Georgia State University ScholarWorks @ Georgia State University

Neuroscience Institute Faculty Publications

Neuroscience Institute

2012

Phase-lag return mappings for a 3 cell multifunctional central pattern generator

Jeremy Wojcik

Robert Clewley Georgia State University, rclewley@gsu.edu

Andrey Shilnikov Georgia State University, ashilnikov@gsu.edu

Follow this and additional works at: http://scholarworks.gsu.edu/neurosci facpub



Part of the Mathematics Commons, and the Neuroscience and Neurobiology Commons

Recommended Citation

Wojcik et al.: Phase-lag return mappings for a 3 cell multifunctional central pattern generator. BMC Neuroscience 2012 13 (Suppl 1):P188. doi: 10.1186/1471-2202-13-S1-P188

This Presentation is brought to you for free and open access by the Neuroscience Institute at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Neuroscience Institute Faculty Publications by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact scholarworks@gsu.edu.



POSTER PRESENTATION

Open Access

Phase-lag return mappings for a 3 cell multifunctional central pattern generator

Jeremy Wojcik^{1,2*}, Robert Clewley^{1,2}, Andrey Shilnikov^{1,2}

From Twenty First Annual Computational Neuroscience Meeting: CNS*2012 Decatur, GA, USA. 21-26 July 2012

We describe and expand on a novel computational approach to reduce detailed models of central pattern generation to equationless return mapping for the phase lags between the constituting bursting interneurons [1].

Such mappings are then studied geometrically as the model parameters, including coupling properties of inhibitory and excitatory synapses, or external inputs are varied. Bifurcations of the fixed points and invariant circles of the mappings corresponding to various types of rhythmic activity are examined. These changes uncover possible biophysical mechanisms for control and modulation of

motor-pattern generation. Our analysis does not require knowledge of the equations that model the system, and so provides a powerful new approach to studying detailed models, applicable to a variety of biological phenomena beyond motor control.

Motifs of three coupled cells are a common network configuration including models of biological central pattern generators. We demonstrate our technique on a motif of three reciprocally coupled, inhibitory and excitatory, cells that is able to produce multiple patterns of bursting rhythms. In particular, we examine the qualitative

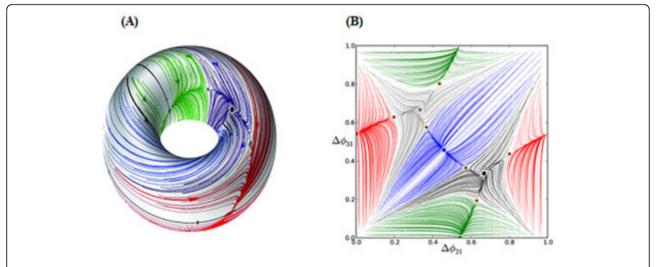


Figure 1 (A). We defined phase-lags for a 3 cell CPG model on a 2D torus. (B) A "flattened" phase-lag mapping showing convergence to 5 distinct attractors. Each stable fixed point represents a rhythmic output of the CPG

Full list of author information is available at the end of the article



^{*} Correspondence: jwojcik1@gsu.edu

¹Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30033, USA

geometric structure of two-dimensional maps for phase lag between the cells. This reveals the organizing centers of emergent polyrhythmic patterns and their bifurcations, as the asymmetry of the synaptic coupling is varied. The presence of multistability and the types of attractors in the network are shown to be determined by the duty cycle of bursting, as well as coupling interactions.

Acknowledgements

We thank W. Kristan, A. Neiman, P. Ashwin, C. Laing, and R. Lin for valuable suggestions. We acknowledge support from NSF Grants CISE/CCF-0829742 (to R.C.), DMS-1009591, RFFI Grant No. 08-01-00083 (to A.S.) and "Grant opportunities for Russian scientists living abroad" Project No. 14.740.11.0919, and the GSU Brains & Behavior program.

Author details

¹Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30033, USA. ²Neuroscience Institute, Georgia State University, Atlanta, GA 30033, USA.

Published: 16 July 2012

Reference

 Wojcik J, Clewley R, Shilnikov A: Order parameter for bursting polyrhythms in multifunctional central pattern generators. *Physics Review E* 2011, 83:056209-6, DOI: 10.1103/PhysRevE.83.056209.

doi:10.1186/1471-2202-13-S1-P188

Cite this article as: Wojcik *et al.*: Phase-lag return mappings for a 3 cell multifunctional central pattern generator. *BMC Neuroscience* 2012 **13** (Suppl 1):P188.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at www.biomedcentral.com/submit

