Final Project Proposal

Guided RRT-Connect

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In homework 2 we noticed that though RRT-Connect is usually the fastest method to find a solution, sometimes it is outperformed by RRT. This happens especially when the start position is heavily surrounded by obstacles, i.e., the start configuration is more constrained than the goal. With respect to this issue, the timing of swapping the trees becomes crucial because normal RRT can basically be treated as a special RRT-Connect in which the trees are never swapped. In this project, we would like to develop a strategy to guide RRT-Connect so that instead of swapping tree at every step, the choice can be more informed, and therefore, hopefully, the efficiency and path quality can be further improved. Some studies discussed about guided RRT [1][2], but the main focus is on the strategy of sampling points instead of swapping trees.

Here, we propose two candidate solutions: learning and heuristic searching. The intuition behind learning is that we can pass in the current state and learn an appropriate action for “SWAP” as a boolean. However, since we cannot use supervised learning (SL) because it is hard to provide expert labels, reinforcement learning (RL) would be the ideal choice in which a reward is provided for each action. Nonetheless, RL has convergence issues and if we have a reward, it already means that we have a metric to evaluate our actions. Thus, a suspected superior method would be directly utilizing heuristics to guide the RRT-Connect. The candidate heuristics are shown as following:

(1) Distance to the closest node in the start / goal tree.
(2) Order to be explored when doing RRT-Connect on the same map but without any obstacle
(3) Spread of the two trees

We plan to implement the above suggested methods on problems where RRT-Connect is commonly used as a planner. Such environments can be multi-agent path planning environments or planning for a n-degree of freedom arm. A good choice for simulating our results for multi-agent path planning problem can be CMUSWARM. Also, for visualizing our results, if we choose to do planning for a n-degree of freedom arm, we can either use the simulation tool which we used in HW2 or use V-Rep.

Reference

[1] W. Xinyu, L. Xiaojuan, G. Yong, S. Jiadong and W. Rui, "Bidirectional Potential Guided RRT* for Motion Planning," in *IEEE Access*, vol. 7, pp. 95046-95057, 2019. doi: 10.1109/ACCESS.2019.2928846. https://ieeexplore.ieee.org/document/8763966

[2] Tahir, Zaid et al. “Potentially Guided Bidirectionalized RRT* for Fast Optimal Path Planning in Cluttered Environments.” Robotics and Autonomous Systems 108, 2018: 13–27. Crossref. Web. https://arxiv.org/abs/1807.08325