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RELATIVE ORBIT DETERMINATION FOR FRACTIONATED SPACECRAFT BASED ON EXTENDED KALMAN-PARTICLE FILTERING

Abstract

Fractionated spacecraft is a creative concept for distributed spacecraft, which has wide application in the Earth observation and deep space exploration, such as system F6, Darwin, LISA and TPF. The high precision relative state estimation based on the obtained absolute and relative measurements is an enabling technology for the cluster formation flying.

Firstly, the relative dynamics equations for the fractionated spacecraft in the inertial frame are established, which can conveniently incorporate various kinds of perturbations. Secondly, laser measuring instruments and radiofrequency ranging equipment are adopted as the relative measurements, which can measure the relative range and angles of the fractionated spacecraft. Then, the algorithms based on the combination of the particle filter and extended Kalman filter are used to estimate the relative state. The calculation process includes the initialization, importance sample and resample, and the sample-importance-resample (SIR) particle filter algorithm is realized. The algorithm can not only generate the particle importance density function by the extended Kalman filter, but also avoid the particle exhaustion problem. Finally, the numerical simulation is carried out. The simulation conditions are as follows: the reference orbit altitude is 500km, the absolute position measurement precision is 10m, the absolute velocity measurement precision is 0.1m/s, the relative range measurement precision is 0.1m, and the relative angle measurement precision is 0.0001rad. The simulation results show that the relative position estimation precision is better than 1e-2m, and the relative velocity estimation precision is better than 2e-4m/s.

This paper presented the relative orbit determination method for fractionated spacecraft based on the extended Kalman-particle filter. The simulation results indicate that the algorithm is effective to improve the relative state estimation precision.