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TASKS-PRIORITY BASED COLLABORATIVE GUIDANCE SCHEME FOR AUTONOMOUS RENDEZVOUS AND DOCKING WITH SPACE NON-COOPERATIVE TARGET

Abstract

Autonomous rendezvous and docking with a space non-cooperative target has attracted widespread attention from various countries and organizations around the world, such as space debris removal, failed satellite maintenance and so on. To fulfill these missions successfully, the following basic tasks should be carried out: (1) no collisions occurs between the service spacecraft and the target during the final proximity process, which is viewed as the precondition of all the subsequent operations; (2) arrival at the docking position and attitude of the target, i.e., the service spacecraft finally reach the desired position with desired attitude; (3) velocity synchronization with the target, which implies that the service spacecraft should tracking the tumbling motion the target during the whole rendezvous and docking process. To tackle the accomplishment of these basic tasks, this paper proposes a tasks-priority based collaborative guidance scheme, which can avoid the conflict among different tasks during the whole proximity operations. Firstly, we assign a relative priority to each basic task and design different guidance commands. Specifically, to realize the collision-avoidance requirement, an elliptic cissoids is introduced to represent the safely approaching corridor, and based on this, a proper artificial potential function is established to ensure the safety of the service spacecraft and the target. Then, the position tracking and attitude synchronization requirement is derived by using Lyapunov methodology. Among these tasks, the collision-avoidance task is assigned with highest priority, and the other two tasks refer to the lower priority accordingly. Subsequently, the guidance strategy of the low-priority task is projected to the null space of the higher-priority task, which results into the compromise collaborative guidance scheme. In this way, the multiple basic tasks can be integrated simultaneously, and avoid any unwanted conflict among the tasks. Finally, simulation scenarios are performed to verify the effectiveness of the proposed scheme. The results show that the proposed guidance scheme can enable the service spacecraft to rendezvous and docking with a non-cooperative target while complying with the approaching corridor strictly.