations. a_1 and a_2 are the parameter of the logistic map. p and q are the numbers of the elements in the subsystems A and B, respectively. Q_a and Q_b are parameter mismatch rates of the two subsystems.

We carry out computer simulations using Eq. (1) and Eq. (2). Here we define the synchronization as the following conditional equation:

$$(|x_{n-1}(i)-x_{n-1}(i+1)|<0.05)\cap(|x_n(i)-x_n(i+1)|<0.05) \tag{3}$$

This equation shows that two consecutive closer values than a given threshold value (0.05) define synchronization.

Figure 1 shows the relationship of the ratio of the synchronization time and small parameter mismatches. We can see that subsystem A and subsystem B are not synchronized at all and increasing Q_b causes increasing a ratio of synchronization time of subsystem A. An experiment result is corresponding to the experiment in the electric circuit.The chaotic circuit is continuous time system. The logistic map is discrete-time system. In spite of this difference, we can observe the phenomena in both systems. Therefore, we consider that the phenomena are closely related to the structure of the system.

3. Conclusions

In this study, asymmetrically coupled chaotic maps are proposed and investigated. Asymmetry of the system is realized by using two parameter values. It was confirmed that ratios of synchronization time of maps using one parameter set are increased by increasing a parameter mismatch rate of the other maps group. We consider that this result is corresponding to the result of our previous study. Investigating this phenomenon is our future research.

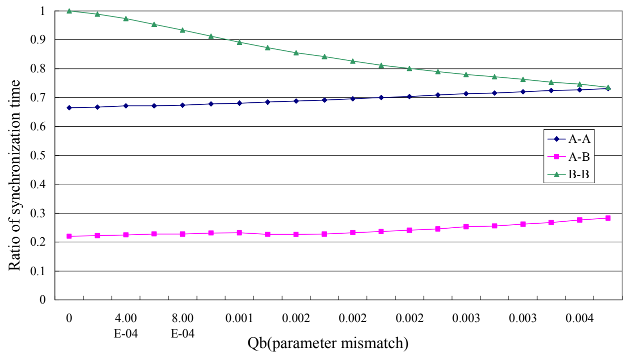

Figure 1: Relationship between the ratio of the synchronization time and small parameter mismatches. p = 10, q = 20, Q_a = 0.002, a_1 = 1.70, a_2 = 1.95 and ε = 0.45. The number of iteration is 1000000.

References

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