

# Distributed Algorithms for Systems of Autonomous Mobile Robots

David Peleg\*

Department of Computer Science, The Weizmann Institute of Science, Rehovot, Israel  
david.peleg@weizmann.ac.il

Over the last five decades, mobile robots have been the focus of extensive research and development activities, with numerous applications for industrial tasks, military operations, search and rescue missions and space exploration, as well as some home applications.

Systems consisting of a group of autonomously operating mobile robots (sometimes referred to as *robot swarms*) have attracted considerable interest throughout the past twenty years, due to their potential for providing flexible, low-cost solutions in hazardous situations (e.g., military operations, toxic environments or fire fighting). The idea is to deal with such applications using swarms consisting of many small and simple robots, with very limited capabilities (e.g., low energy sources, limited communication means and weak processors). The use of tiny, functionally simple and cheap robots may make it acceptable to lose some of the robots, so long as the team manages to achieve its collective goals.

The main research efforts invested so far in mobile robots focused on the main engineering aspects of providing physical functionalities. Nevertheless, it seems clear that the design of very large robots swarms makes it essential to reconsider also control and coordination issues. For instance, managing the movements of a robot swarm involves new and interesting algorithmic problems due to the need to coordinate the movements of the individual robots and avoid collisions and over-crowding. Coordination tasks studied so far in the literature include gathering a robot swarm to a single point, pattern formation, flocking (or following a leader), partitioning, spreading and searching.

Most existing experimental settings of robot swarms involve small swarms (of, say, up to a dozen robots), which allow centralized control. However, future robot swarms, consisting of tens of thousands of robots, can no longer be controlled centrally in an efficient manner, and it seems that certain tasks may need to be managed by distributed protocols. Indeed, there have been a number of recent studies on distributed coordination and control protocols for robot swarms. From the point of view of the community of distributed algorithms and systems, this presents an interesting new distributed model that differs in a number of key aspects from the traditional models, and raises some intriguing research problems.

The talk will review this exciting research area, present some of the main problems and issues raised by it, and discuss directions for future study.

---

\* Supported by the Israel Science Foundation (grant No. 693/04).