Map Making as a Support for Cooperation

Fumihiko Chimura and Mario Tokoro
Department of Computer Science,
Faculty of Science and Technology, Keio University.
3 – 14 – 1 Hiyoshi, Kohoku-ku, Yokohama 223, Japan.
{chimura, mario}@mt.cs.keio.ac.jp

This research deals with search tasks of agents, in particular, a meeting task where agents try to gather into a single location starting from distributed arrangements. The meeting task is ubiquitous in cooperation because agents need to approach one another if they wish to work together effectively. For example, in cooperative computation, multiple processes must come near in order to reduce communication cost. An efficient solution is one in which all agents work simultaneously, and in which the meeting location determines adaptively. However, the difficulty with this solution is that the agents, and hence the meeting location, will move unpredictably.

The search task of moving targets requires many moves when agents try to react, as soon as possible, to each move of the targets (Ishida & Korf 1991). The *trailblazer search* makes a tradeoff between reaction time and the number of moves (Chimura & Tokoro 1994). It dynamically maintains a *map* of where the agent has already searched through in the problem space. The map is a routing table that records paths found in the searched region. Once the agent finds a mapped path to the target, it flashes back using those paths. The idea contrasts with that of conducting a lookahead search (Ishida 1992).

Assuming the map is useful to overcome the unpredictability issue of the meeting task, we evaluate a dynamic solution that uses the trailblazer search as the search strategy of agents. We compare three solutions.

- **Single Agent Traveling Search (SATS)**
  Without using a map, a single agent tries to reach the locations of all the other agents that stay still.
- **Static Meeting Point Search (SMPS)**
  Without using maps, all agents simultaneously try to reach a predefined meeting location.
- **Dynamic Meeting Point Search (DMPS)**
  Using maps that record moves of agents, all agents simultaneously try to reach the locations of all the other agents.

For evaluation, we use a simple grid-like, rectangular problem space of size 40 junctions on each side, placing agents and obstacles randomly on junctions. Obstacles realize unpredictable motions of agents. The estimated total cost of search is the sum $d * D + e * E$ of the cost D of map maintenance and the number E of moves, for the last agent to reach the meeting location, and where d is set to 10^{-3} and e to 1.

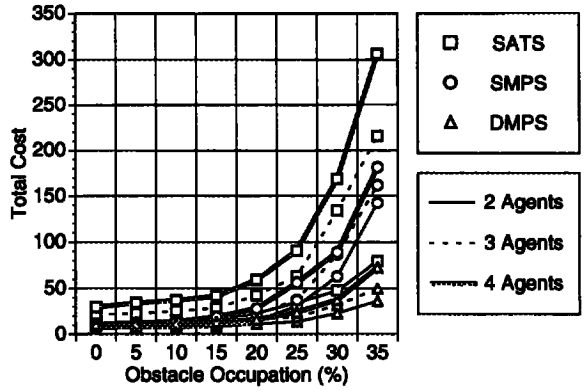

Figure 1: Results for the Meeting Task

DMPS is efficient due to the benefit of the map. The reason is that, even in the face of unpredictable motions, when agents try to come near and meet each other, there is high probability that they run into passed regions of each other. In this case, the map can be highly utilized. We are further studying the case of agents using locally valid, incomplete maps.

References

Chimura, F., and Tokoro, M. 1994. The Trailblazer Search: A New Method for Searching and Capturing Moving Targets. In *Proceedings of the Twelfth National Conference on Artificial Intelligence*, 1347–1352. AAAI.

Ishida, T., and Korf, R. E. 1991. Moving Target Search. In *Proceedings of the Twelfth International Joint Conference on Artificial Intelligence*, 204–210.

Ishida, T. 1992. Moving Target Search with Intelligence. In *Proceedings of the Tenth National Conference on Artificial Intelligence*, 525–532. AAAI.