Paper ID: 70575
oral
student

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

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HIERARCHICAL REASONING ALGORITHM WITH COUPLING TEMPORAL CONSTRAINTS FOR FLEXIBLE LANDER

Abstract

China is about to implement an asteroid sample return mission, and a stable landing is the key to mission success. However, a major challenge in the field of asteroid detection is the safe and stable landing of the probe in the complicated environment of irregular weak gravitational field and complex surface terrain. Therefore, our team developed a multi-body lander wrapped in a flexible structure to absorb impact energy and prevent the lander from rebounding during landing. Each body is a little probe with similar functions. Because these probes are physically connected, their activities will have an impact on one another. Compared to discrete systems, these probes are subject to a higher degree of coupling in terms of temporal constraints when performing mission planning in the track, and achieving fast processing of temporal constraints is a major challenge. In order to address the problem of the large number of nodes in the temporal constraint network, we proposed a coupled temporal constraint hierarchical reasoning method. First, according to the characteristics of the lander, we established a "Probe-System-Action" hierarchical temporal constraint processing architecture. The systems are defined as local agents contained in the probes, whereas the probes are defined as global agents. Considering the privacy of agents, the temporal constraints are divided into two categories: shared and private, and then the simple time network of each intelligence is partitioned. Next, the lower layer shared temporal constraints are used in the upper layer to construct a shared temporal constraint network that prioritizes the coordination of abstract task times. Then, the consistent time network is input to the lower layer, and the time is allocated to the private network of each agent. Once a time conflict occurs in the lower layer, the result is returned to the upper layer for time adjustment. Finally, a landing scenario is set up and experiments are conducted with the 2016HO3 asteroid planned to be detected by China as the target, and the results show the effectiveness and rapidity of the algorithm. The method effectively reduces the size of the temporal constraint network and takes into account the privacy of the agents at the same time.