Multi-Robot Path Planning Combining Heuristics and Multi-Agent Reinforcement Learning

Problem they are trying to solve / Purpose of method

Robots must navigate efficiently while avoiding collisions with other moving robots. This is crucial for factories, parking lots, and drone fleets, where safe and efficient movement is essential.

How does it differ from other methods?

Heuristic planners like A*, D* and D* lite provide efficient path optimization in static environments but face challenges with dynamic obstacles.

Conflict-Based Search uses a two-level approach. It plans paths independently and resolves conflicts, ensuring optimal paths but at a high computational cost.

Learning-Base approaches like deep Reinforcement Learning enables real-time adaption, but struggles with sparse rewards and high training costs.

MAPPOHR integrates a heuristic planner and a real-time MARL-based planner (MAPPO).

How the method works

MAPPOHR: Multi-Agent Proximal Policy Optimization with Heuristics and Rules

In short: Multi Agent Proximal Policy Optimization combined with heuristic planners like A* or D*.

- The heuristic planner A* or D*, provides a globally optimal path.
- Real-time planner detects dynamic obstacles and makes decisions based on local observations to avoid collisions.
- The heuristic planner finds optimal paths, while MARL adapts to dynamic obstacles, ensuring efficient and collision-free navigation.

The agents choose from four actions; move, wait, back, or replan, based on observations processed by the critic and actor networks.

The model balances learned policies with heuristic adjustments, ensuring both efficiency and adaptability in dynamic environments.