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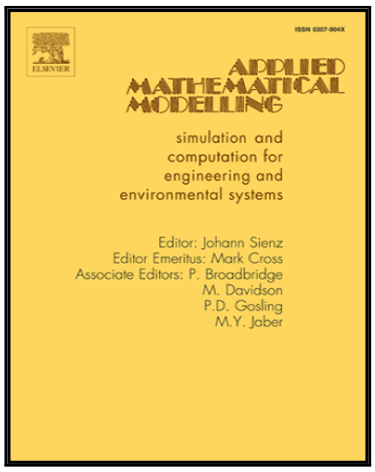

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A cellular automata ant memory model of foraging in a swarm of robots

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Abstract

This study proposes a cellular automata ant memory model (CAAM) that controls a robot swarm when undertaking the foraging task in a previously known environment with nests. The floor field is well known to all robots, which share the same environment, communicating through the inverted pheromone. This substance is deposited by each swarm robot over every step in searching, which results in a repulsive force between team members. Besides, a short-term memory inspired by Tabu Search is applied to enable robots to remember their last positions and to avoid useless explorations. On the other hand, homing is based on the behavior observed in pedestrian evacuation, resulting in an attractive force through the nests. Moreover, a dynamic information is used to avoid queues of robots and bottlenecks next to the nests. Each robot step is a first choice movement with a stochastic conflict solver, which results in a non-deterministic characteristic to the model. The proposed model was implemented and submitted to several simulations to evaluate its resultant behavior. Different environmental conditions were employed to refine its intrinsic parameters. The results shown that the proposed model is able to perform the foraging task in a competitive way: in searching the swarm perform a good environment coverage and in homing robots are able to find the most adequate nests.

Keywords: Cellular automata, swarm robots, search, foraging, dynamical systems, parallelism.

1 Introduction

Human behavior manifests features of social interaction, forming general-purpose clusters. People swarm dynamics have currently come under greater investigation due to their wide applicability [2], [4]. The analysis of a swarm in unsafe conditions is relevant as pedestrians make mistakes when trying to escape by encountering unsuccessful trajectories or poorly designed exits [1], creating conditions where evacuations create risks to health and even death [3]. In such investigations, simulations are structured from environmental abstractions and the results help determine safety levels for building security, suggesting practical ways to prevent dangerous crowd pressures.

Another research field aligned with this objective, and which has attracted attention from researchers over recent years is the study of mobile search robot swarms [11]. In many situations, the sheer number of tasks necessary for performing a job makes it unfeasible through use of a single robot. Even using a team of robots, they must maintain cooperative strategies to finish the task effectively. In this context, each swarm robot requires a simple architecture. Among those previously investigated scenarios one can mention, transportation of equipment in industries, vehicle control, air robotics, sports competitions

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