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COOPERATIVE GUIDANCE FOR MULTIPLE IMPACTORS AGAINST MULTIPLE ASTEROID DEBRIS

Abstract

With the threat of asteroids impacting the Earth being taken seriously, asteroid defense has become an important topic in the area of aerospace. Kinetic impact can disintegrate the asteroid or deflect the orbit of asteroid. In the case of a short warning time and the proximity of the asteroid to the Earth, disintegrating the asteroid through kinetic impact is an effective way to dispose of an asteroid. The asteroid may be broken up into multiple debris after the kinetic impact, and the large debris are still at risk of impacting the Earth. Therefore, the secondary impact of the multiple debris is necessary, and a cooperative guidance method focusing on multi-targets impact is required. In a coordinated impact mission, the tiny fragments generated in the vicinity of the targets affect the flight of the impactors on the secondary impact, and the flight paths of the multiple impactors may conflict. Thus, the cooperative guidance method needs the capability of collision avoidance and obstacle avoidance. In this paper, to achieve the secondary impact for multiple targets, a cooperative guidance method is proposed. The method consists of a multiple warning region of collision, a constraint neural network and a multi-agent reinforcement learning algorithm. First, to avoid the collisions of the impactor with obstacles and other impactors, a multiple warning region of collision is designed, and the collision avoidance constraints can be described. Then, to improve the adaptability of guidance with the obstacle avoidance constraints changed dynamically, a constraint neural network is built. On this basis, the multi-agent system is constructed, and the agents are trained using the multi-agent reinforcement learning. The cooperative guidance commands for multi-impactors are generated by trained agents. Finally, the proposed method is simulated in the scenarios with fixed and dynamic obstacles. The simulation results of the fixed obstacle scenario show that the method can avoid the collision of the impactors with obstacles and accomplish the cooperative impacts on multiple targets. The simulation results of dynamic obstacle scenarios show that the method can be applied to a multi-targets impact task with uncertain obstacle.