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FLEXIBLE EXECUTION OF TEMPORAL PLANS WITH UNCERTAINTY FOR AUTONOMOUS SPACECRAFT

Abstract

In current and future space applications, on-board autonomy is needed for spacecraft operation. In traditional telemetering and remote control method, predefined sequences of executed commands are made on the ground and can fulfill the needs for satellites in predictable contexts. However, this approach is not suitable for spacecraft operating in partially observable, unknown or unpredictable environment, such as deep space exploration. In such a case, robust plan execution is a key technology to operate robustly dealing with context uncertainty outside ground contact, based on flexible plans generated by a planner.

In order to support autonomous operation of deep space probe and funded by National Natural Science Foundation of China, this paper focus on a robust execution strategy of temporal plans with uncertainty for autonomous operation. First, a control framework of execution is proposed and control cycles are given to determine advancement of time and reactivity frequency. In the framework, executable time and temporal constraints are represented by simple temporal network with uncertainty to check dynamic controllability. Then, causal relations between actions are transformed into conditions on arcs in the network, which can represent logic relationship among executable operations of the probe. Next, three types of actions are defined including controllable, uncontrollable and partially controllable actions, to describe uncertainty from environment and system. At the same time, relate different strategies to control these actions are given for the achievement of flexible execution. Finally, experiments on domains about deep space exploration are run and results indicate our technology can improve the robust of execution and further guarantee the achievement of mission goals.