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b3M33MKR: Multi-Robot Coordination

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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.

Basic tasks in multi-robot systems:

Communication - exchange information

Coordination - don't interfere with others

Cooperation - work together

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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)**

Three basic types of interaction

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

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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)

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

Motion Coordination

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- ▶ **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**