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MULTI-SATELLITE COOPERATIVE TASK PLANNING AND SCHEDULING FOR REGIONAL TARGET OBSERVATION

Abstract

As a current research hotspot in the aerospace field, the success of remote sensing satellites in operation and application is closely tied to task planning and scheduling. With the proliferation and complexity of regional satellite constellations, research on multi-satellite cooperative task planning and scheduling has emerged, offering the potential to optimize satellite resource utilization, enhance task efficiency, and improve data quality. This holds significant implications for the advancement of remote-sensing satellite technology.

Aiming at the regional targets observation challenges of co-orbit heterogeneous payload satellite constellation, this paper introduces a method for multi-satellite cooperative task planning and scheduling. Initiating with considerations for the field of view payload and attitude manoeuvrability of satellites, the analytical form of the detection limit for satellites concerning regional targets is derived. This derivation forms the basis for calculating satellite visibility towards regional targets. Addressing large regional targets involves introducing a central projection transformation, converting the problem of spherical polygon intersection into a planar polygon clipping problem. This, combined with a spherical polygon area algorithm, facilitates efficient and precise coverage of a given region.

Subsequently, focusing on the characteristics of a satellite constellation with heterogeneous payloads in the same orbit, a fundamental description and assumptions for the multi-satellite cooperative task planning and scheduling problem are presented. The mathematical model is established with an emphasis on minimizing scheduling time and the number of utilized satellites. Leveraging the Particle Swarm Optimization algorithm introducing the initial feasible solution generated by the greedy algorithm and resampling, also known as the GRPSO (Greedy Resampling Particle Swarm Optimization) algorithm, along with the Greedy algorithm and the Improved Genetic Algorithm, solution frameworks for the problem are constructed. Simulation instances are employed to compare the best fitness, completion time, and memory usage among these algorithms, facilitating the selection of the most optimal solving algorithm.

The simulation results show favourable scheduling outcomes, thereby validating the effectiveness and practicality of the mathematical models and solution algorithms, particularly under dynamic conditions.