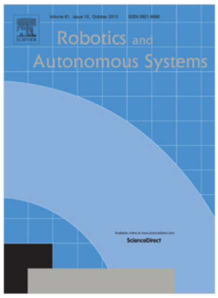

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PII: S0921-8890(17)30233-6
DOI: http://dx.doi.org/10.1016/j.robot.2017.06.004
Reference: ROBOT 2862

To appear in: *Robotics and Autonomous Systems*

Received date : 8 April 2017
Revised date : 14 May 2017
Accepted date : 12 June 2017

Chaotic Analysis of Embodied and Situated Agents

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Abstract

Embodied and situated view of cognition is a transdisciplinary framework which stresses the importance of real time and dynamical interaction of an agent with the surrounding environment. This article presents a series of evolutionary robotics experiments that operationalize such concept, training miniature two-wheeled mobile robots to autonomously solve a temporal task. In order to provide a numerical description of the robots behavior, chaotic measures are estimated on the attractor reconstructed from the recorded positions of the agent. Chaos theory provides a rigorous mathematical framework consistent with an antireductionist approach, useful for understanding embodied and situated systems while avoiding a decomposition of the integrated system brain-body-environment. Time series are analyzed in detail using nonlinear mathematical tools in order to verify the presence of low-dimensional deterministic dynamical systems, a fundamental prerequisite for chaos theory. In particular, the recorded time series are evaluated with nonlinear prediction error to unveil deterministic dynamics, cross-prediction error to determine the stationarity of the signal, and surrogate data testing to verify the existence of nonlinear components in the underlying system. Estimators for quantifying level of chaos and fractal dimension are applied to suitable datasets. Results show that robots governed by a chaotic dynamic are more efficient at adapting to environments never experience during evolution, demonstrating robustness towards novel and

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