

Paper Review

Hierarchical Task and Motion Planning in the Now

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October 20, 2021

1 Paper Summary

This paper presents a recursively hierarchical planner that integrates both task level planning and motion level planning. They formulate the planning problem as meeting a conjunction of conditions, or fluents as they call it. Each condition might be achieved through achieving its pre-conditions and some primitive action. The planning process search from the most abstract goal state condition, and builds up a hierarchical planning tree where the less abstract sub-goals are generated to meet the pre-conditions. The length of the planned execution is somewhat minimized by finding the sub-goal with the weakest pre-conditions (easiest to achieve). The lowest level action planner uses sampling based method such as RRT to generate the motion of the robotic manipulator, while tightly integrated with hierarchical task planner. The author also conducted experiments by hand designing a set of conditions and primitive actions and the relationship among each other under the setting of commonly seen indoor cleaning tasks. The results has shown that their hierarchical planner is capable of planning for complicated multi-sequence tasks in long horizon.

2 What I Learned

1. Long-sequence task planning problems can be modeled with hand designed hierarchical task dependence, while the plan can be generated through search algorithms on such hierarchical dependence tree.
2. The length of the planned task sequence can be optimized by meeting sub-goals with the weakest pre-conditions.

3 Opinions

3.1 Up Votes

- I like how they walk through a concrete design of the hierarchical planner they are proposing. The walk through of planning the problem of cleaning dishes in the room really made the abstract mathematical definitions of those fluents, operators, and goals very easy to follow.
- I also like how they provided proofs for the completeness and correctness of the proposed hierarchi-

cal planner. This is crucial for real-world deployment as it provides certain level of guarantees on successfully finding feasible plans even for complicated long-sequence tasks.

3.2 Down Votes

Even though they mentioned in the very beginning that the states are three dimensional, their illustrations are pretty much two dimensional. I think they over simplified many real-world geometries such as dishes and dish washers. For example, planning for grasp pose on dishes and bowls alone is quite a challenging task, but here they are simplified as simple polygonal objects. Dish washer is abstracted simply as an area in this paper, but in reality could have complex geometries to deal with.

4 Evaluations

The goal of this paper is to present a planning methods that tightly integrates task level planning and motion planning. This is a valid objective because until the time of this work, there has been a long standing challenge for combining task planners and geometric motion planners and taking the complementary strength from both types of planners. This work delivers their goal by bringing forth a formally treated design of hierarchical planning system that is capable of planning long horizon multiple-sequence tasks.

The overall quality of this paper is great. They did deliver a formal representation of such hierarchical planning system that can both be implemented and be proven complete and correct. However, one implicit assumption for this method to work is that there is some well defined (also fixed) relationship among some pre-defined sub-goals. Normally, for one specific task such as cleaning dishes with a dish washer, those sub-goals and their dependency with each other are well defined and easy to design. For more complex day-to-day routines, different people may have different preferences, and therefore different things can be done with different ways and in different orders. It will then become very difficult to hand engineer the task dependencies for those more complicated situations. Another thing that this method fall short of is that it assumes the knowledge of the full states of the world as well as the robot manipulator. This is to-date still unrealistic given estimation under unknown environment is still a challenging open questions to be solved.

5 Questions

1. How do they define the sub-goals with the "weakest" pre-conditions? Is it with the least number of pre-conditions?
2. I am a little confused about what they meant by "postponing" a pre-condition.