Synchronization Engineering via Global Delayed Nonlinear Feedback

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Populations of interacting rhythmic components can produce complex behavior in biology, communications, population dynamics, and chemistry. In biology, synchronization can be beneficial, such as in orchestrating the circadian rhythms in mammals, or pathological, such as in the occurrence of Parkinson's disease. We consider here the engineering of desirable states through the introduction of mild feedback, mild such that the behavior of the individual components is not substantially changed by the introduction of the external signal. Our proposed theoretical framework, which is based on phase models, allows a nonlinear time delayed feedback signal to be constructed which produces an interaction function corresponding to the desired global behavior of the system [1, 2]. It is shown theoretically and confirmed in numerical simulations and in electrochemical experiments that a polynomial, delayed feedback is a versatile tool to tune synchronization patterns.

[1] I.Z. Kiss, C.G. Rusin, H. Kori, and J.L. Hudson, "Engineering Complex Dynamical Structures: Sequential Patterns and Desynchronization", Science **316**, 1886, 2007.
[2] H. Kori, C.G. Rusin, I.Z. Kiss, and J.L. Hudson. "Synchronization Engineering: Theoretical Framework and Application to Dynamical Clustering", submitted.

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