Paper ID: 65858
student

28th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Constellations and Distributed Systems (7)

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A PATH PLANNING METHOD FOR ENCIRCLING NON-COOPERATIVE SPACE TARGETS BY MICROSATELLITES CLUSTER

Abstract

Using space microsatellites cluster is a new development direction of in-orbit service technology to clean up failed space targets ,recover the movement ability of failed space targets or perform monitoring tasks .Reasonable planning path of the micro-satellite cluster approaching to non-cooperative targets will become the foundation for the development of this new direction .Accordingly ,a new method for capturing dynamic non-cooperative targets is proposed in this paper, and on this basis, a collaborative path planning method for multi-micro satellite clusters considering collision constraints, field of view constraints and dynamic constraints has been proposed. Firstly, the initial configuration is generated for the micro-satellite cluster acquisition task based on the space non-cooperative target specification, and the final configuration of the micro-satellite cluster is designed according to the constraints. Secondly, based on the discrete relative dynamics model, the dynamic encirclement configuration of the micro-satellite cluster is designed according to the target position and pose motion law, and the path planning problem is transformed into a nonlinear programming problem. Thirdly, according to the distribution characteristics of satellite formation flight, a coevolutionary particle swarm optimization method is proposed to solve the cluster path planning problem. On the one hand, the improved Particle swarm optimization (PSO) enables each particle to satisfy the satellite dynamics constraints, which improves the planning efficiency and accuracy. On the other hand, each satellite is given a particle swarm, which enables the satellite to be optimized independently, further improving the planning efficiency, and achieving collision avoidance by exchanging position information at a fixed time. In the environment of multiple obstacles, collision avoidance is realized by the combination of repulsive ball and cost function. Finally, the effectiveness and applicability of the proposed planning algorithm are verified by the simulation of the dynamic non-cooperative target in the encirclement space of micro-satellite cluster in the environment with obstacles. The advantage of the proposed path planning algorithm is that it greatly reduces the computation amount of the collaborative path planning method of the micro-satellite cluster, and overcomes the shortcomings of the particle swarm optimization algorithm in solving the constrained optimization problems, such as poor processing power and long computation time, which provides technical support for the on-orbit service path planning task of the micro-satellite cluster.