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MULTI-AGENT PLANNING UNDER COMPLEX CONSTRAINS FOR SMALL PROBES GROUP IN DEEP-SPACE EXPLORATION TASK

Abstract

The complexity and unknown nature of deep space environment bring challenges to the safe operation of the probe. In a deep space exploration mission with only one probe, once the probe is damaged by space debris impact or other factors, it may be difficult to repair and lead to mission failure. With the development of launch technology and the miniaturization of probe, multiple small probes and even probe swarm can be used in a single exploration mission to deal with the risk of probe failure. In order to make full use of the capability of each probe and reduce the waste of resources, rational planning is necessary when multiple probes are used to perform tasks. In this artical, a dynamic distributed multi-probe group formation mechanism is designed, which is based on the communication links between probes.If a probe is chosen to be the leader, it will plan for all probes in the group. A multi-agent planning method based on negotiation and complex constraints check is used to plan the observation and ground communication actions of probe. Two kinds of agents are established in the planner. Each probe is an execution agent, and each space target that needs to be observed is a target agent. Probe time constraints, storage constraints and energy constraints are considered in the planning. The planning process is divided into three phases. The first phase is greedy task allocation in which each target agent evaluates the obsevation time windows it has and sends the best window to the corresponding task execution agent as a observation task. The second phase is task negotiation in which two kinds of agents send messages to each other to negotiate the allocation of obsevation windows. Meanwhile, execution agents check the time constrains of the tasks. In the third phase, storge and energy constrains checking algorithms are designed to check the constrains for execution agents. At the same time execution agents selects data transmission tasks according to the situation of constraints satisfaction and abandon the observation task who violates constraints. The experimental results show that the proposed multi-agent planning method can obtain rational plans satisfying complex constraints for the small probe groups.