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Author: Mr. JinTao Li
Northwestern Polytechnical University, China

Prof. Zhanxia Zhu
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China
Dr. Mingming Wang
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University, China
Prof. Jianjun Luo
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China

AN EFFICIENT PDDLSTREAM-BASED TASK AND MOTION PLANNING METHOD FOR CHINA SPACE STATION MANIPULATOR

Abstract

The action sequences obtained by Task and Motion Planning (TAMP) are a prerequisite for China Space Station Manipulator (CSSM) operation. How to model and solve TAMP problems is the basis of obtaining implementable action sequences that satisfy the constraints. As a general TAMP modelling language, PDDLStream can effectively describe the TAMP problem of CSSM. For solving TAMP problem, conditional generators are introduced to satisfy constraints by solving the continuous action parameters. However, the efficiency of solving TAMP problem will be affected by the relationship between action parameter solving and action sequence planning. The time required for motion planning for CSSM is much longer than the solving time for inverse kinematics. To this end, we propose a Mild algorithm for TAMP of CSSM considering different constraints, according to the characteristics of long-short-term for solving the continuous action parameters. The main contributions of this paper are TAMP problem modelling and solving. During TAMP modelling, the conditional generators are classified based on the different solving time of action parameters. The inverse kinematics solving conditional generator with short solving time is defined as the short-term condition generator. The motion planning conditional generator with long solving time is defined as the long-term condition generator. During TAMP solving, the short-term conditional generator is employed to solve the configuration parameters of CSSM which will result in a plan skeleton. Then, the long-term conditional generator is employed to generate the motion trajectory given the plan skeleton. The employment of short-term conditional generator will reduce the probability of re-planning while the plan skeleton can reduce the number of calls of the long-term conditional generator, thus improving the overall planning efficiency for solving the TAMP problem. The algorithm is verified via a space station segment transposition task. Compared with Incremental algorithm, the planning time is reduced by 242.18s and approximately 93.87%. Compared with Optimistic algorithm, the planning time is reduced by 5.266s and approximately 25.03%. Consequently, The simulation results illustrate that our proposed algorithm shows higher planning efficiency than compared algorithms when solving the TAMP problem of CSSM.