Abstract

Path planning aims at navigating a robot from an initial configuration to a goal configuration without violating various constraints. The problem of path planning is theoretically intractable (PSPACE hard), but in everyday life we (as human beings) navigate in our environment without much difficulty. This is partially due to the fact that most objects we encounter today are similar or identical to the objects we encountered yesterday or even years ago. Environments with similar objects are quite common. For example, desks and chairs in a classroom or in an office may be moved around from one place to another frequently, but unfamiliar items are seldom introduced. A dynamic environment where obstacles are allowed to move can be considered as a continuous sequence of similar static environments due to motion coherence. We term "discrete similar-workspace problem" for static environments and "continuous similar-workspace problem" for dynamic environments. In this thesis, I designed path planners that address both problems. These planners significantly improve not only the efficiency but also robustness over existing planners.

More specifically, I have developed a path planner which exploits similarity across different static environments. This planner can remember and reuse the computation for every obstacle encountered. To address the "continuous similar-workspace problem", existing methods have explored the temporal coherence (i.e. similarity). However, all these methods repair blindly and periodically at fixed time intervals with little attempt to analyze the similarity across different time instances. This results in either redundant updates or failure to detect invalid edges and nodes. To address these issues, I designed two path planners for dynamic environments which can detect critical events such as the topological changes in configuration space for known environments or predicted collisions amidst obstacles with unknown motion. The experimental results show that our planners which explore similarity across different environments not only provide significant time efficiency, but also improves the chances of finding a solution.