8th Colloquium of the
SPP 1183 Organic Computing

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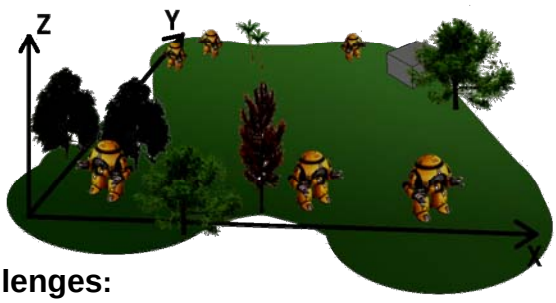
Smart Teams

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.

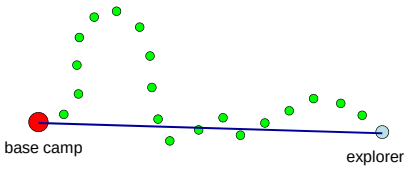


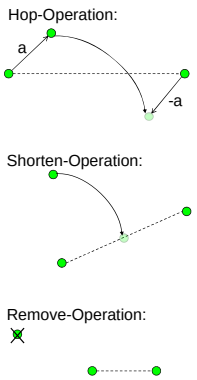
Challenges:

- 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?

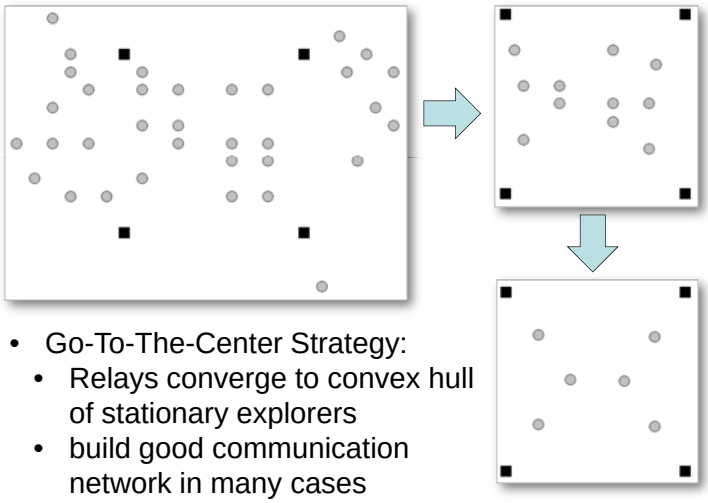
Communication

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





- Hopper-Strategy:
  - Linear convergence
  - Constant speed of explorer

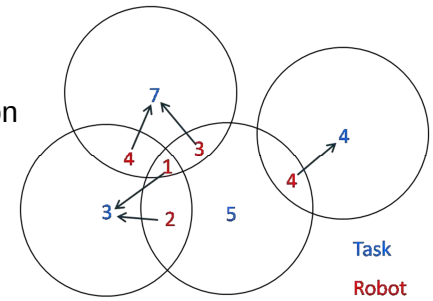


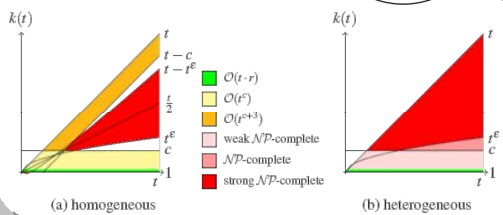
- Go-To-The-Center Strategy:
  - Relays converge to convex hull of stationary explorers
  - build good communication network in many cases

Assignment

- Assign robots to tasks
- Tasks need a certain amount of robot power
- Maximize number of fulfilled tasks
- Geometric locality constraints

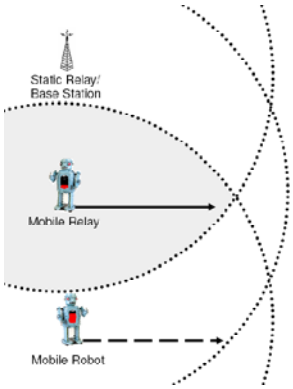
Local approximation algorithm with resource augmentation

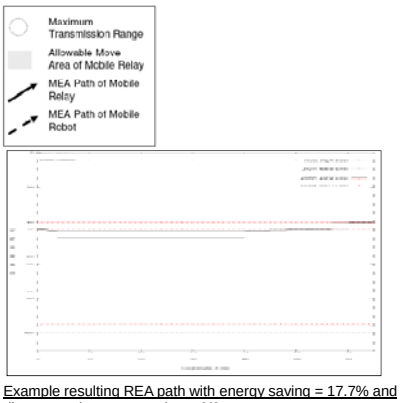




NP-hard in most settings

Energy Efficiency





Example resulting REA path with energy saving = 17.7% and distance ratio among nodes = 2/3

- Communication cost and motion cost
- Robots move and communicate simultaneously
- Optimized energy allocation
- PCM-Dijkstra-Refinement and REA Path Computation strategies

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