COMP550 Project5

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1. A problem statement and a short motivation for why solving this problem is useful.

For this project, I am looking into how to do motion planning for multiple robots efficiently. If we need to deal with multiple robots altogether, the dimension of configuration space expands rapidly with number of robots and as a result it would be quite difficult to find a feasible solution.

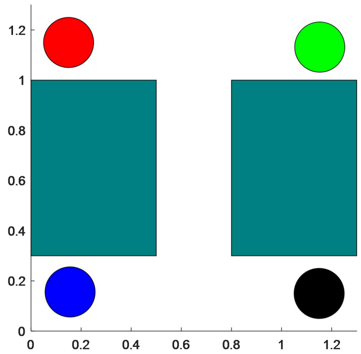
2. The details of your approach and an explanation of how/why this approach solves your problem.

To solve motion planning for multiple robots, I used dRRT algorithm. This algorithm grows a tree over the composite roadmap. Specifically, q_{new} is found in the closest direction of q_{rand}, which makes the tree growth biased to the goal state.

3. A description of the experiments you conducted. Be precise about any assumptions you make on the robot or its environment.

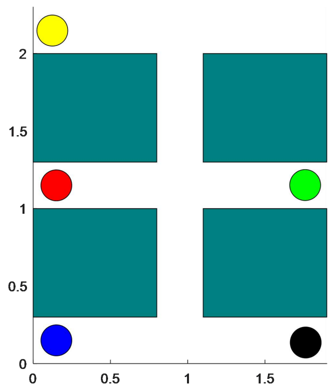
I set up a problem for 4 robots and a problem for 5 robots. I assume the robots are rigid planar circle robots.

Problem for 4 robots:



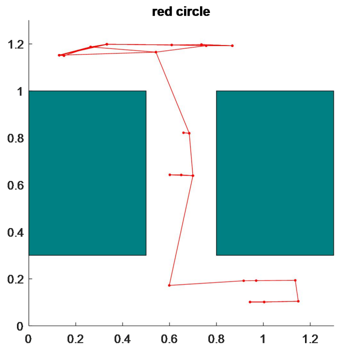
Problem description: red circle and black circle swap their positions, blue circle and green circle swap their positions.

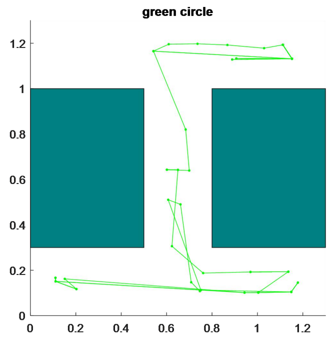
Problem for 5 robots:

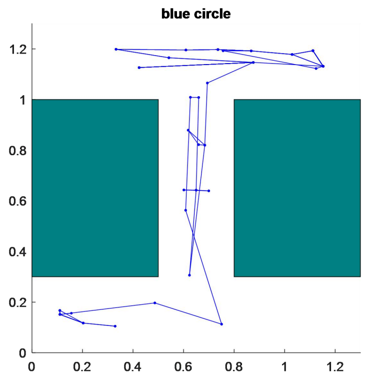


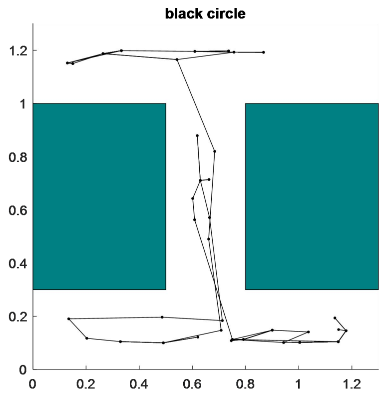
Problem description: yellow circle and green circle swap their positions. Red circle moves to position of blue circle, blue circle moves to position of black circle, black circle moves to position of red circle.

4. A quantitative and qualitative analysis of your approach using the experiments you conduct.
Solution path for 4-robots problem:



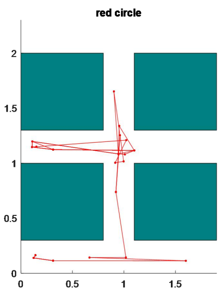


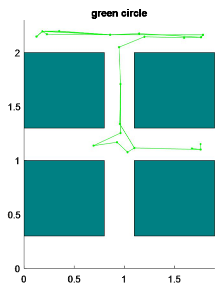


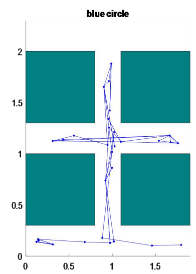


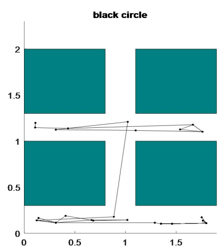
For a more direct visualization of solution path, please refer to the video “rob4_topopaths.avi” that I uploaded.

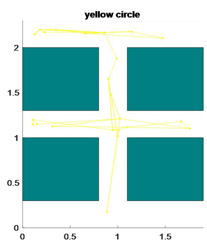
Solution path for 5-robots problem:





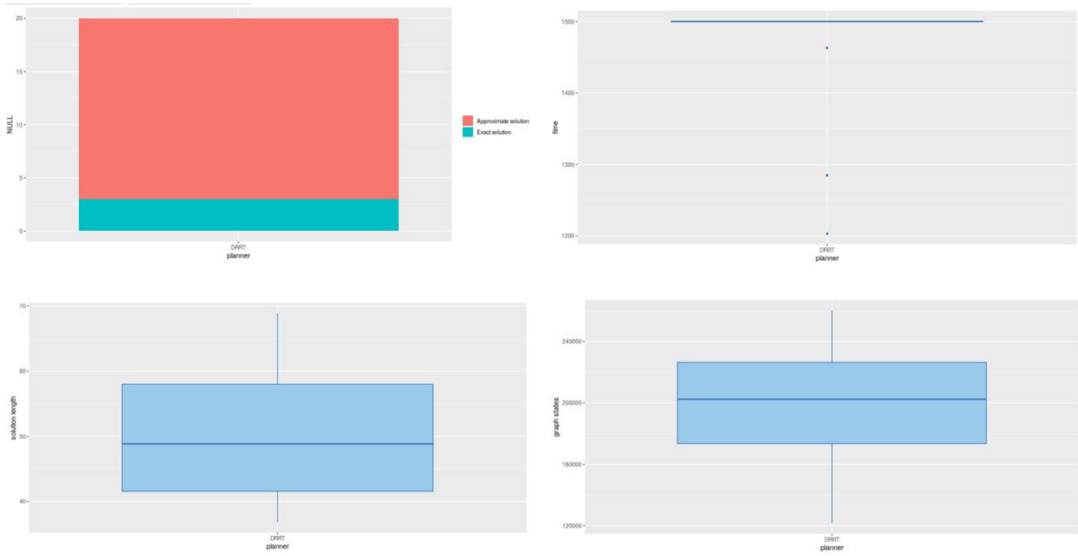




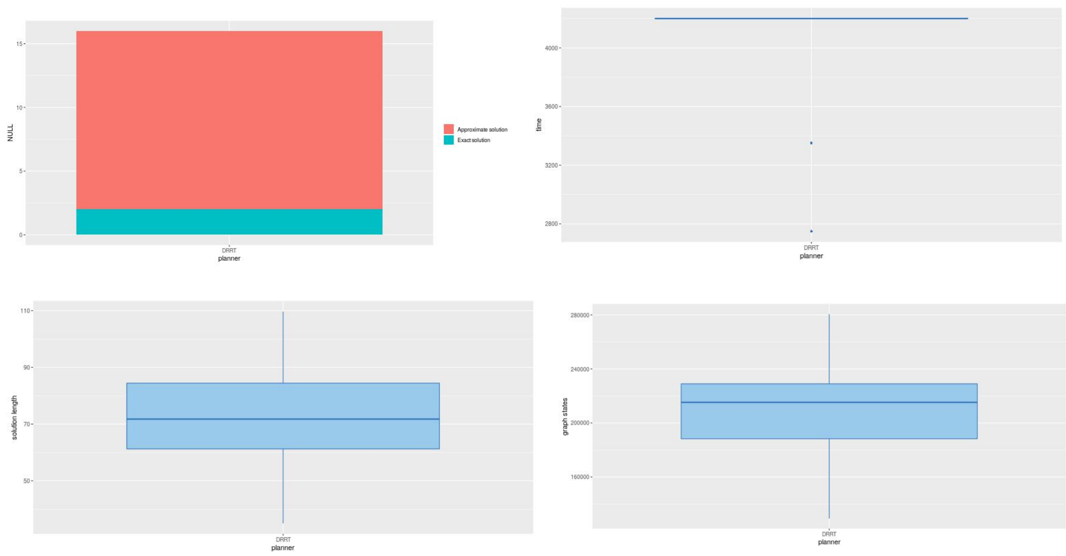


For a more direct visualization of solution path, please refer to the video “rob5_topopaths.avi” that I uploaded.

Benchmark data for 4-robots problem:



Benchmark data for 5-robots problem:



My dRRT is not always able to find a solution. Since the number of vertices of composite roadmap grows exponentially with the number of robots. Even though I just added one more robot, 5-robots problem is much more difficult than 4-robots problem. From the benchmark data, we can see that 5-robots problem takes much more time and explores much more states than 4-robots problem.

From my observation, there is a trade-off between quality of single robot PRM and running time. If the PRM is very dense, it is easy to coordinate the motions among multi-robots but number of vertices of composite roadmap increases. On the other hand, if the PRM is sparse, number of vertices of composite roadmap decreases but it would be more difficult to find a solution.

Reference:

K. Solovey, O. Salzman, and D. Halperin, Finding a needle in an exponential haystack: Discrete RRT for exploration of implicit roadmaps in multi-robot motion planning. In Algorithmic Foundations of Robotics, 2014.