Synchronization phenomena of van der Pol oscillators with frustration coupling scheme

Kazuki Ueta, Yoko Uwate, Yoshifumi Nishio
Tokushima University, Japan

It is important to understand synchronization phenomena to elucidate various nonlinear phenomena. Synchronization are typical nonlinear phenomena that we can often observe in natural animate beings with collective actions. For example, we often observe firefly luminescence, cry of birds and frogs, applause of many people, and so on. Therefore, study of synchronization phenomena has been widely reported not only in the engineering but also physical and biological fields. Especially, investigation of coupled oscillators is focused by many researchers, because coupled oscillatory networks produce interesting synchronization phenomena, such as the phase propagation wave, clustering, and complex patterns. In addition, these oscillatory patterns are similar to biological and chemical reaction. However, the reports on complex networks of coupled oscillators with more complicated structures are not enough yet. In this study, we investigate a complex network of van der Pol oscillators with a ring structure and a star structure at the same time. By circuit experiments and computer simulations, we observe several types of synchronization phenomena by changing the number of oscillators and the coupling scheme.

Synchronization in coupled chaotic circuits with competitive interactions

Yoko Uwate[1], Yoshifumi Nishio[1] and Ruedi Stoop[2,3]
[1] Tokushima University, Japan
[2] Institute of Neuroinformatics, University of Zurich and ETH Zurich, Switzerland
[3] Institute for Computational Science, University of Zurich, Switzerland

Coupled oscillatory circuits provide simple models for high-dimensional nonlinear real-world phenomena. Synchronization, in particular, is one of the most important features that can be described and explored with the help of oscillators, because, upon their coupling, strongly correlated rhythms emerge among the oscillators, called synchronized states. Here, we present results obtained for a new paradigm of coupled oscillatory networks, called competitive interaction networks.
Whereas in the past, emphasis was on the role that the interactions themselves have on the synchronized states, the focus in competitive interaction networks is on the effect that temporal on/off switching of connections may have on synchronization. In our approach that is largely based on simulated hardware oscillators, we not only reveal the salient properties of a process that has great engineering relevance, we also pave the way towards a mathematical analysis of the observed synchronization phenomena.