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b3M33MKR: Multi-Robot Coordination

Karel Košnar

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Assignment

There is a group of robots moving in 2D environment with few narrow passages. Coordinate the movement of all robots, that there will be no collisions and there will be no dead-lock. The shared resource is in this case the space.

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Introduction

Basic tasks in multi-robot systems:

Communication - exchange information

Coordination - don't interfere with others

Cooperation - work together

Communication

Two basic types of communication

Implicit - by observing others and inferring the intentions (inner states, etc.)

Explicit - by exchanging messages in defined formats over communication media.

- directly one-to-one (possibly with discovery server)
- over the server (message broker, blackboard)
- broadcasting

Different messaging patterns

- request - reply (services in ROS)
- publish - subscribe (topics in ROS)
- push - pull (parallel processing / load balancing)

Communication

Three basic types of interaction

- via environment
- via sensing and interaction
- via explicit communication

Coordination

- Needed where resource conflict can occur (e.g. mutual exclusion)
- Control access to shared resources (space in our case)
- Each robot can do its own tasks
- Communication is required (can be implicit)

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Coordination

Static (off-line) coordination - fixed set of rules (e.g. traffic rules)

Dynamic (on-line) coordination - during the execution of tasks

Explicit - uses intentional communication and decisions

Implicit - uses dynamics of interactions - emergent behavior

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Motion Coordination

- Coupled centralized approach - planning for composite robot (all robots together as an multi-body robot)
- Decoupled approach - prioritized planning (sequence of planning steps, where the previously planned robot is taken as a dynamic obstacle)
- Path coordination approach - individually planned paths are fixed and only velocities are changed to avoid collisions

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Assignment

Implement path planning algorithm, that

- plan the collision-free path for n-robots
- avoid the deadlocks (no indefinite waiting)
- can plan on arbitrary map (correct format)

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Simulator

STDR simulator is simple 2D multi-robot simulator.

- Integrated into the ROS
- Provides position of all robots
- Simulates the sensors of robot (not used in this task)

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Group of Turtlebots

Integrates the Particle filter localization.

- Integrates the Particle filter localization (from later assignment)
- Be aware that localization is not precise (uncertainty)