6th Colloquium of the
SPP 1183 Organic Computing

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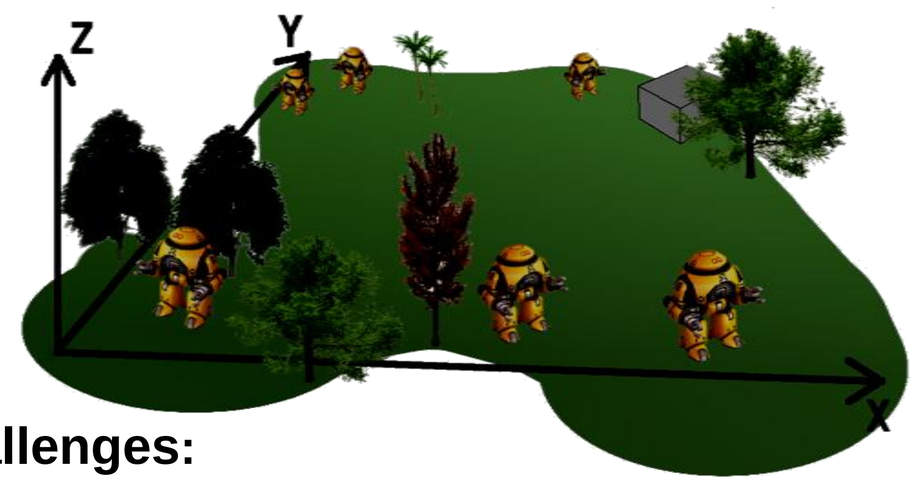
Smart Teams

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.

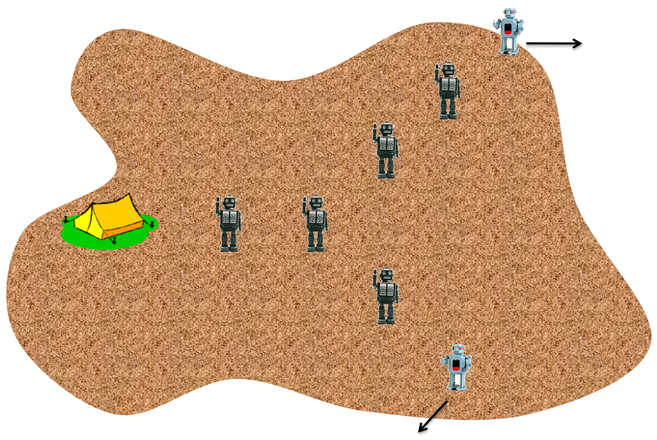


Challenges:

- 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?
- Can we have a truly organic system?

Exploration & Communications

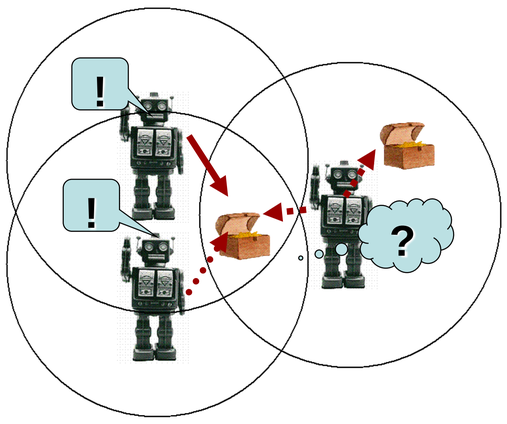
- Relays build multi-hop communication network (base to moving explorers)
- Local strategies for relays required
- Terrain: modeled as a plane with or without polygonal obstacles



- Up to now:
  - strategies for scenarios with one moving explorer or a group of stationary explorers
  - upper and lower bounds for collective exploration in trees

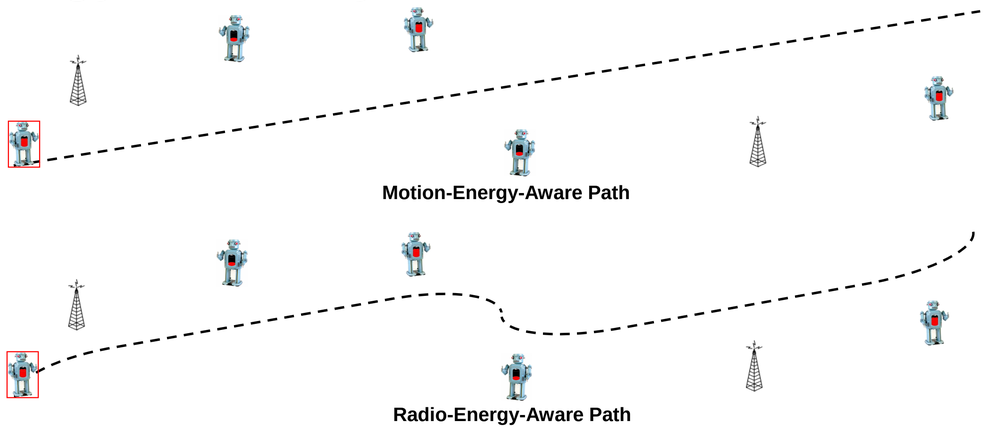
Assignment

- Assign sub-teams of robots to tasks
- Robots have jointly the capabilities to fulfill tasks
- Maximize number of fulfilled tasks
- Local strategies required
- Global problem already NP-hard
- Local approximation



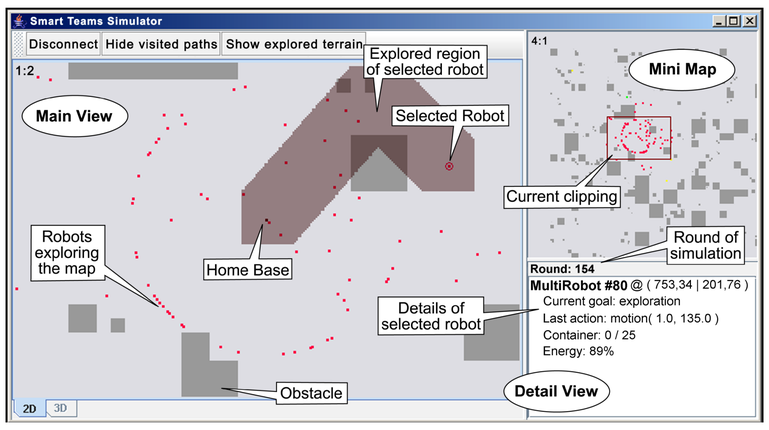
- Theoretical analysis of worst-case instances

Energy Efficiency

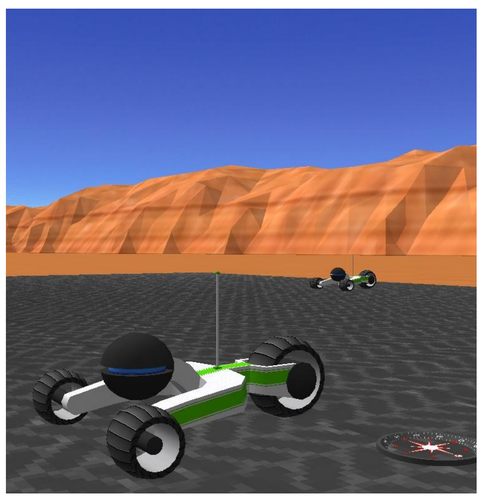


- Robot moves and communicates simultaneously
- To find the energy-optimal path, we consider both motion and communication costs
- We introduce PCM-Dijkstra-Refinement and REA Path Computation strategies

Smart Teams Simulator



- Real-time simulation of
  - up to 1000 robots (each with local view)
  - on a vast topology (up to 10,000 km²)
  - with millions of obstacles
- Framework for easy development of strategies
- Convenient evaluation of strategies via 2D-/3D-Visualization



Applications

- Exploration of dangerous areas
- Planetary and oceanic exploration
- Search and rescue actions
- Intelligent surveillance and monitoring system

Team Members

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