

Introduction to Autonomous Mobile Robot Framework



Jan.19 2018

Outline

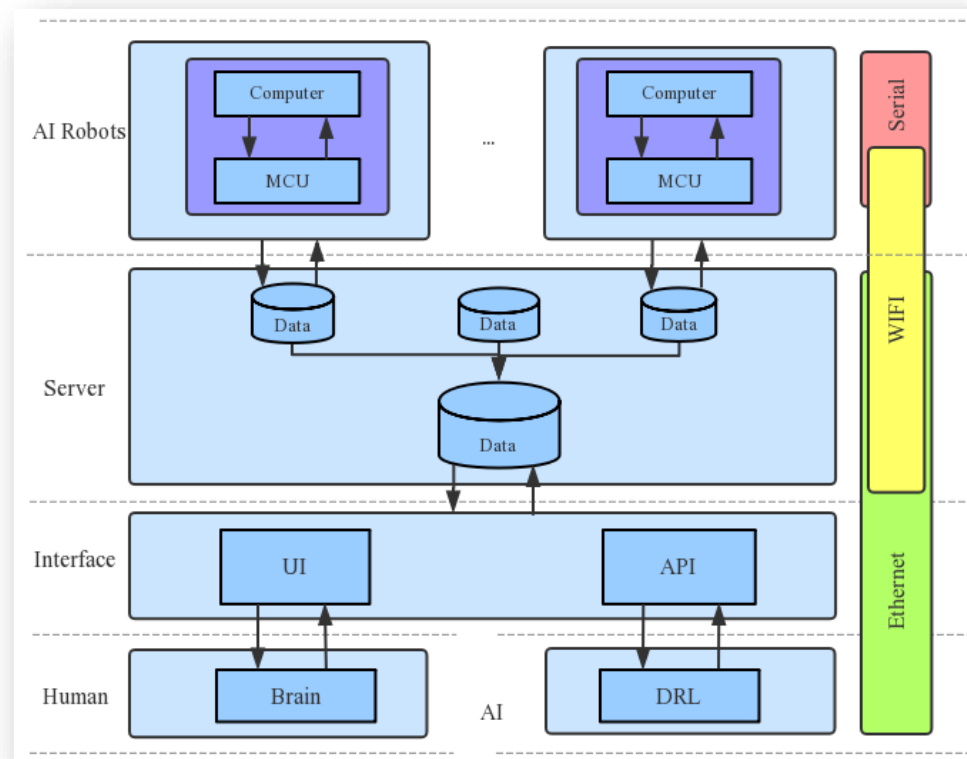
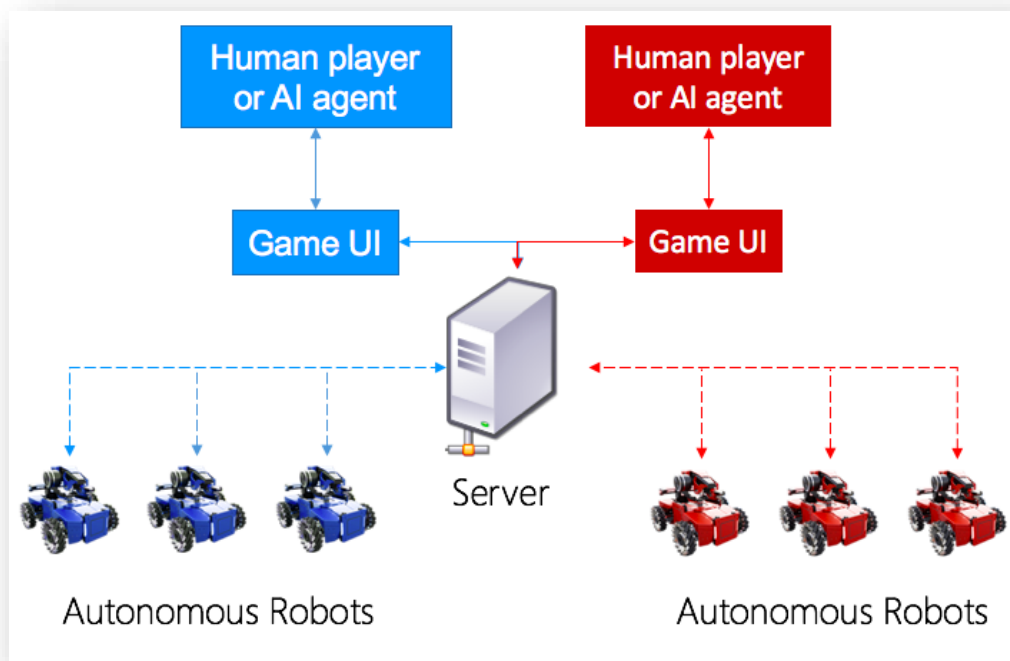
System overview

Hardware framework

Software framework

- ✓ **Perception**
- ✓ **Decision and Planning**
- ✓ **Control**

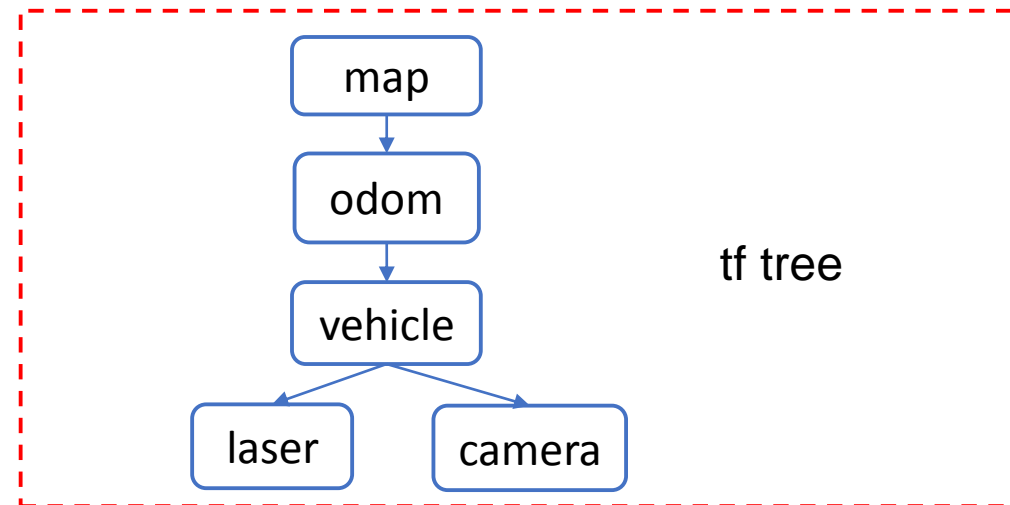
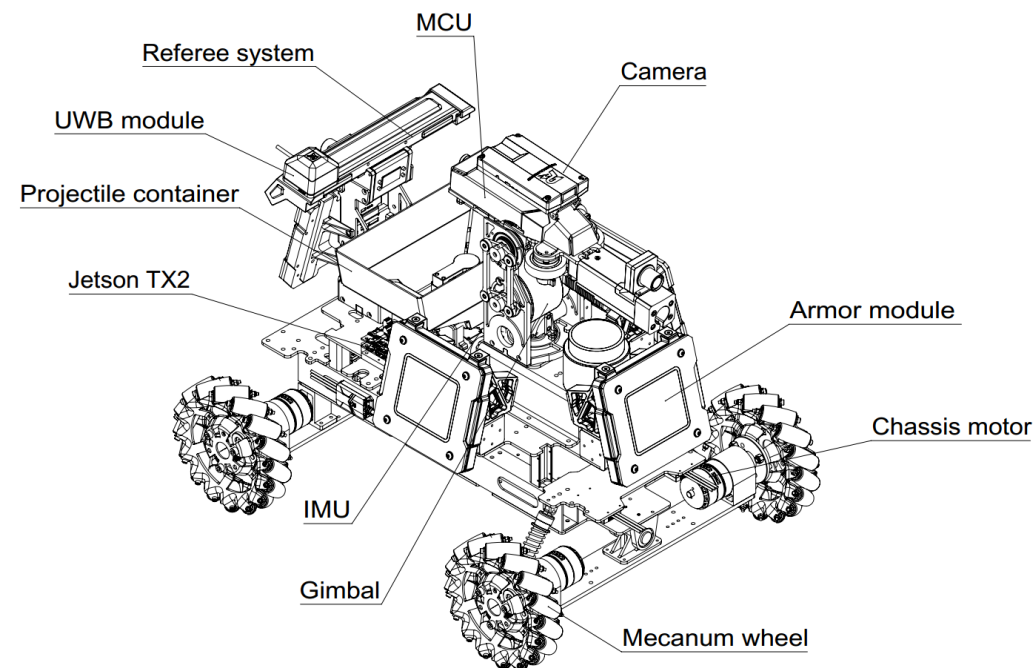
System overview



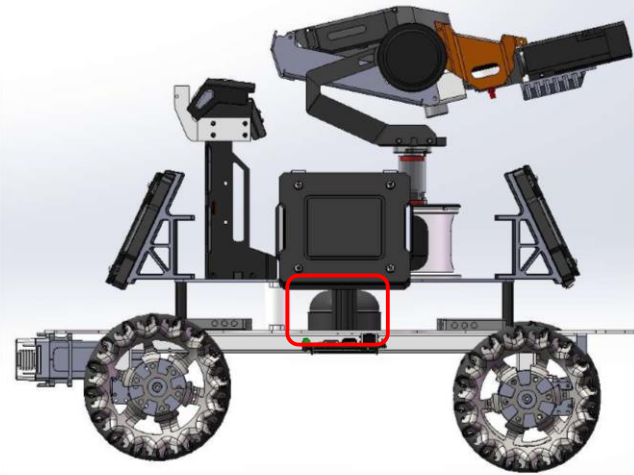
Hardware

Hardware Assembly

Number	Name	Quantity	Note
1	Jetson TX1/TX2	1	Computer
2	CTIM-ASG003	1	Carrier for Jetson TX1/TX2
3	2D LIDAR	1	
4	Camera	2	
5	RM Infantry	1	
6	USB hub	1	
7	IMU	1	



Lidar Placement



Open



Semi-closed

Advantage

✓ Flexible to move

Disadvantage

✓ Large volume

Advantage

✓ Compact structure

Disadvantage

✓ None omni-directional obstacle avoidance

Camera Placement



Fixed on the chassis



Fixed on the gimbal

Advantage

✓ Easy to control

Disadvantage

✓ Lose enemy easily

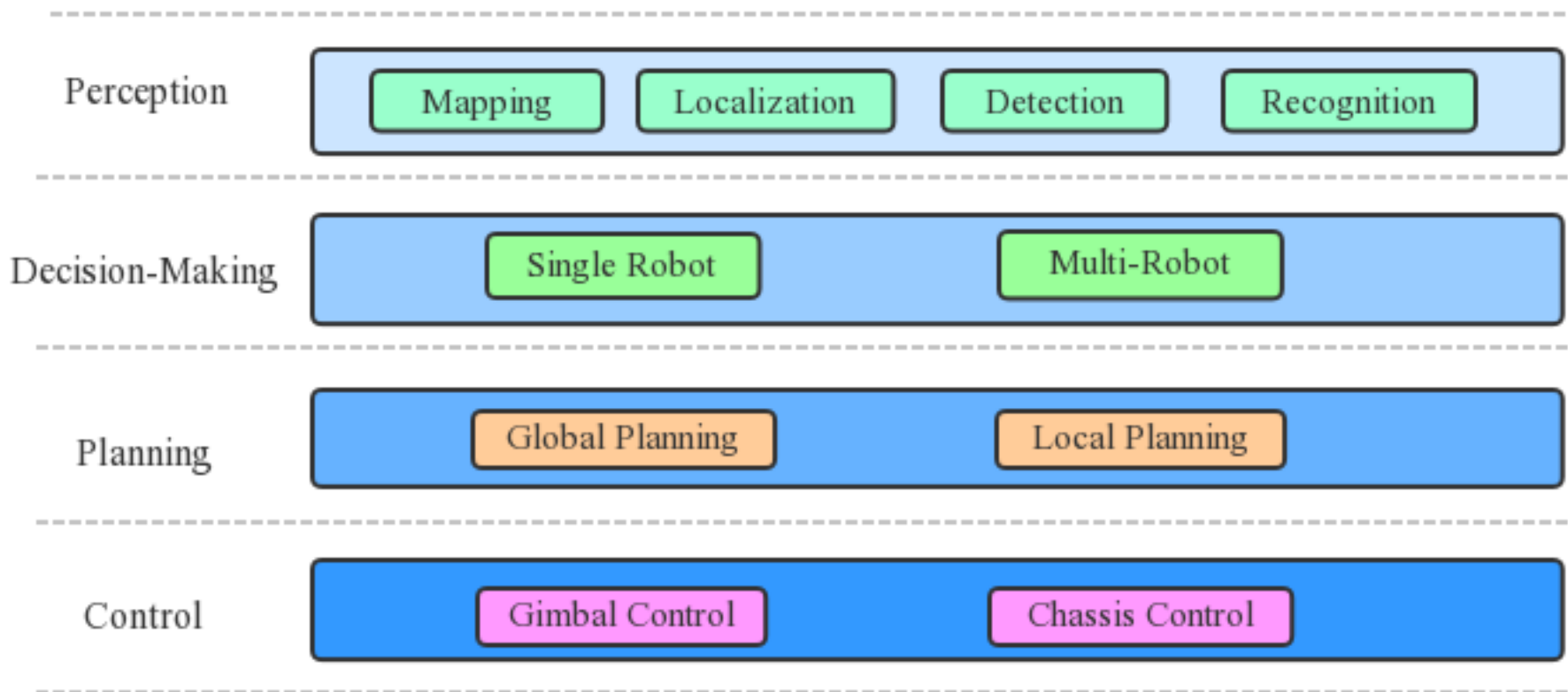
Advantage

✓ Flexible following

Disadvantage

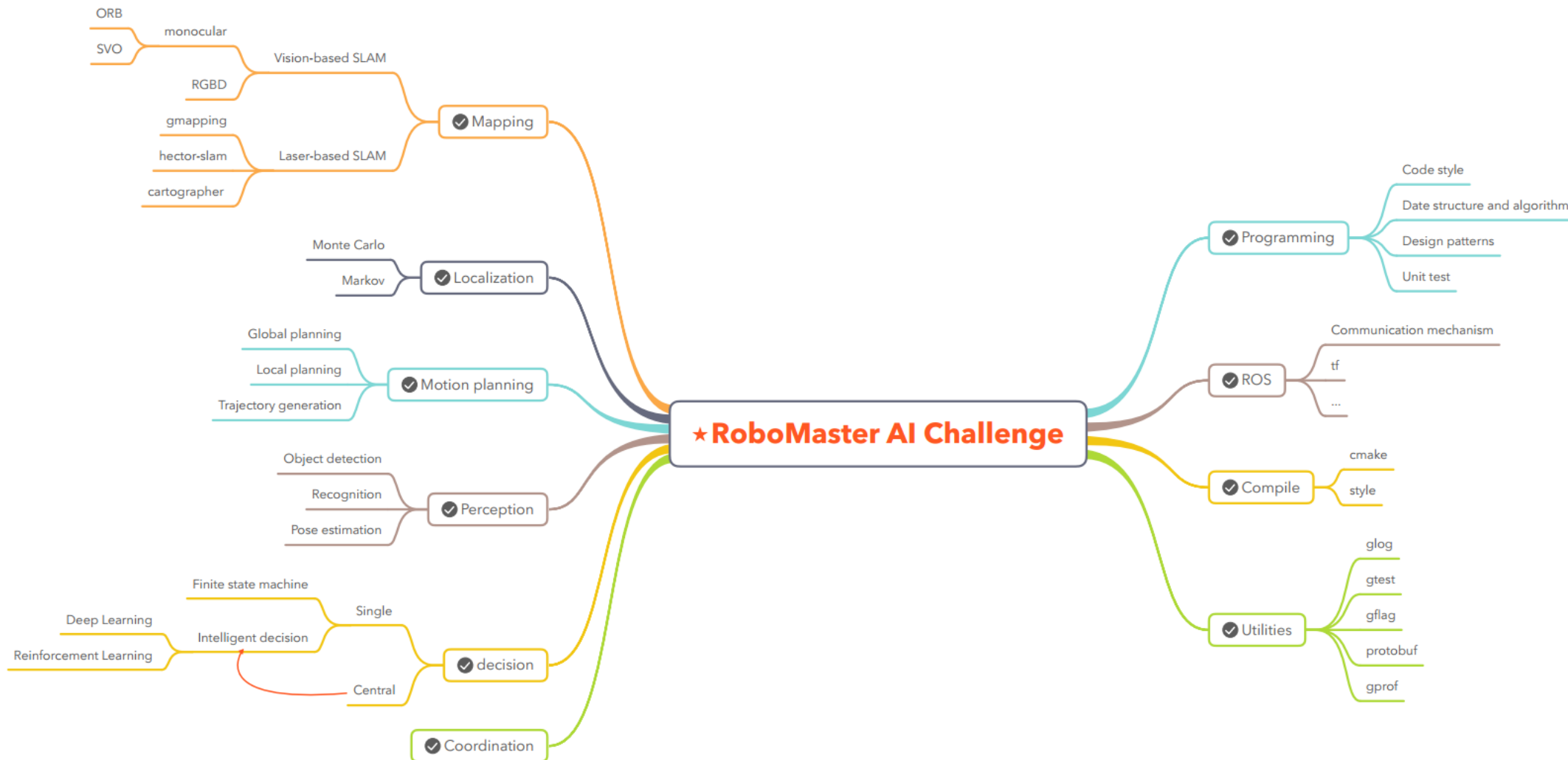
✓ Streaking

Software

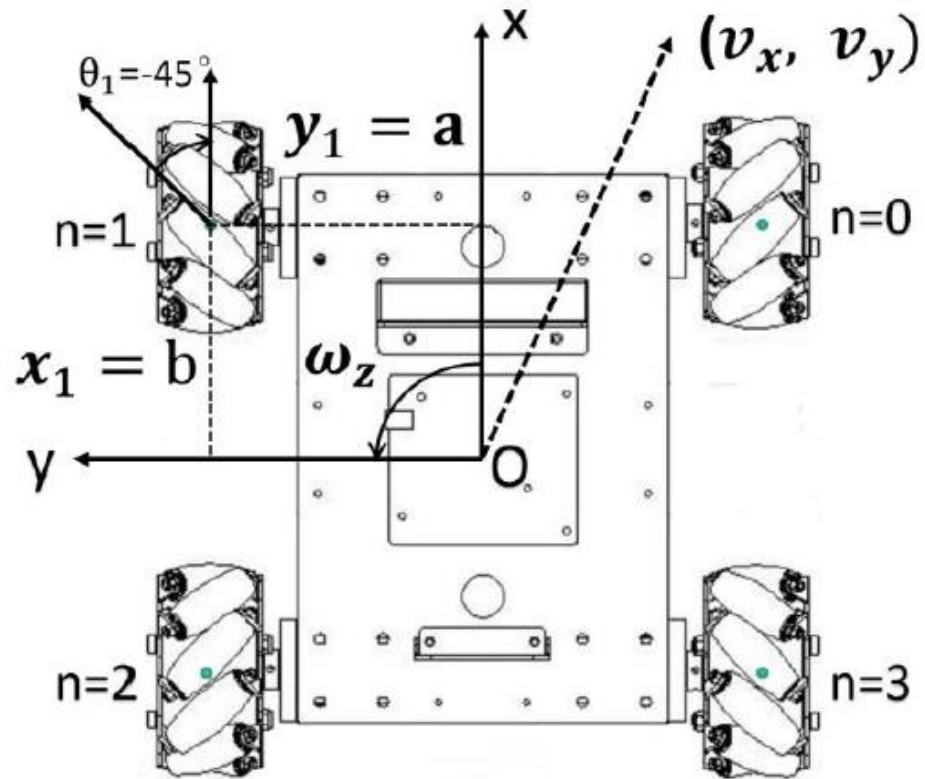




Technical Requirements



Kinematics model



Forward Kinematics

$$Y = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & -\frac{1}{4} \\ -\frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4K} & -\frac{1}{4K} & -\frac{1}{4K} & \frac{1}{4K} \end{bmatrix}$$

$$\Omega = [\omega_0 \quad \omega_1 \quad \omega_2 \quad \omega_3]^T$$

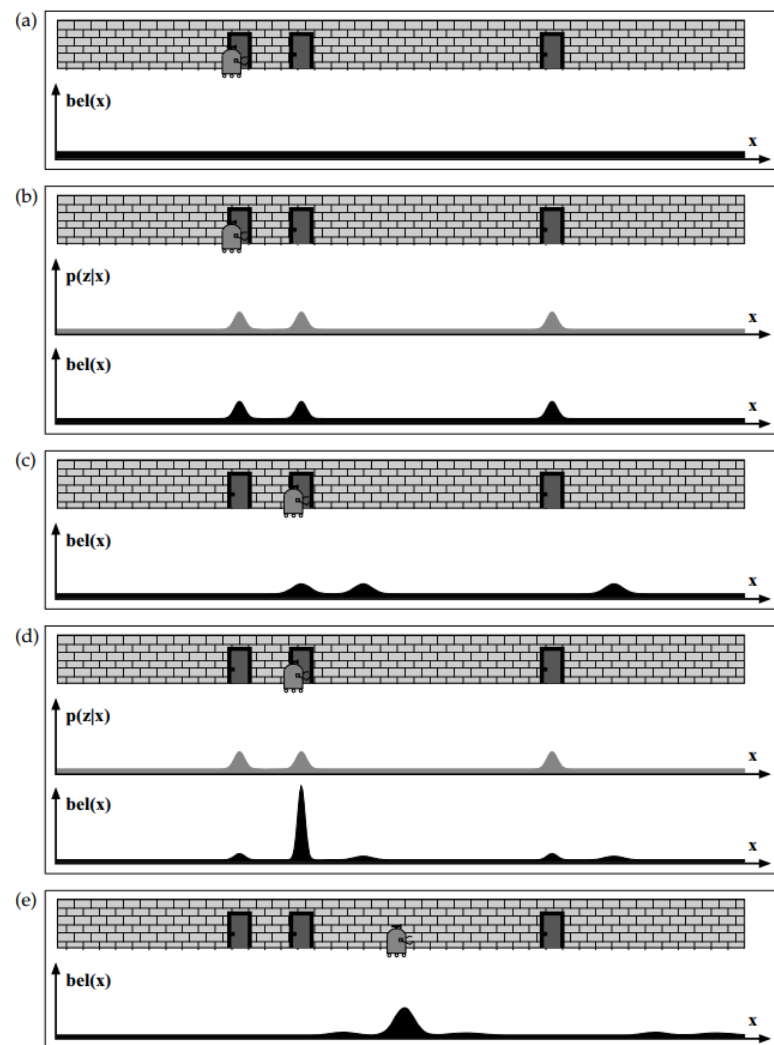
$$K = A + B$$

$$Y \cdot \Omega \cdot r = v$$

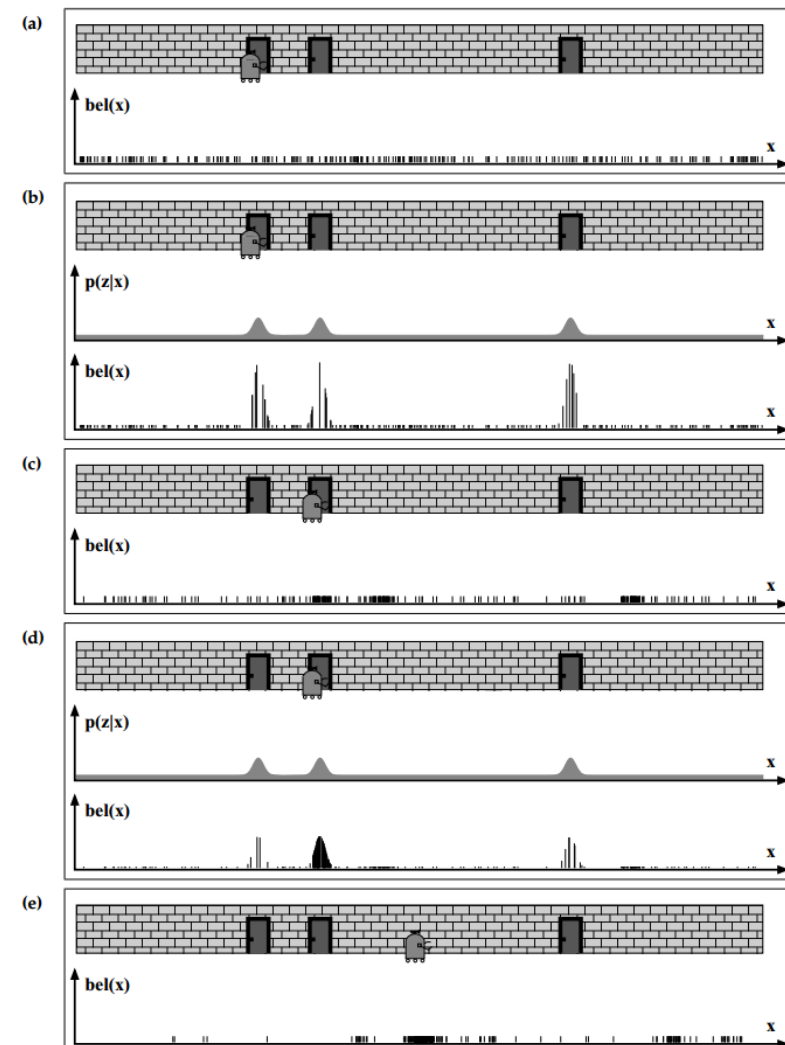
integral
odometry

Localization

Localization

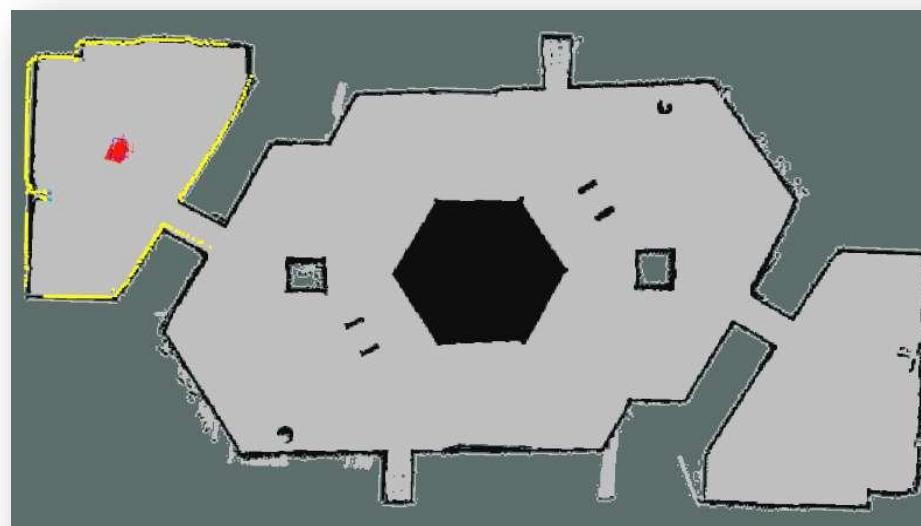
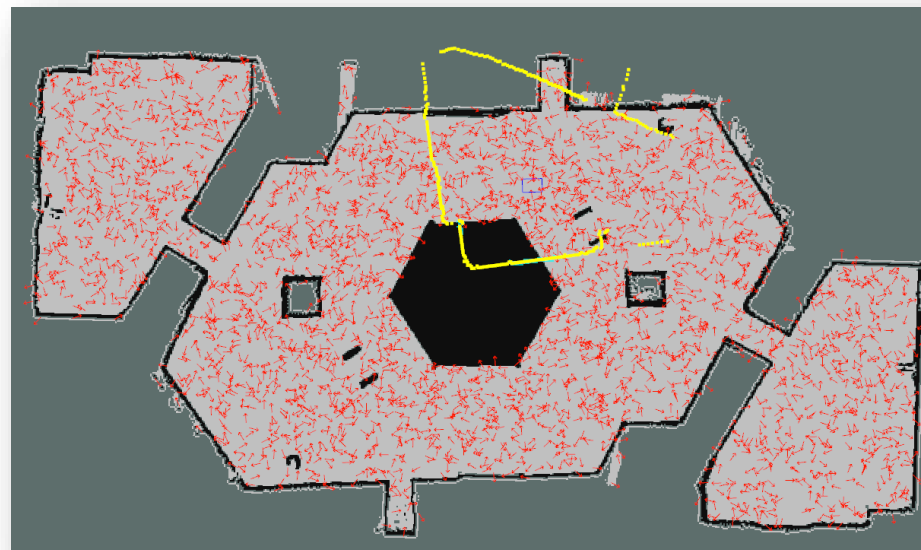


Markov



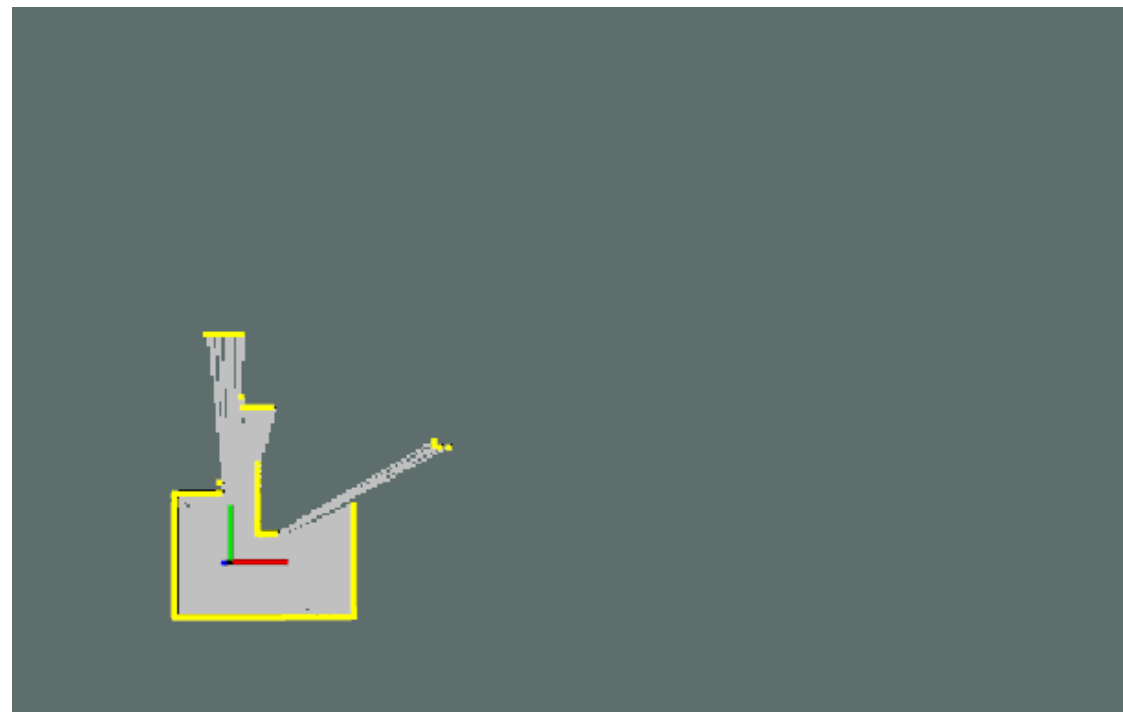
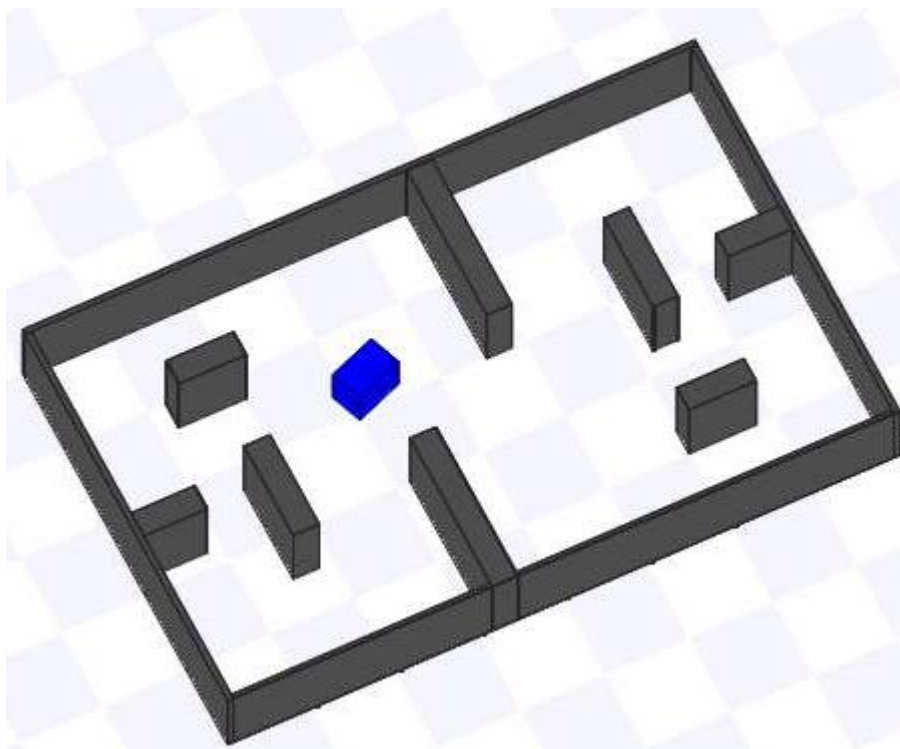
Monte Carlo

Monte Carlo Localization

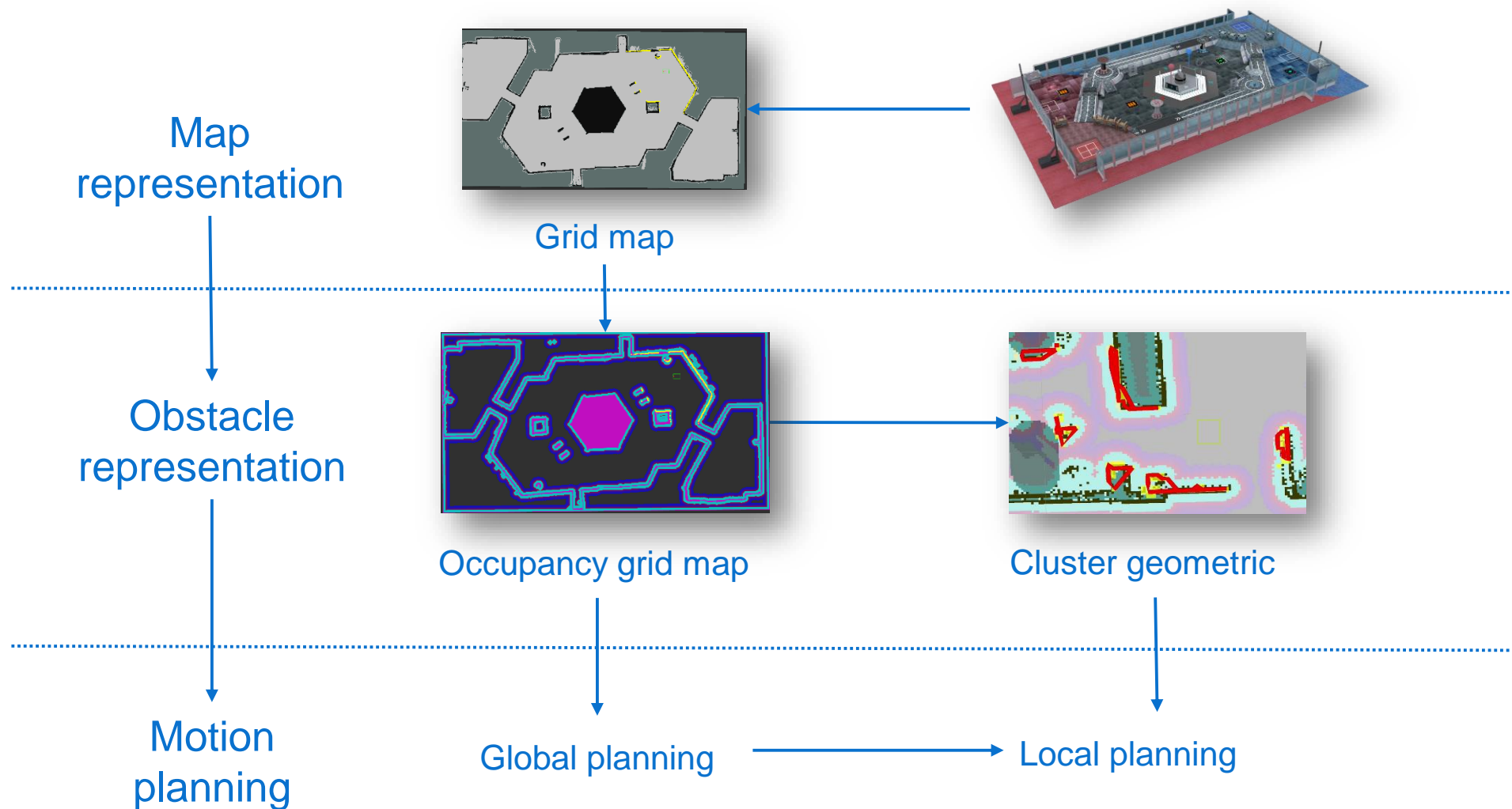


Mapping

Mapping

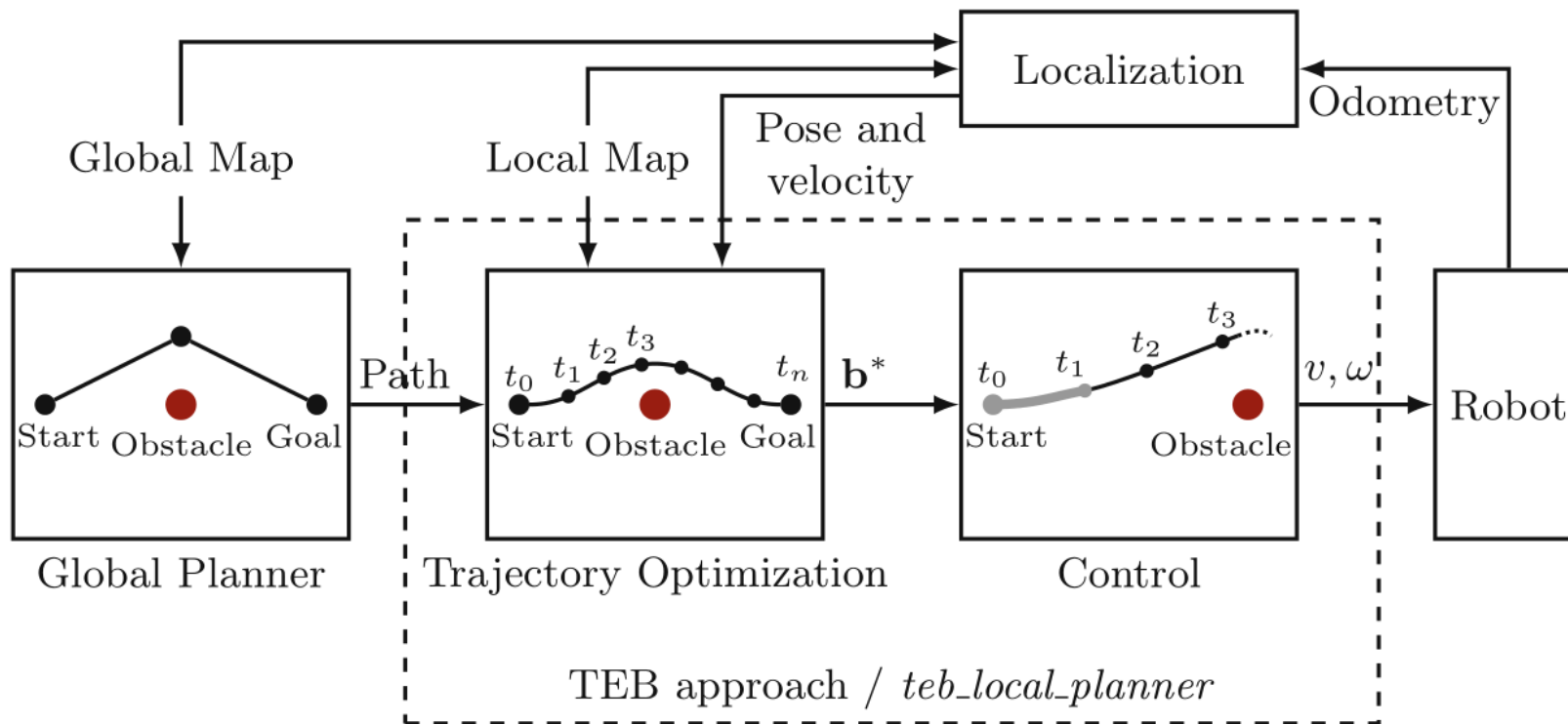


Map Representation

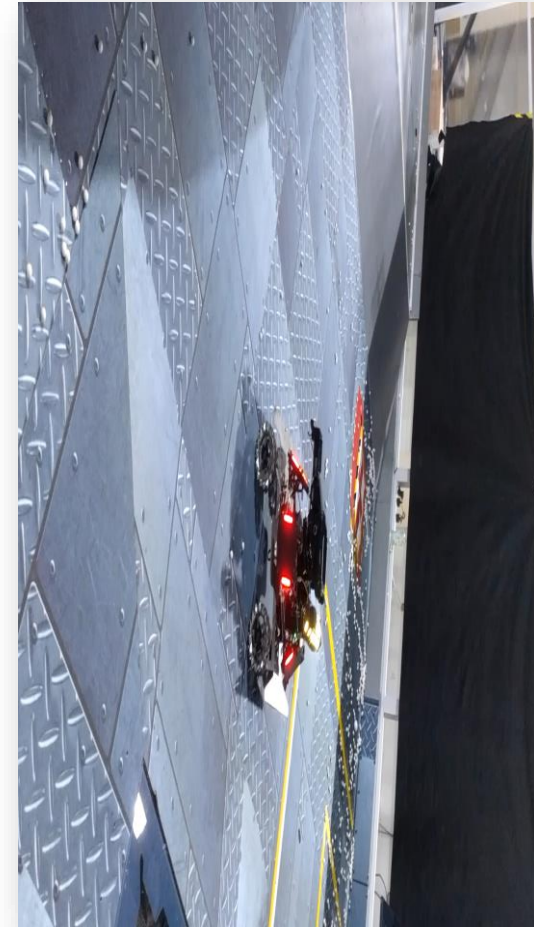
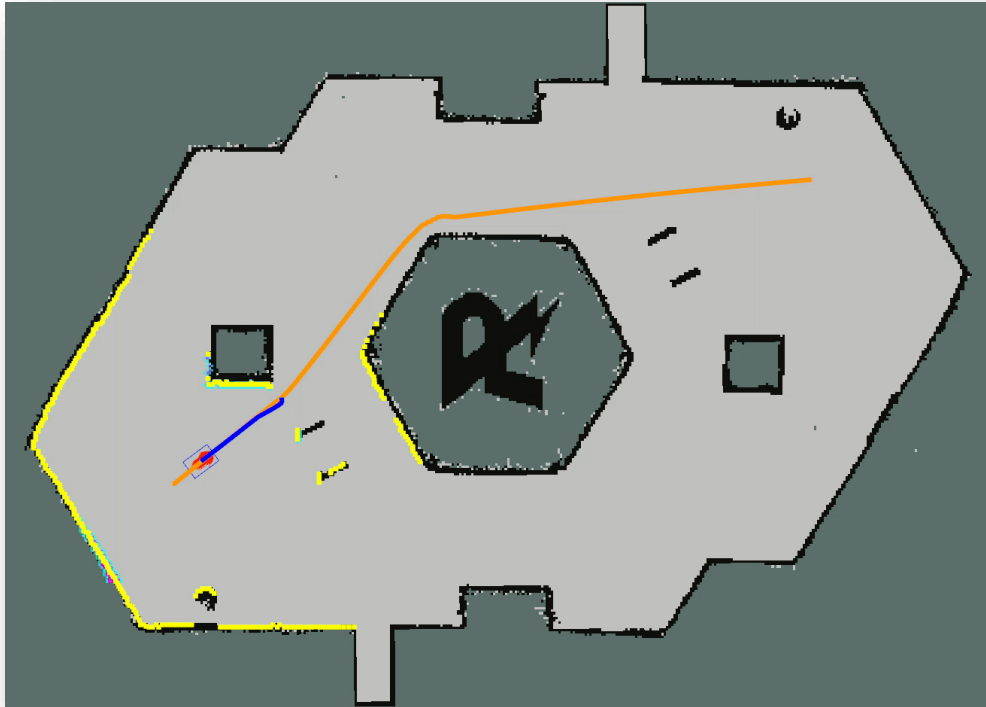


Planning

Planning

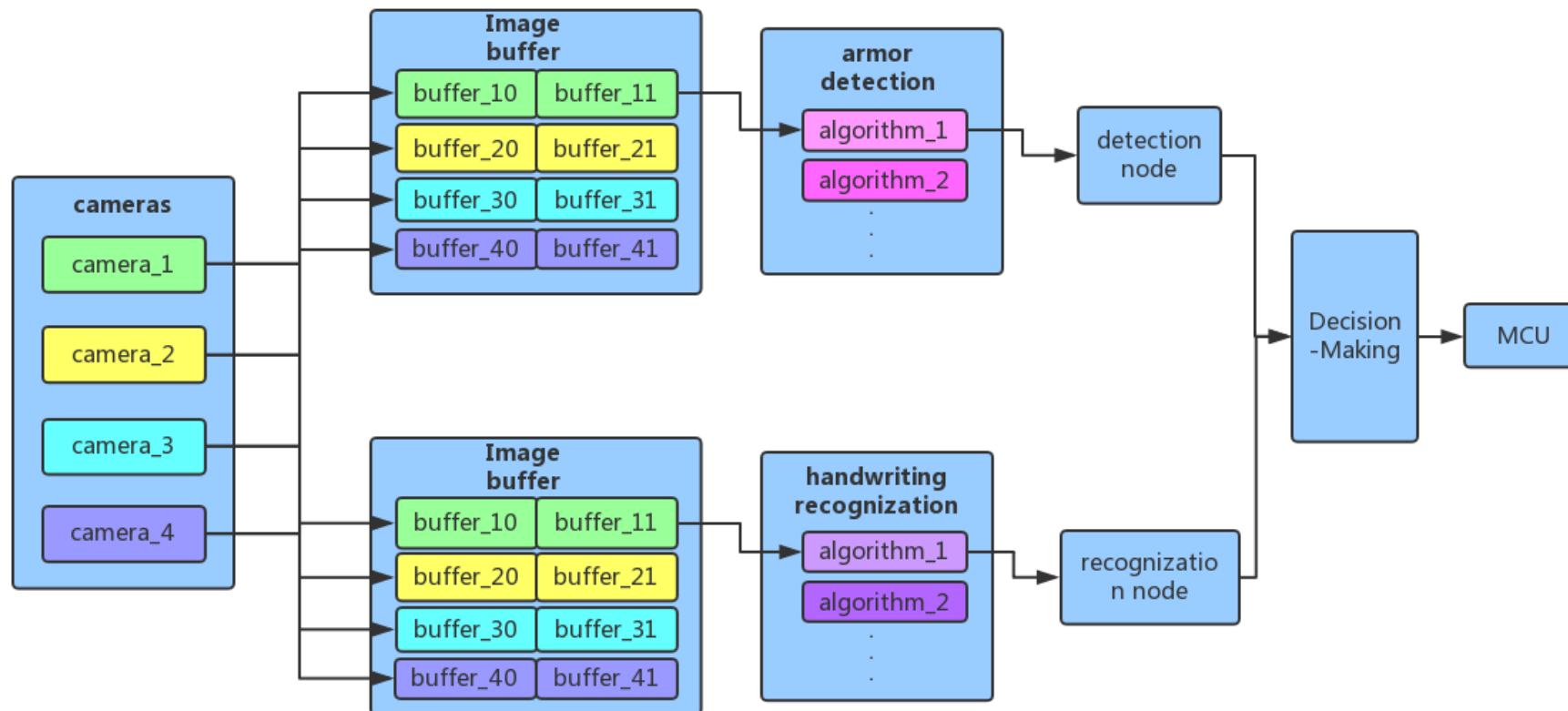


Global and Local Planning



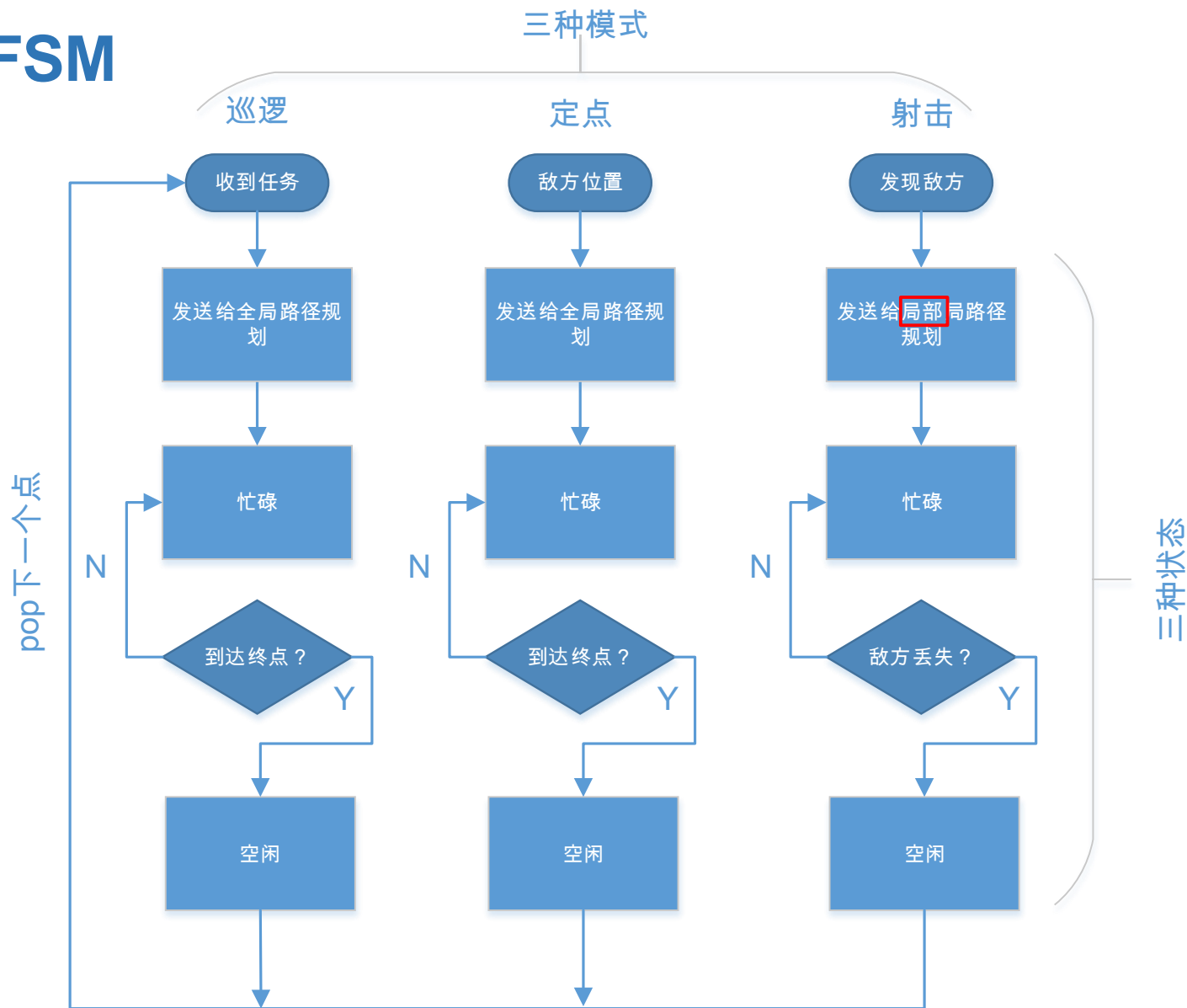
Detection

Armor Detection

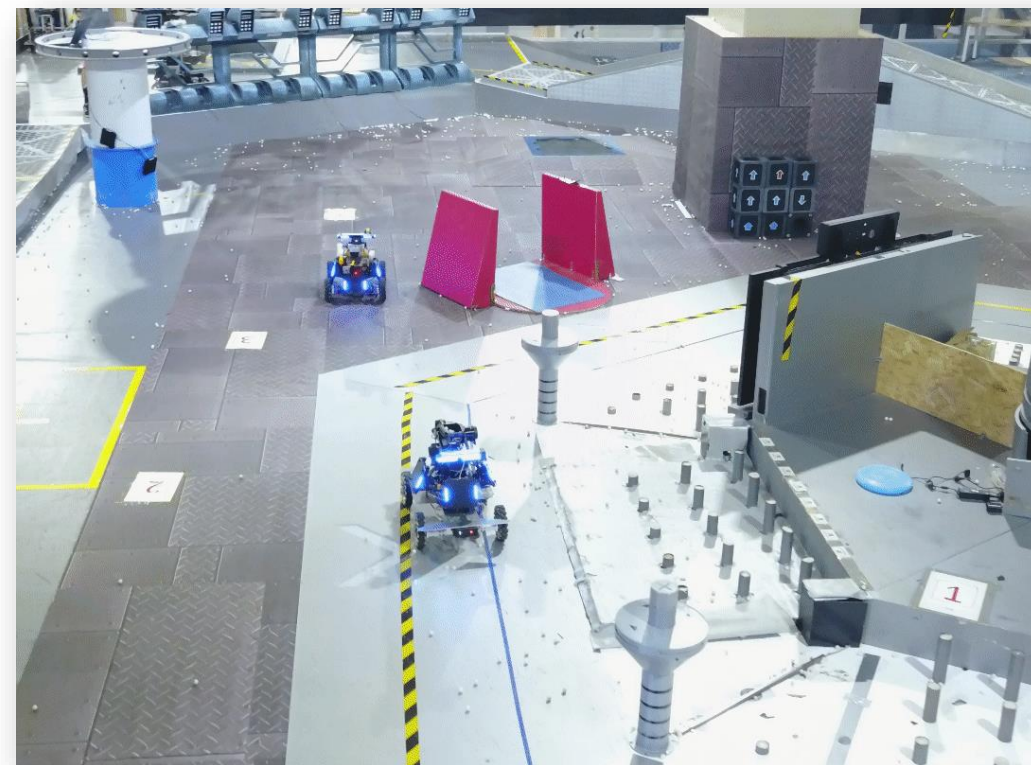


Decision-Making

Single Robot FSM



Shooting



Multi-Robot System Classification

Size of team

- ✓ Single unit
- ✓ Multi-unit
- ✓ Swarms

Re-organize

- ✓ Static
- ✓ Coordinated
- ✓ Dynamic

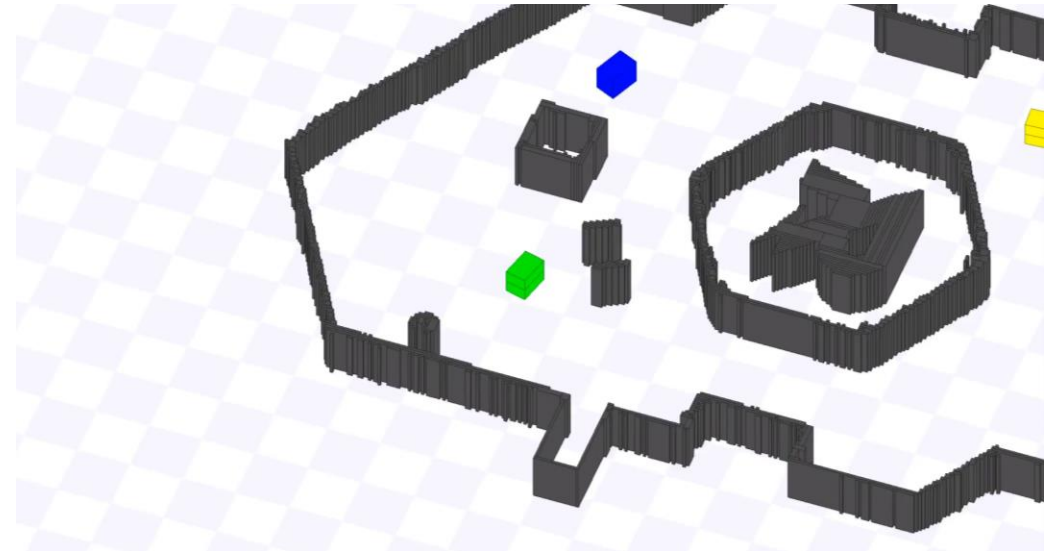
Morphology

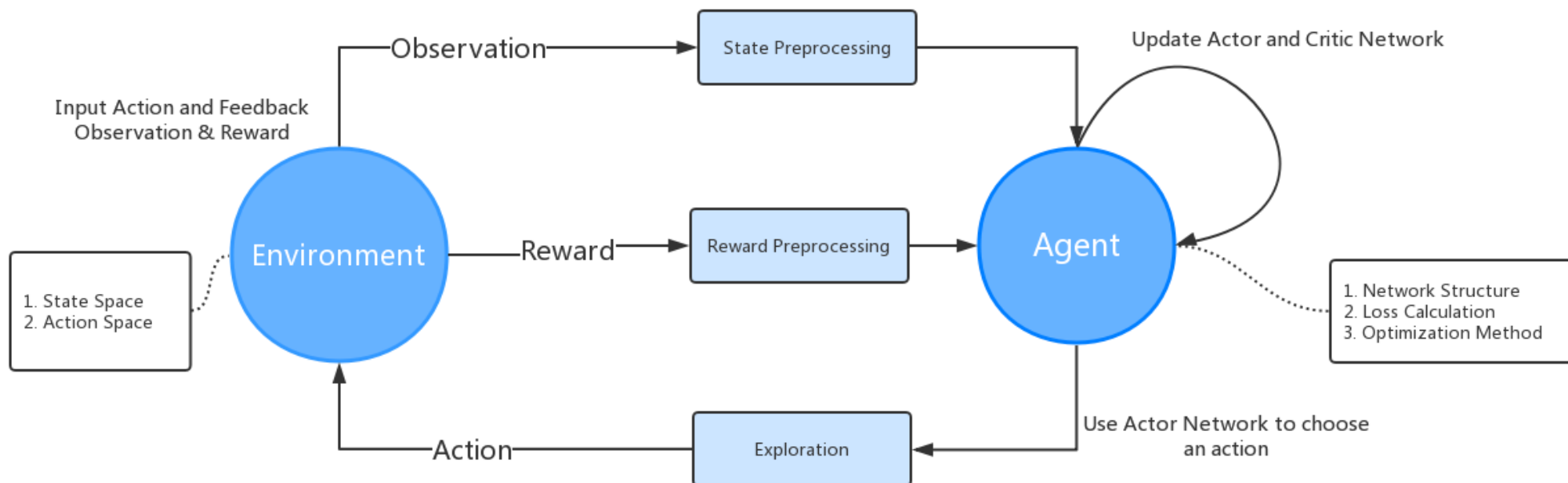
- ✓ Identical
- ✓ Homogeneous
- ✓ Heterogeneous

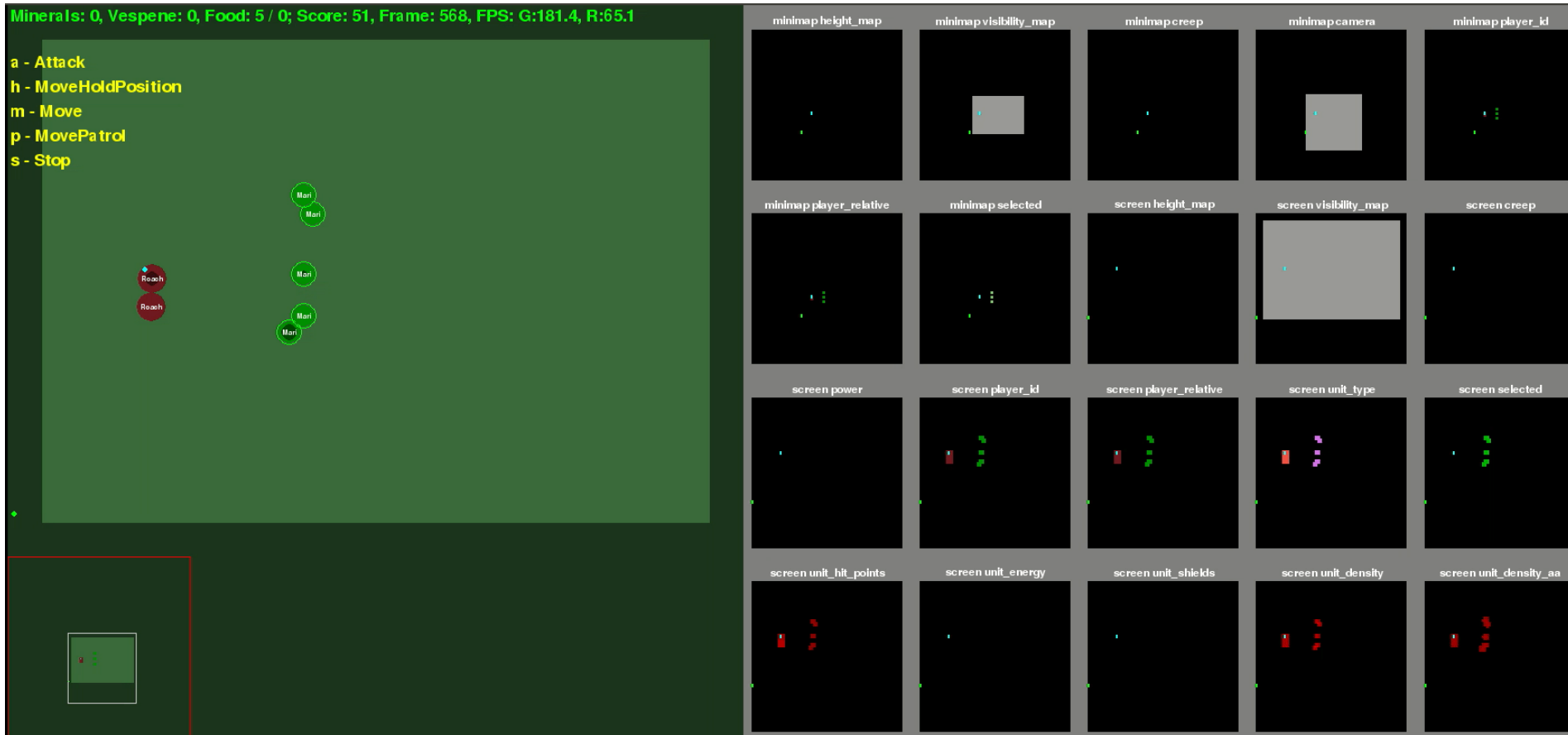
Infantry robot

Infantry robot and
here robot

Infantry robot
and UAV



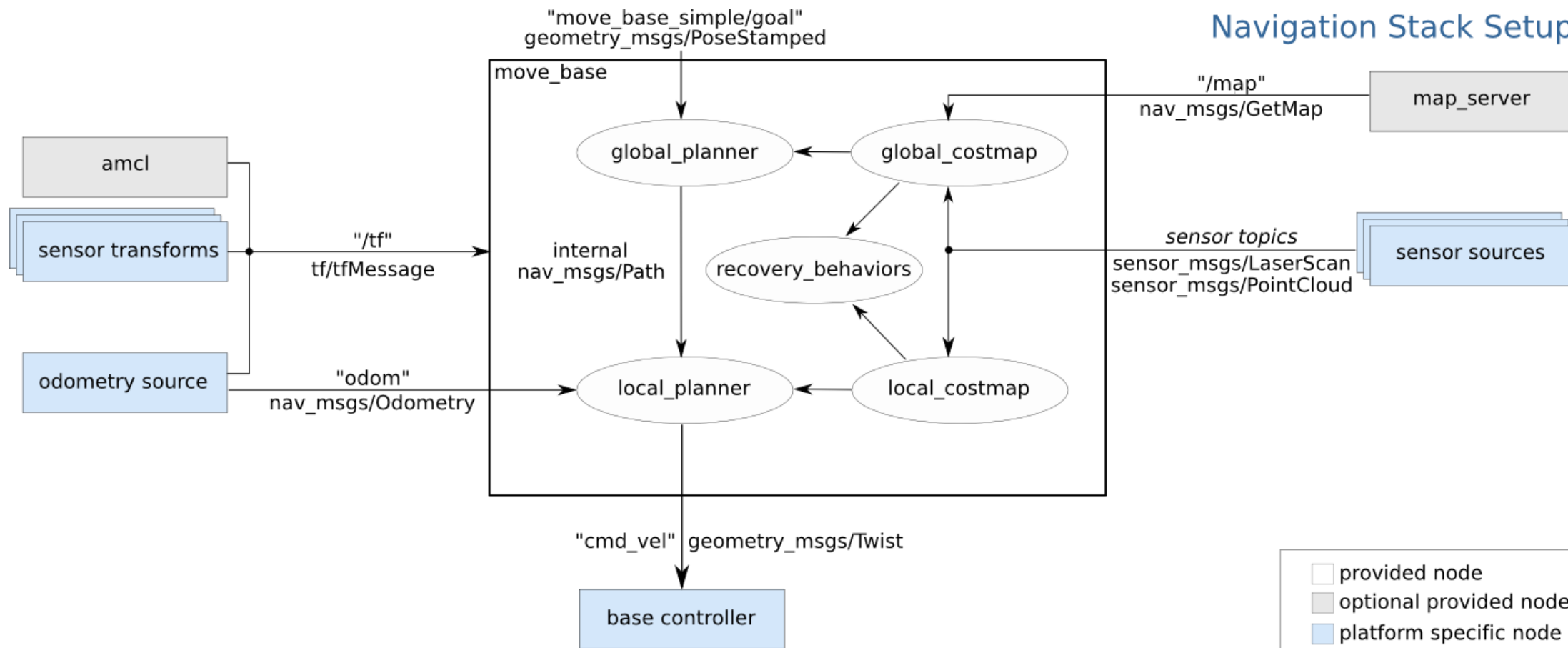




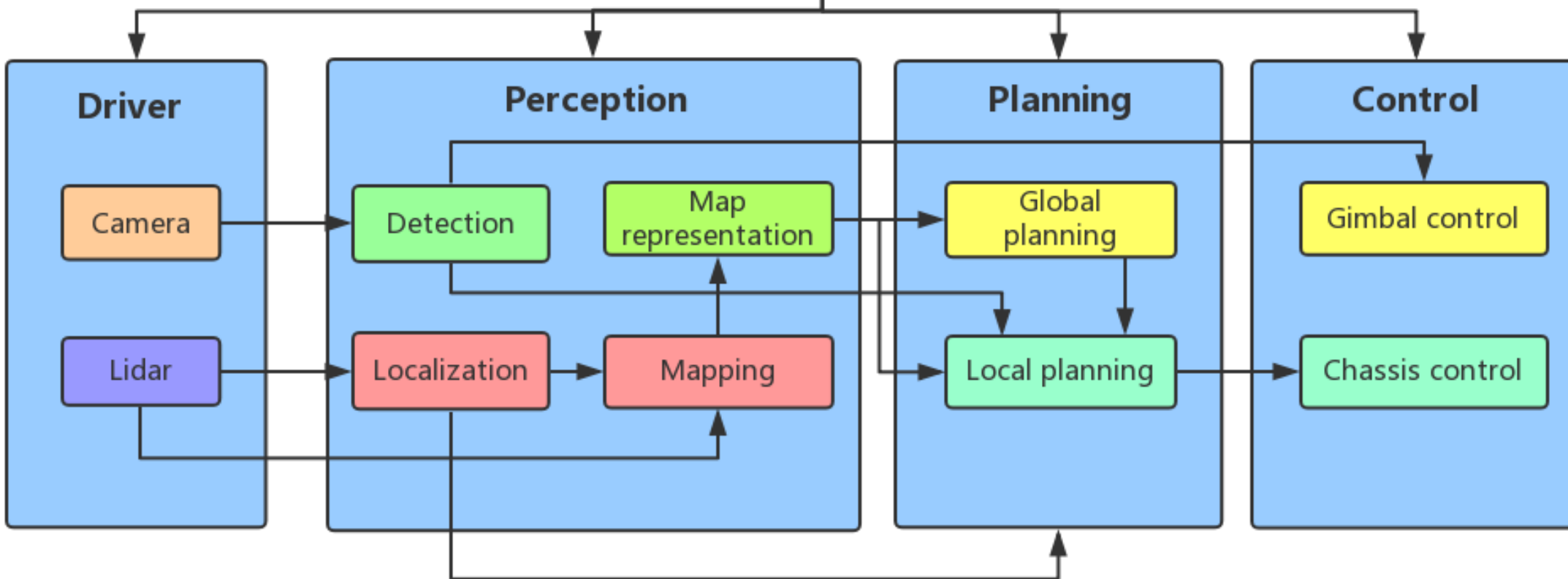
- ✓ Huge state space
- ✓ Huge action space

Train agents in StarCraft2 using DRL

ROS Navigation



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graph TD; A[Decision-Making] --> B[Management]
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References

- [1] Probabilistic robotics
- [2] Planning algorithms
- [3] Integrated online trajectory planning and optimization in distinctive topologies
- [4] Convex optimization
- [5] Deep learning
- [6] State estimation for robotics
- [7] The Robotarium: A remotely accessible swarm robotics research testbed
- [8] Robustness of Control Barrier Functions for Safety Critical Control
- [9] Reinforcement Learning: An Introduction
- [10] Autonomous mobile robots
- [11] Machine learning A probabilistic perspective
- [12] Pattern recognition and machine learning

Q&A