Trajectory Optimization for The Proximity Rendezvous Operation Considering The Relative Navigation Error

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Descrizione

Autonomous spacecraft proximity operation is demanded to achieve future missions, such as in-orbit servicing, active debris removal, object inspection and in-orbit assembly. The relative navigation is one of the factors which affect the overall performance and reliability of the rendezvous. Generally, the relative navigation sensors such as cameras with image processing or LiDAR are used to obtain the relative position or the attitude. However, when rendezvous to the non-cooperative target, the relative navigation at the proximity will be unstable and navigation performance is easily deteriorated by absence of illumination, shadows, strong reflection from the target, shape and surface of the target, etc. If the worst condition for navigation, the solution will be unstable and contains larger error, and in the worst case, the solution cannot be obtained. Those large error or absence of the navigation directly leads to the failure of the rendezvous and forced to rendezvous from the beginning again. In order to avoid the unstable navigation, the trajectory which can expect high reliability and precision navigation needs to be obtained. Hence in this research, the trajectory optimizing the relative navigation accuracy is studied. The two relative navigation accuracy model was adopted for general image processing with single camera toward the small satellite and LiDAR based matching toward the used rocket body. The simulation results revealed that the optimized trajectory is obtained for both cases and both cases had the low navigation error expectation throughout the rendezvous process. The proposed approach can be used for any relative sensors as long as their performance is evaluated beforehand.

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