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NOVEL AUTONOMOUS ORBIT DETERMINATION METHOD FOR LUNAR RENDEZVOUS AND DOCKING

Abstract

Autonomous rendezvous and docking in lunar orbit is a key technology in order to take back lunar soil sample from the moon to the earth by unmanned lunar spacecraft. In the lunar RVD flight process, not only relative navigation system is needed, which can provide relative position and velocity estimations based on rendezvous sensors (such as rendezvous radar, etc), but also absolute orbit elements both of chaser and target spacecrafts are necessary to be determined, which can be used as the attitude point of reference and backup of relative navigation. Optical imaging sensor is a good way to determine the absolute lunar orbit elements. But optical imaging sensor is only valid in lunar day. It is necessary to find another autonomous way to determine absolute orbit in lunar night. Psiaki has proposed that absolute orbit elements both of two spacecrafts can be determined by relative position measurements, but the determination precision is poor when the chaser is gradually approaching to the target. In this paper, a novel lunar autonomous navigation method used in rendezvous and docking process is proposed. In lunar day, the navigation filter based on optical imaging sensor is used, and another filter which uses measurements from rendezvous radar and laser altimeter will be applied in lunar night. Both of filters are designed by Unscented Kalman Filter(UKF), and the observability of this navigation method is also analysed in depth. Mathematic simulation results show the validity of this new method.