Self-organizing techniques to improve the decentralized multi-task distribution in multi-robot systems

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Abstract
This paper focuses on the general problem of coordinating multiple robots, in particular, addresses the problem of the distribution of heterogeneous multi-task in a robust and efficient manner. The main interest in these systems is to understand how from simple rules inspired by the division of labor in social insects, a group of robots can perform tasks in an organized and coordinated way. We take into account a specifically distributed or decentralized approach as we are particularly interested in experimenting with truly autonomous and decentralized techniques in which the robots themselves are responsible for choosing a particular task in an autonomous and individual way. Under this approach we can speak of multi-task selection instead of multi-task assignment, which means, that the agents or robots select the tasks instead of being assigned a task by a central controller. In this regard, we have established an experimental scenario to solve the corresponding multi-task distribution problem and we propose a solution using different approaches by applying the response threshold models inspired by division of labor in social insects, the application of the reinforcement learning algorithm based on learning automata theory and ant colony optimization-based deterministic algorithms. We have evaluated the robustness of the algorithms, perturbing the number of pending loads to simulate the robot’s error in estimating the real number of pending tasks and also the dynamic generation of loads through time. The paper ends with a critical discussion of experimental results.

Keywords
Multi-robot systems; Bio-inspired threshold models; Stochastic learning automata; Ant colony optimization; Multi-task distribution; Self-coordination of multiple robots
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