Tightly-coupled Task+Motion Planning with PDDL+?

HAPS planning problem is a combination of subproblems: (1) a time-dependent multi-vehicle routing problem, (2) a classical (task) planning problem and a (3) kinodynamic motion planning problem.

PDDL+ (Problem Domain Definition Language) can formulate mixed discrete-continuous planning problems that can be solved with compatible planners.

While the formulation of subproblems (1) and (2) in PDDL+ are more commonly known, the formulation of subproblem (3) is not. Fig. 4 outlines how a kinodynamic motion planning problem can be mapped to PDDL+ while the figure on the right shows the one-step task and motion planning (TMP) architecture intended. TMP is “tightly-coupled”, as the search spaces are merged.

Validation and Performance Benchmarking

Performance tests on the integrated task and motion planning approach against the previous sequential planning framework, in which a complete task plan is generated to be “refined” by the numeric motion planner. The integrated approach has a higher success rate for generating feasible plans within an imposed planning time, with comparable plan quality (i.e. comparable number of PoI monitored) within a given planning horizon.

Conclusion and Future Work

This work has exhibited the advantages of combining search spaces of different granularity levels to solve a complex real-world planning problem. As future work, the framework can be made more generic, in order to be aligned with the “domain-independent” nature of the PDDL+ planner (i.e. ENHSP). This can be done by:

- Including an interface to the framework for defining domain-dependent meta-heuristics.
- Using a domain-independent “stitching” method while improving the plan locally by “removing” and “inserting” a new task assignment.