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GPS-based Orbit Determination for LEO Using AKF Bidirectional Filter

Xian-ping QIN and Yuan-xi YANG
(qinxianping1975@163.com)

In the paper, the principle of GPS-based orbit determination for low earth orbiter (LEO) using adaptive Kalman filtering (AKF) is introduced. The difference of AKF with reduced dynamic technique (RDT) in LEO precise orbit determination (POD) is analyzed. The arithmetic of using bidirectional filter to improve AKF and RDT POD is put forward. Adopting AKF bidirectional filter and RDT bidirectional filter[U+FF0C]two GRACE satellites orbits are determined by using the on-board GPS data observed from March 31 to April 4, 2004.
When the orbits of two GRACE satellites are computed, the IERS Convention 2000 is closely followed. The EIGEN2 gravity model is employed. JPL planetary ephemeris DE403/LE403 is adopted. DTM94 is used as the empirical atmospheric density model. A simple ball model is used to compute solar radiation pressure. The zero-differenced ionosphere free carrier phase observations (taken at the 30 second processing interval) is processed when using AKF/RDT bidirectional filter to compute GRACE satellites orbits. When using RDT bidirectional filter POD, the total size of the filter state is always equal to 12+n, which including 6-dimensional spacecraft state, 3 empirical accelerations, 1 atmospheric drag coefficient, 1 solar radiation pressure coefficient, 1 receiver clock offset and n ionosphere free carrier phase biases. While the total size of the filter state is always equal to 7+n, which including 6-dimensional spacecraft state, 1 receiver clock offset and n ionosphere free carrier phase biases, when satellite orbit determination using AKF bidirectional filter.
The results are compared with the orbits provided by JPL and independently validated with satellite laser range (SLR) data. By comparison and analysis, we find that when satellite orbit determination using AKF bidirectional filter, the orbit precision of GRACE-A and GRACE-B is better than 10 cm in 3-Dimension position, and is about 5 cm in radial(R), transverse(T) and normal(N) direction respectively. We also find that the influence of the measurement outliers on AKF bidirectional filter POD is less than that on RDT bidirectional filter POD. The results of AKF bidirectional filter POD are more smoothed than the results of RDT bidirectional filter POD. The precision of the orbit from the EKF bidirectional filter is better than that from the RDT bidirectional filter.

Keywords: Global Positioning System, low earth orbiter, satellite orbit determination, adaptive filtering