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A-STC: auction-based spanning tree coverage algorithm for motion planning of cooperative robots

Key words: Coverage motion planning; Multi-robot system; Auction algorithm; Spanning tree coverage algorithm

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Motivation

1. The heuristic pattern-based GA can handle all cases. Nevertheless, it has high computation costs.

2. The complete DARP algorithm can obtain the optimal solution in some cases; unfortunately, it cannot deal with some situations, such as a disconnected configuration space or a configuration space where mega cells are occupied partially by obstacles.

3. To design a complete MCMP algorithm which can deal with all cases, we propose a novel auction-based spanning tree coverage (A-STC) algorithm.

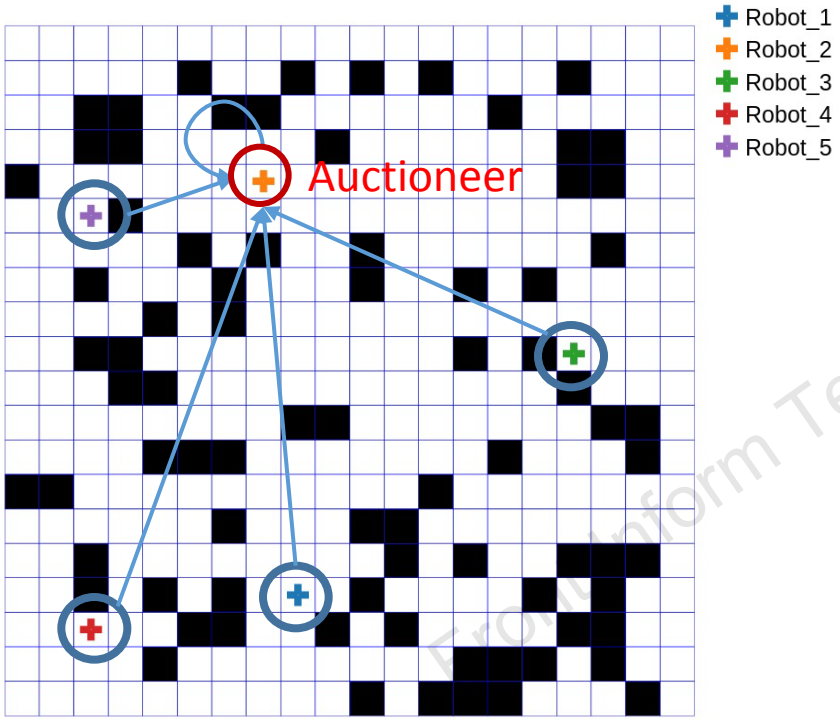
Main idea

1. The proposed auction strategies guarantee that each robot's spanning tree is connected, and that the workload is balanced for all robots.

2. The proposed MCMP algorithm is complete and can handle situations where mega cells are partially occupied by obstacles.

3. Acceptable makespans and trajectories can be obtained in a short computation time using auction strategies.

Method



Selecting an auctioneer

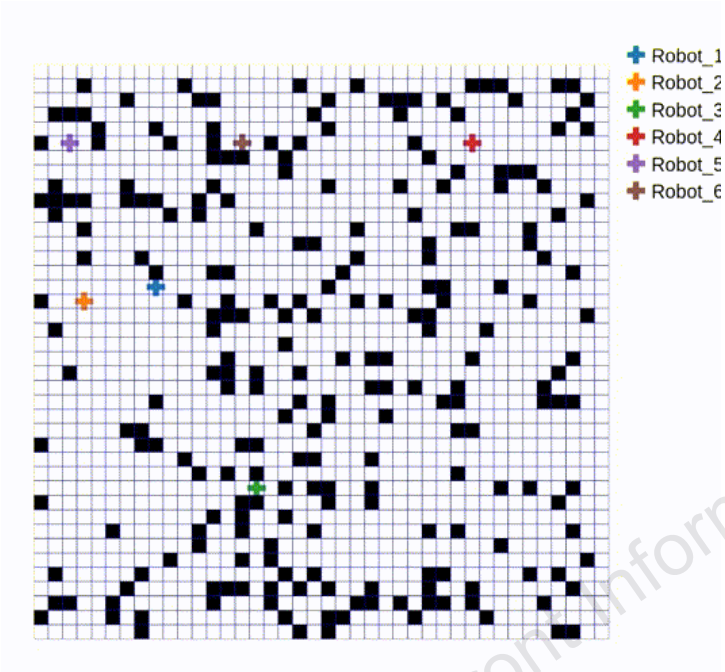
Auctioneer determines an auctioneer item

Bidders provide bids

Auctioneer determines a winner robot

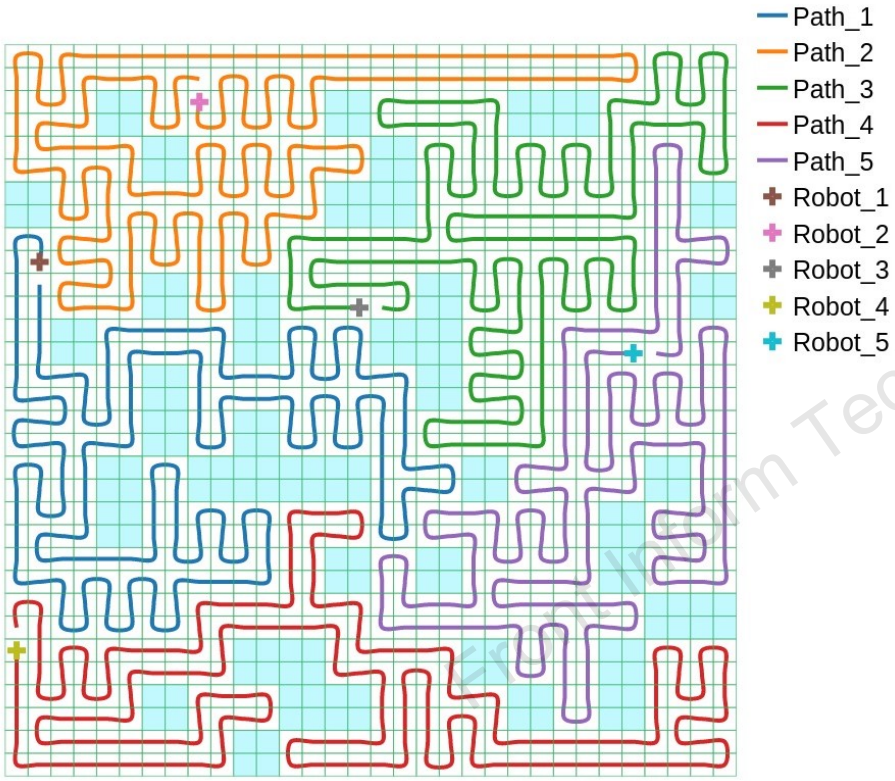
Bidders update own statuses and spanning trees

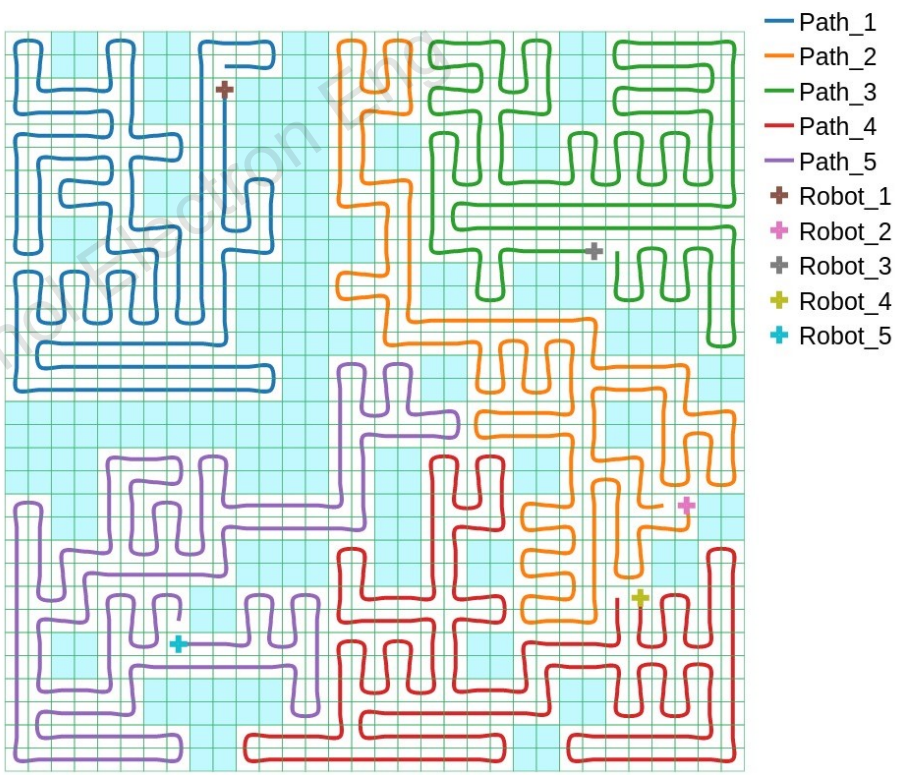
Major results



- Covering every accessible cell in the configuration space
- Unassigned vertexes are rapidly assigned
- Robots' spanning trees trend to keep far away from each other
- Assigned vertexes can be re-allocated

Major results





The **adaptability** of the proposed algorithm to the **configuration spaces** and the **number of robots** are verified.

Conclusions

1. An A-STC algorithm that contains an auction mechanism was proposed to manage multiple spanning trees. In the proposed algorithm, the spanning tree of every robot can be generated rapidly.

2. The A-STC algorithm ensures the connectedness of each spanning tree, and tries to balance the workload among robots.

3. The validity and adaptability of the A-STC algorithm to different environments and robot positions were verified by computational experiments.