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THE INTEGRATED DYNAMICS MODELING AND COUPLING ANALYSIS FOR ORBIT AND ATTITUDE OF SPACECRAFTS

Abstract

The traditional spacecraft dynamics model usually describes the orbital and the attitude motion separately, and does not take into account the coupling effect between the two parts of the motion. Therefore, the motion characteristics of the spacecraft can not be truly characterized, and for some special space missions, tumbling target docking, debris cleaning, small aircraft and large spacecraft docking,etc., which may not use inertial spindle docking, so it is need to establish a non-centroid relative motion model. For the dual quaternion established relative motion model, its orbit and attitude is coupled with each other, it can play model's maximum value in the model application by comprehensive analyzing the coupling mechanism and the process of influence. Therefore, aiming at the problem of orbital and attitude coupling during the close operation of the spacecraft, the relative posture integrated model of centroid(RPMC) is established based on the dual quaternion and the basic principles of mechanics. Meanwhile, considering the effect of non-centroid docking on the posture coupling, the relative posture integrated model of non-centroid(RPMNC) is also constructed. Then, the posture coupling of the two models is analyzed by the control variable method. The physical causes of coupling are defined and the key coupling parameters are determined. And the influence of the coupling terms in the two models on the relative posture of the spacecraft and are analyzed by changing the modulus and dimension of the coupling terms. The simulation results show that the additional moments and gravity gradient moments generated by thrust eccentricity are the main causes of relative posture coupling. The angular velocity of the target spacecraft has a great influence on the relative angular acceleration. With the increase of the angular velocity and the dimension of the target spacecraft, the size and modulus of the relative angular acceleration are increasing. The size and dimension of the angular velocity of the spacecraft will have an effect on the relative acceleration. As the angular velocity of the chasing spacecraft is increased, the relative acceleration is also increasing. And the effect of RPMNC is greater than that of RPMC. the effect

of angular velocity on the relative acceleration of the target spacecraft is similar to that of the angular velocity of the chasing spacecraft. In addition, the relative angular velocity has a great influence on the relative acceleration. With the increase of the relative angular velocity, the relative acceleration is also increased, and the influence effect is more obvious than the effect of the angular velocity of the chasinging and target spacecraft, and the effects of the two models have the same effect; For eccentricity, the effect of the relative orbit on the two models is small,which can be neglected.These results can provide a reference for the design of the relative posture coordination control system.