IEICE Proceeding Series

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Vol. 1 pp. 364-364
Publication Date: 2014/03/17
Online ISSN: 2188-5079

On the Role of Intrinsic Neuronal Dynamics for Relay Synchronization

Christian Finke† , Epaminondas Rosa‡ , Hans A. Braun* and Ulrike Feudel†

†Theoretical Physics/Complex Systems Group, ICBM, Carl von Ossietzky University Oldenburg, 26111 Oldenburg, Germany
‡ Physics Department, Illinois State University, Normal, Illinois, USA
*Neurodynamics Group, Institute for Physiology, Philipps University Marburg, 35037 Marburg, Germany
Email: christian.finke@uni-oldenburg.de, erosa@ilstu.edu, braun@staff.uni-marburg.de, ulrike.feudel@uni-oldenburg.de

Abstract–

Synchronization plays a vital role for most functional activities of brain and body, and many different forms of synchrony like phase-locking or complete synchronization have been shown to occur in the interaction of neurons. Recently, a new form of synchronous behaviour has been discovered in a general context where two oscillators synchronize without being directly coupled, and the information transmission is going only via a third, relaying oscillator which is not synchronizing with the other ones. This phenomenon has been named „relay synchronization“ or „dynamical relaying“ [1]. For the first time, a thorough computational study of the effect of different intrinsic dynamical states of model neurons exhibiting relay synchronization under gap-junction coupling is presented in our work.
All calculations are carried out using the four-dimensional Huber-Braun neuron model [2].
Depending on the dynamical state of each individual neuron in the chain, the conditions under which relay synchronization can appear and break down are elucidated using bifurcation theory and statistical methods. The mechanism behind the phenomenon is investigated, and implications for physiological processes using relay synchronization on the basis of synaptic plasticity are discussed.

Acknowledgments

Christian Finke has been supported by Grant No. FE359/10 of the German Science Foundation (DFG).

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