Paper ID: 77173
student

IAF SPACE OPERATIONS SYMPOSIUM (B6)
Interactive Presentations - IAF SPACE OPERATIONS SYMPOSIUM (IP)

Author: Mr. Junhui Zhou
School of Aerospace Engineering, Beijing Institute of Technology, China

Prof. Rui Xu
Beijing Institute of technology(BIT), China
Ms. Zhaoyu Li
Beijing Institute of Technology, China

A DECENTRALIZED APPROACH FOR MULTI-SPACECRAFT MISSION PLANNING

Abstract

More and more space missions require multi-spacecraft cooperation, such as multiple spacecraft attitude adjustment for laser communication, multi-satellite continuous Earth observation, multiple lunar robots cooperative transporting and assembly tasks, etc. . Classical planning techniques have been used to solve many long-term maintenance and scheduling problems of spacecraft. Multi-agent planning technology aims at solving the similar problems by treating each spacecraft as an agent and fulfilling the common goals through the cooperation among the agents. Planning for multi-spacecraft system is a complex problem, and one of the biggest challenges is how to deal with the cooperative constraints between activities of multiple spacecraft. However, the current research still lacks the consideration of cooperative activities leading to difficulty in applying to practical missions. Instead, the main contribution of the paper is explicitly representing the cooperative constraints between spacecraft activities in the planning domain model and using multi-agent planning technology to generate plans in line with the cooperative constraints. In this paper, we propose a decentralized multi-agent planning method based on activity tagging, that is, cooperative activities and constraints are tagged. Given a multi-spacecraft cooperative task, our method firstly assigns each task goal to specific spacecraft. The goals include private goals (which can be accomplished independently by a single spacecraft) and public goals (which require the cooperation of multiple spacecraft) . Next, based on the constraint relaxation theory, the chosen spacecraft (agents) solve problems individually to fulfill the private goals they received by ignoring the interactions (with the help of tags) arising from other agents. Then, agents accomplish the public goals synergistically and generate new plans by exchanging information (i.e. a subset of plans, states, activities, constraints and goals) through communication between spacecraft. We perform extensive sets of experiments in domains relative with multi-spacecraft cooperation and the results show the effectiveness of the proposed method.