10th Colloquium of the
SPP 1183 Organic Computing

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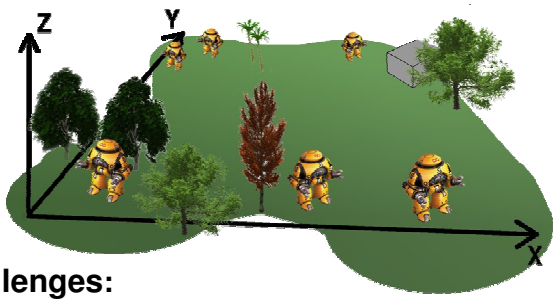
Smart Teams

Local Distributed Strategies for Self-organizing Robotic Exploration Teams

We lay the algorithmic foundations for a scenario where an exploration team of robots (a smart team) self-organizes itself in order to explore an unknown terrain and execute work in this terrain. The work is guided by strategies for exploration, for finding important objects, and for assigning to such an object a subgroup. All tasks have to be executed by local, distributed strategies that act on the mobile network of the moving robots, and have to result in a robust, effective self-organization of the team. No robot ever will have knowledge about the global state of the system. Decisions are solely based on local information. We analyze the quality of our strategies theoretically and experimentally.

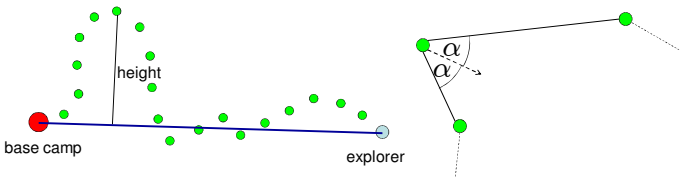


Challenges:

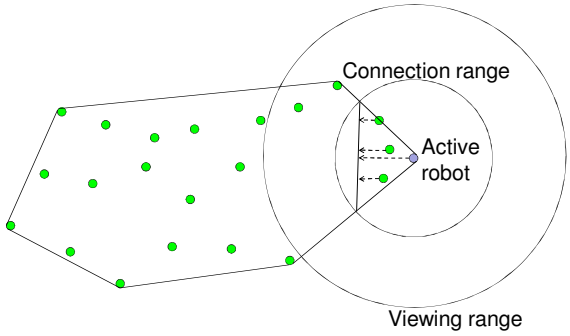
- How can the Smart Team organize itself to explore an unknown terrain?
- How to keep the group connected?
- How to agree upon a fair resources assignment?
- How to minimize the overall energy consumption?

Communication

- Use mobile relay robots to maintain a communication structure among mobile explorers
- Local strategies for relays required



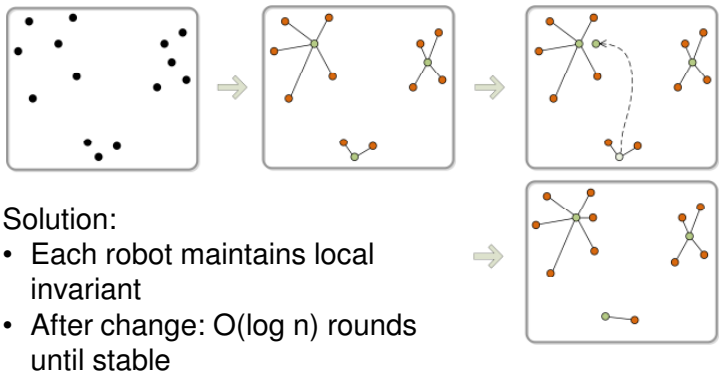
- Continuous Move-On-Bisector strategy:
  - Moves robots to line between base camp and explorer
  - Needs time O(height+length)



- Move-Neighbors Strategy:
  - Relays gather in one point
  - Runtime $O(n^2)$ in expectation

Assignment

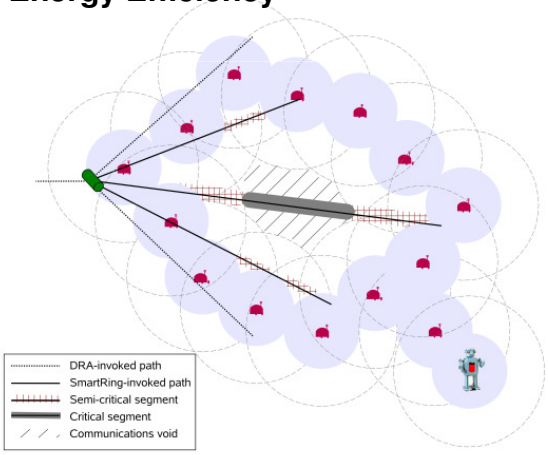
- Robots can be client or facility: Assign robot r_i to role
- Facilities provide costly service: costs f_i
- Clients connect to closest facility f_j: costs $d_i \cdot \text{dist}(r_i, r_j)$
- Maintain good solution under movement of robots



Solution:

- Each robot maintains local invariant
- After change: O(log n) rounds until stable
- Stable solution: 17-approximation of optimal solution

Energy Efficiency



- Robot pursuing mobile target
- Wireless Ad Hoc Sensor Network tracks target
- Task:
  - Find pursuer path strategies
  - Compensate network coverage holes

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