Feedback-dependent control of stochastic synchronization in coupled neural systems

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(Submitted on 12 Nov 2009)

We investigate the synchronization dynamics of two coupled noise-driven FitzHugh-Nagumo systems, representing two neural populations. For certain choices of the noise intensities and coupling strength, we find cooperative stochastic dynamics such as frequency synchronization and phase synchronization, where the degree of synchronization can be quantified by the ratio of the interspike interval of the two excitable neural populations and the phase synchronization index, respectively. The stochastic synchronization can be either enhanced or suppressed by local time-delayed feedback control, depending upon the delay time and the coupling strength. The control depends crucially upon the coupling scheme of the control force, i.e., whether the control force is generated from the activator or inhibitor signal, and applied to either component. For inhibitor self-coupling, synchronization is most strongly enhanced, whereas for activator self-coupling there exist distinct values of the delay time where the synchronization is strongly suppressed even in the strong synchronization regime. For cross-coupling strongly modulated behavior is found.

Subjects: **Adaptation and Self-Organizing Systems (nlin.AO)**
Cite as: **arXiv:0911.2334v1 [nlin.AO]**

Submission history

From: Philipp Hövel [view email]
[v1] Thu, 12 Nov 2009 09:25:25 GMT (487kb)

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