Emergent Behavior Control Patterns in Robotic Collectives

Book Series	Lecture Notes in Computer Science
Publisher	Springer Berlin / Heidelberg
ISSN	0302-9743 (Print) 1611-3349 (Online)
Volume	Volume 5928/2009
Book	Intelligent Robotics and Applications
DOI	10.1007/978-3-642-10817-4
Copyright	2009
ISBN	978-3-642-10816-7
DOI	10.1007/978-3-642-10817-4_16
Pages	165-173
Subject Collection	Computer Science
SpringerLink Date	Wednesday, December 16, 2009

Razvan-Dorel Cioarga[1], **Mihai V. Micea**[1], **Vladimir Cretu**[1] and **Daniel Racoceanu**[2]

(1) Department of Computer and Software Engineering (DCSE), "Politehnica" University of Timisoara, 2, Vasile Parvan Blvd., 300223 Timisoara, Romania

(2) Image Perception, Access & Language (UMI CNRS 2955), International Research Unit (CNRS, NUS, I2R A*STAR, UJF), Singapore, 1 Fusionopolis Way, #21-01 Connexis South Tower, Singapore, 138632

Abstract

This paper focuses on the implementation and evaluation of a set of integrated models for the representation of emergent behavior control patterns in robotic environments. The models have been validated on a custom developed emergent behavior simulator and tested using the CORE-TX (COllaborative Robotic Environment - the Timisoara eXperiment) prototype platform. Four metrics (pheromone intensity, path affinity, reachability and liveness) are introduced and used to evaluate the performance of the proposed control patterns. Experimental results for an environment which employs ant colony behavior patterns in obstacle avoidance applications show that the emergent behavior of the robotic collective is triggered by a number ranging from 9 to 11 entities. The results are also consistent with the theoretical model-based predictions. When doubling the number of entities, the performance of the system can be further increased by 19.3%. On the other hand, a high concentration of entities has been noted to affect the emergent behavior of the system and, thus, its performance, mainly due to the interaction overhead. An upper bound to the number of individuals has been computed, based on a set of parameters which model each particular application. The experimental validation of the proposed behavior control patterns endorses them as a good framework for the analysis and development of complex applications which require collaborative and distributed intelligence, perception and operation.

This work is supported by the Romanian Ministry of Education and Research, through the grant PNCDI II ID-22/2007-2010 and, in parts through the grant PNCDI II PDP-2306/2007-2010.

Razvan-Dorel Cioarga
Email: razvan.cioarga@cs.upt.ro

Mihai V. Micea
Email: mihai.micea@cs.upt.ro

Vladimir Cretu
Email: vladimir.cretu@cs.upt.ro

Daniel Racoceanu
Email: daniel.racoceanu@ens2m.fr

Fulltext Preview (Small, Large)

Emergent Behavior Control Patterns in Robotic Collectives

Razvan-Dorel Cioarga[1], Mihai V. Micea[1], Vladimir Cretu[1], and Daniel Racoceanu[2]

[1] Department of Computer and Software Engineering (DCSE), "Politehnica" University of Timisoara, 2, Vasile Parvan Blvd., 300223 - Timisoara, Romania
[2] Image Perception, Access & Language (UMI CNRS 2955), International Research Unit (CNRS, NUS, I2R A*STAR, UJF), Singapore, 1 Fusionopolis Way, #21-01 Connexis South Tower, Singapore 138632
{razvan.cioarga,mihai.micea,vladimir.cretu@cs.upt.ro}@cs.upt.ro, daniel.racoceanu@ens2m.fr

Abstract. This paper focuses on the implementation and evaluation of a set of integrated models for the representation of emergent behavior control patterns in robotic environments. The models have been validated on a custom developed emergent behavior simulator and tested using the CORE-TX (COllaborative Robotic Environment - the Timisoara eXperiment) prototype platform. Four metrics (pheromone intensity, path affinity, reachability and liveness) are introduced and used to evaluate the performance of the proposed control patterns. Experimental results for an environment which employs ant colony behavior patterns in obstacle avoidance applications show that the emergent behavior of the robotic collective is triggered by a number ranging from 9 to 11 entities. The results are also consistent with the theoretical model-based predictions. When doubling the number of entities, the performance of the system can be further increased by 19.3%. On the other hand, a high concentration of entities has been noted to affect the emergent behavior of the system and, thus, its performance, mainly due to the interaction overhead. An upper bound to the number of individuals has been computed, based on a set of parameters which model each particular application. The experimental validation of the proposed behavior control patterns endorses them as a good framework for the analysis and development of complex applications which require collaborative and distributed intelligence, perception and operation.

1 Introduction

The evolution of information processing equipment and the need of adaptable digital control systems generate an extraordinary spreading of digital equipment in all fields of life including military applications, service industries, space exploration, agriculture, mining, factory automation, health care, waste management, disaster intervention

* This work is supported by the Romanian Ministry of Education and Research, through the grant PNCDI II ID-22/2007-2010 and, in parts through the grant PNCDI II PDP-2306/2007-2010.

M. Xie et al. (Eds.): ICIRA 2009, LNAI 5928, pp. 165–173, 2009.