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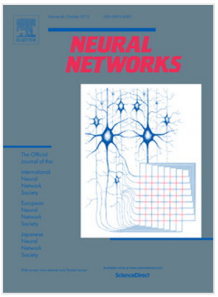


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# A Limit-Cycle Self-Organizing Map Architecture for Stable Arm Control

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**Abstract**

Inspired by the oscillatory nature of cerebral cortex activity, we recently proposed and studied self-organizing maps (SOMs) based on limit cycle neural activity in an attempt to improve the information efficiency and robustness of conventional single-node, single-pattern representations. Here we explore for the first time the use of limit cycle SOMs to build a neural architecture that controls a robotic arm by solving inverse kinematics in reach-and-hold tasks. This multi-map architecture integrates open-loop and closed-loop controls that learn to self-organize oscillatory neural representations and to harness non-fixed-point neural activity even for fixed-point arm reaching tasks. We show through computer simulations that our architecture generalizes well, achieves accurate, fast, and smooth arm movements, and is robust in the face of arm perturbations, map damage, and variations of internal timing parameters controlling the flow of activity. A robotic implementation is evaluated successfully without further training, demonstrating for the first time that limit cycle maps can control a physical robot arm. We conclude that architectures based on limit cycle maps can be organized to function effectively as neural controllers.

**Keywords:** Self-Organizing Map, Neural Architecture, Limit Cycle Attractor, Robotic Arm Control, Neural Oscillation

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