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NOVEL ORBIT IMPROVEMENT METHOD THROUGH PSEUDO RELATIVE MOTION ANALYSIS

Abstract

A novel method for orbit improvement is proposed in this paper. The proposed method can further improve the orbit determination accuracy by reprocessing filtering data of classical orbit determination methods, such as least-squares method and Kalman filter. The key idea of the proposed method is pseudo relative motion analysis.

The output filtering data of classical orbit determination method is used as observation orbit of the proposed method. Prediction orbit can be obtained through propagation of observation orbit. The pseudo relative motion is the difference between observation orbit and prediction orbit in relative coordinate system. The pseudo relative motion follows the law of orbit relative motion, and is consistent with the Hill-Clohessy-Wiltshire equation, which includes the constant, secular, and periodic components. Frequency analysis and nonlinear curve fitting can be used to process the pseudo relative motion data, and extract the magnitude, phase and frequency of different components, which is used to correct the initial orbit determination error.

To validate the feasibility of the proposed orbit improvement method, autonomous geomagnetic navigation for low Earth orbit is used for numerical simulation. Magnetometer measurement data of ESA SWARM spacecraft is first processed by Kalman filter, and then reprocessed by pseudo relative motion analysis. GPS data of SWARM spacecraft is used as criterion to get the orbit determination accuracy. Autonomous orbit determination accuracy by Kalman filter is about 5 km order using only magnetometer measure data. After reprocessing Kalman filtering output data by pseudo relative motion analysis, orbit determination accuracy can be improved to 1 km order. The proposed method can improve the orbit determination accuracy remarkably.