Advanced methods for hard planning problems in mobile robotics

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Planning for Search & Rescue

Goal: Plan paths for all entities so that every point in the environment can be visible by at least one entity. The length of the longest path has to be minimized.
Planning for Search & Rescue
Mobile Robot Exploration of an Unknown Environment

**Exploration:** A process of autonomous navigation of a mobile robot in an unknown environment in order to build a model of this environment with minimal resources used.

**Frontier based algorithm**
Yamauchi (1997)

```
repeat
  Get the updated map.
  Detect goal candidates.
  Evaluate the goal candidates.
  Select the best candidate.
  Navigate to the chosen candidate.
until accessible frontier found;
```

Performance metric: Time to create the map of the whole environment
Multi-Robot Exploration of an Unknown Environment

**Exploration:** A process of autonomous navigation of mobile robots in an unknown environment in order to build a model of this environment with minimal resources used.
Travelling Deliveryman & Graph Search Problems

- **Goal:** find a tour that minimizes the expected time to find the required information.
- **A fast metaheuristic** (Greedy Randomized Adaptive Search Procedure) producing near-optimal results.
- **Extensions:**
  - Multi-robot case.
  - Employed in a search scenario.
  - Search in a spatio-temporal domain
  - Exploration/exploitation (learning when and where to assist people)
  - Localization-Aware Exploration for UAVs

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- **PDM [%]**
  - 0.0
  - 0.5
  - 1.0
  - 1.5
  - 2.0
  - 2.5
  - 3.0

- **Number of iterations**
  - 10
  - 100
  - 200
  - 300
  - 500
  - 700
  - 1000

- **TSP**
- **TDP**

- **brdl4051_80_6**
Planning in Automated Warehouses

Goal: Coordination of robots and humans in the warehouse to maximize the number of picks per time
Planning in Automated Warehouses

Goal: Coordination of robots and humans in the warehouse to maximize the number of picks per time

- Requirements:
  - Collision-free trajectories
  - No deadlocks
  - Heterogeneous robots
  - Minimal waiting times
  - Minimal (no) waiting of a picker
  - Fairness
  - “In operation” charging
  - Low computational complexity

- Minimal setup
  - 150 AGVs
  - 2000 containers
  - 12 picking stations
  - 6000 assignments/hour
Human-aware Planning in Automated Warehouses

Goal: To guarantee human safety when he/she enters a warehouse:
   ▶ Planning for a human
   ▶ Replanning of robots to avoid collisions
Human-aware Planning in Automated Warehouses

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Conclusion

Expertise in

▶ Graph theory
▶ Computational geometry
▶ Neural networks
▶ Operational research

applicable in

▶ Search & Rescue
▶ Inspection & maintenance
▶ Goods delivery and Management
▶ Automated Warehouses
▶ Logistics
▶ Planning, routing, and scheduling ...
Thank You your attention!

For more information visit:

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