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# DISTRIBUTED COLLABORATIVE TASK PLANNING ALGORITHM FOR EARTH OBSERVING CONSTELLATIONS BASED ON DEEP LEARNING

**Abstract**

Satellite constellations can break the limitations of single satellite in payload capacity and orbital maneuverability, providing multivariate functions and wider coverage areas. Earth observing constellations are playing an increasingly crucial role in disaster relief efforts such as storms, earthquakes, and forest fires. Due to high unpredictability of these missions, the observation requirements are always uncertain, which makes higher demands on the timeliness and adaptability of multi-satellite cooperative task planning. A distributed collaborative task planning algorithm for earth observing constellations based on multidimensional tensor state graphs is proposed in this paper. With designing states, it is Innovative to utilize multidimensional tensors to describe system states and extend satellite usage constraints as a third-dimensional variable on the basis of two-dimensional states of satellites and task observation windows. This method comprehensively considers various constraints, such as satellite resources and task information, making the algorithm more closely aligned with practical applications. With designing actions, the complete tasks are decomposed to visible window selections and observation period calculations as action spaces. Then the observation planning results for individual targets are systematically generated, which is advantageous in reducing the complexity of the planning model. With designing environment, the algorithm feeds back the planning results for individual targets into the state graph, facilitating the updating of satellite resources and task information. This process ensures the satisfaction of task constraints while avoiding conflicts in the planning results. With designing reward, the algorithm calculates a reward function based on metrics such as target value and observation quality. This reward function guides the optimization process of the planning algorithm. The design of these elements enables

the algorithm to adaptively accommodate dynamic changes in the number of satellites, thereby ensuring scalability.Comparison with traditional heuristic task planning algorithms demonstrates significant advantages in optimization capability and quick convergence ability, making it better suited for highly dynamic and strongly uncertain environments.